Prevention of **HEALTHCARE** Associated Infections

Infection Prevention and Control

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Dedication

We humbly dedicate this book to our patients due to whom we continuously endeavour to improve our knowledge and services for providing best healthcare.

Usha Krishan Baveja
Yatin Mehta

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The chapters in the book are contributed by various practicing medical experts. Each chapter reflects the opinion of the author/s of the chapter, based on their expert interpretation of published literature and guidelines on the subject.

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FOREWORD

Healthcare-associated infections (HCAIs) are a global phenomenon, the fact underscored by the current pandemic of SARS-CoV-2 infection. Patients admitted in a healthcare facility/healthcare professionals providing medical care/services and visitors to the hospital, all are at risk of acquiring an infection during their stay in the facility/hospital. The degree of risk varies from facility to facility, country to country, host factors, type of hospital, type of patient population, type of infection prevention and control practices, antimicrobial management, and many other factors. An ever-increasing range of these infections is being caused by the resistant superbugs, namely multidrug resistant (MDR), extensively drug resistant (XDR), pandrug resistant (PDR) (including bacteria, parasites, viruses, and fungi) and newly emerging microorganisms including viruses like MERS and SARS-CoV-2. The misuse of antimicrobials leads to development of resistant microorganisms and transmission of these viruses through laxity in infection control practices like hand hygiene, contact precautions, and airborne precautions. HCAIs caused by such highly resistant newly emerged microorganisms (SARS-CoV-2) are a serious threat to patient's safety and global public health. Such infections result in worse clinical outcomes like death and high cost. New resistant microorganisms and new viruses continuously emerge and spread in the hospital and the community. The appropriate use of antimicrobial agents to prevent emergence of resistant superbugs and a robust infection prevention and control program are the two most important strategies to prevent/contain emergence and transmission of resistant microorganisms and newly emerging viruses like SARS-CoV-2 that cause HCAIs, locally and globally.

A lot of literature and guidelines on infection prevention and control are available in print and on websites. However, most of these pertain to and refer to facilities available in other/developed nations. Medical professionals in developing countries like ours are many a times at loss to decide as to what best can be done in a particular situation/facility within the limited available resources and facilities to control HCAIs.

This book deals with all the relevant details of various HCAIs (including COVID-19) giving risk factors, how and why HCAIs happen, how to treat these, how to break the various links in the chain of infection in the hospital, how to develop, implement, and monitor various infection prevention and control policies, procedures and protocols taking into account the latest published literature and guidelines, and adapting them to our situation.

I am sure this book will be of immense help to experts functioning at different levels of healthcare (primary, mid-level, and tertiary care centers in public and private sectors) in the development and implementation of need-based infection prevention and control program for already existing and newly emerging infections like COVID-19, successfully.

I congratulate Dr Usha Krishan Baveja, a renowned medical microbiologist, Dr Yatin Mehta, a renowned critical care specialist, both also being experienced infection preventionists, and all the expert contributors for their commendable efforts for the book. We hope our doctors will use the book and help to prevent and control the existing and newly emerging (COVID-19) HCAIs in healthcare facilities/hospitals.

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Awarded: Padma Bhushan and Padma Shri

PREFACE

Healthcare-associated infections (HCAIs), the most important preventable inpatient global problem that are adversely affecting the patient safety as well as the safety of care providers. The fact has been amply emphasized by the ongoing pandemic of SARS-CoV-2 infection. The burden of HCAIs is not exactly known in our country. However, there are reports suggesting that HCAIs are an increasing problem associated with adverse patient outcomes including death. Why this is so? Why the HCAIs have become a serious national and global problem?

One important factor for HCAIs is the rapid advances in medical technology and improved delivery of healthcare with the increasing use of devices, implants, and prostheses, particularly in an aging population. Inappropriate use of these inert devices/implants leads to colonization by microorganisms, formation of a biofilm, and finally an infection.

Another factor is the increased life expectancy today, resulting in a large population of vulnerable patients seeking care in hospitals including patients at extremes of age groups, inpatients with devices and implants, patients on immunosuppressive therapy, oncology patients, post-transplant cases, and so on. Such cases stay in the hospital for long period of time, receive multiple antibiotics, and are exposed to hospital superbugs through various means. The device-related HCAIs like central line-associated infections, catheter-associated urinary tract infections, and ventilator-associated events including pneumonia are common in patients with long stay in hospital particularly in critical care. Majority of HCAIs are associated with implantable devices such as catheters.

Inappropriate use of antimicrobial agents in the community as well as in hospitals resulting in the emergence and transmission of superbugs [such as methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant *Staphylococcus* aureus (VRSA), vancomycin-resistant *Enterococcus* (VRE), carbapenem-resistant *Enterobacteriaceae* (CRE), *Pseudomonas aeruginosa* and *Acinetobacter* species, extended-spectrum beta-lactamase (ESBL)-producing *Enterobacteriaceae*, and newer non-*Candida* fungi including *Candida auris*] causing HCAIs is an additional threat to patient safety. Antimicrobial resistance contributes to the treatment failure, complications, and mortality in patients having HCAIs caused by such resistant microorganisms. Emerging zoonotic viral infections like H1N1, MERS and COVID-19 (SARS-CoV-2), for some of which successful treatment prophylaxis and vaccination are not yet available are transmitted in the hospital setting from infected patients to other patients and healthcare personnel, thus adding to the problem.

The availability of a large number of antimicrobial agents led to a false sense of security among clinicians resulting in carelessness in practice of simple infection control measures like hand hygiene and consequent transmission of microorganisms and infections. HCAIs have emerged as a serious threat to inpatient care. This threat can only be challenged through diligent infection prevention and infection control practices and the rational use of antimicrobial agents, antimicrobial stewardship by every healthcare provider in every department of the hospital aimed at prevention of transmission of superbugs and newly emerged viruses like SARS-CoV-2. The present book is a step in this direction.

This book details the basic science of infection, the microorganisms circulating in a hospital, and the antimicrobial agents available including the rational use of these along with antimicrobial stewardship. There are chapters describing A, B, C of various HCAIs including COVID-19 caused by SARS-CoV-2 and how to develop a need-based infection prevention and control program (IPCP) for different levels of healthcare to prevent HCAIs. There are many chapters describing strategies of IPCP including hand hygiene, standard precautions, airborne and contact precautions, sterilization and disinfection, central sterilization and supplies, laundry management, biomedical waste management, and so on. Infection prevention and control in various areas of the hospital for various groups of patients, role of nursing, and role of microbiology laboratory to prevent and control HCAIs are described. There are chapters on investigation of an outbreak, maintenance of occupational health of healthcare professionals (HCPs), maintenance of clean environment, heating, ventilation, and air conditioning (HVAC) system, OTs, ICUs and negative pressure rooms, etc. The latest strategies to prevent infections in different possible situations (ICU, HDU, post transplant units and Burns unit, etc.) in a healthcare facility including the clinical laboratory are described.

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Each chapter has been contributed by experts who are knowledgeable, conversant with the latest knowledge on the subject, and are involved in implementing the program in their respective hospitals. The chapters are structured in a way (with MCQs at the end) that the book can be used for training and education. In addition, there are chapters providing teaching and training materials for prevention of HCAIs including COVID-19 and laboratory-acquired infections (LAIs), respectively.

We have tried to include the details of all aspects of prevention of HCAIs—infection prevention and control in such a way that the reader will be able to understand, develop, and implement the IPCP in his/her hospital and train the HCPs to help contain this menace of HCAIs. We hope the tome will be useful for each and every individual engaged in providing healthcare services to practice infection prevention and control and thus reduce HCAIs in hospitals, hospices and other healthcare institutions.

Usha Krishan Baveja
Yatin Mehta

ACKNOWLEDGMENTS

We thank the God Almighty for blessing us with knowledge, energy, clarity, and continuous support received in bringing forth this book.

We thank our parents and teachers for educating, guiding, and enabling us to think and understand the subject and help to prepare the book to prevent infections and thus improve patient care.

We thank our family members and our friends for their support and helpful suggestions.

We thank each and every author for his/her contribution, for the precise knowledge presented lucidly in the chapters contributed, to enable the readers to understand and implement the practices as relevant to their respective healthcare facilities.

We thank Ms Poonam Anand for rendering secretarial support as and when required.

We are most grateful to Jaypee Brothers Medical Publishers (P) Ltd, the publishers who understood the importance of the subject of healthcare-associated infections and encouraged us to edit this book on prevention and control of these infections. Last but not the least, we express our thanks to the Editorial team at Jaypee Brothers Medical Publishers (P) Ltd for their constant support and suggestions to improve the book.

We hope that the readers will find this book easy to understand and useful, and this will help them to put the knowledge gained into effective infection control practices to prevent and control healthcare-associated infections.

Usha Krishan Baveja
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PRACTICAL PEDIATRIC ENDOCRINOLOGY

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FOREWORD

Pediatric Endocrinology is one of the important emerging specialities of Pediatrics. Endocrine glands affect directly or indirectly all organs of body and may cause organ dysfunction. An early diagnosis of problem is of paramount importance as it helps in early institution of treatment and prevents damage to organs. Pediatricians need to know about various disorders, diagnostic algorithm and treatment of disorders arising out of malfunctioning of endocrine glands. There are books on Pediatric Endocrinology but these are written for specialist training. There is a lack of book that can be a table reference for a Pediatrician.

This multi-author book entitled "Practical Pediatric Endocrinology" is written; keeping Pediatricians as target audience. The authors are well known experts with long experience in managing children with endocrine disorders. They have provided simple algorithmic approach about suspecting, diagnosis, management and monitoring of children and adolescents with various endocrine disorders.

Indian Journal of Pediatrics publishes books to improve child health and survival. We are confident that this book will be of immense value to Pediatric residents, practicing Pediatricians and clinicians with special interest in Endocrinology. It will also serve as an initial reference book for all specialist pediatricians to suspect, diagnose and institute initial management awaiting consultation with Pediatric Endocrinologist.

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Chapter 6

Thyrotoxicosis

Rahul Jahagirdar and Nikhil Lohiya

Background

Hyperthyroidism is a condition that occurs due to excessiv oduction of thyroid hormones by the thyroid gland. Thyrotoxicosis is a dition that occurs due to excessive thyroid hormone due to any cause therefore includes hyperthyroidism. These terms are often used inte angeably.

Hyperthyroidism is a state of thyroid characterized by excess of thyroid hormones including thyroxine (T4) and tri-iodothyronine (T3). It is a less common endocrine problem in children but has significant therapeutic considerations. The most common etiology of hyperthyroidism in children is Graves disease caused due to thyroid stimulating hormone (TSH) receptor activating antibodies.

Pathophysiology

Thyrotoxicosis is caused by either increased production or release of thyroid hormones.

- In Graves hyperthyroidism there are TSH receptor antibodies (TSH-R-Ab) which activate the TSH receptors and cause excessive synthesis and secretion of thyroid hormones (T3 & T4).
- The same antibodies act against the TSH receptor-like protein in retroorbital connective tissue leading to Graves ophthalmopathy.
- There is a family history of autoimmune disorder in patients with Graves disease.
- Release of preformed hormones occurs in thyroiditis, which can be bacterial, viral or immune in origin. They usually do not have the eye signs as seen in Graves disease.
- Hyperthyroidism can be seen in McCune-Albright syndrome which occurs due to activating mutation of α-subunit of the G-protein; they tend to have a multi-nodular goiter.

Etiology

Etiology of hyperthyroidism is shown in Fig. 1.

Clinical Evaluation

The onset of clinical manifestations in children with hyperthyroidism is insidious; changes may be present for months or even years before the diagnosis is made.

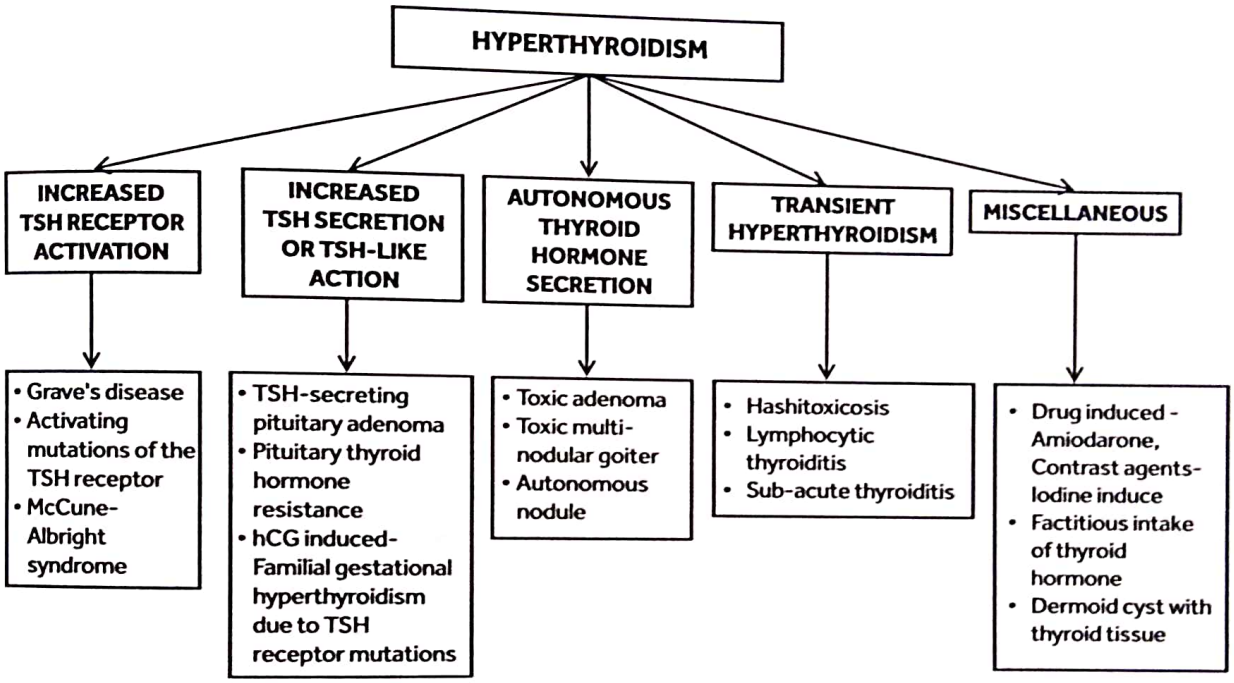

Fig. 1. Etiology of hyperthyroidism.

hCG Human chorionic gonadotropin; *TSH* Thyorid stimulating hormone

- ***Goiter:*** Enlargement of thyroid gland is seen in children with hyperthyroidism. The clinical findings vary with the etiology. In Graves disease, the goiter is diffuse with a smooth surface, fleshy in consistency with no nodules. In Hashitoxicosis, the goiter will be diffusely enlarged with bosselated surface and firm consistency. In subacute thyroiditis, goiter is generally painful. In multinodular goiter, there is enlarged thyroid with multiple nodules. A single nodule in thyroid gland without goiter is seen in autonomous thyroid nodule. On auscultation, a bruit can often be noted over the gland in hyperthyroid patients.
- ***Eyes:*** Exophthalmos is one of the cardinal features of Graves disease. Though observed in children, it is milder than adults. There is lid lag and stare look. Proptosis with impaired movement of eye and periorbital edema has been observed. There could be pain in the eyes with gritty feel (Fig. 2).

Fig. 2. Clinical picture of a 12-y-old girl child with hyperthyroidism. Classical exophthalmos can be made out.

[Child's assent and parents consent was obtained for publishing the photograph]

- ***Growth*:** Children with hyperthyroidism of long standing like Graves disease can have accelerated growth with advanced bone age. The duration of 1-2 y of illness might increase the height from 50th centile to 75th centile. The final height achieved by these children is in their target range due to relatively advanced bone age.
- ***Puberty:*** The age of attainment of puberty is not affected by hyperthyroidism. However, girls who have undergone menarche can complaint of oligomenorrhea or secondary amenorrhea.
- ***Cardiovascular:*** There could be tachycardia with high blood pressure. The blood pressure will show wide pulse pressure due to decrease in peripheral vascular resistance.
- ***Gastrointestinal:*** There could be a loss of weight despite good appetite. The gut motility is increased leading to increased frequency of stool passage. The children might not be necessarily underweight at the time of diagnosis.
- ***Neuro-psychologic:*** Tremors or tremulousness can be seen in hyperthyroidism. Ataxia, chorea and exaggerated deep tendon reflexes may be present. Occasionally there might be personality changes,

agitation, depression, mania, or psychosis. The attention span is reduced, poor sleep, deterioration in school performance and hyperactivity might be observed in children with hyperthyroidism.

- ***Bone & muscle:*** Proximal muscle weakness with decreased muscle mass and decreased efficiency of muscle contraction is also observed in hyperthyroidism. Hypokalemic periodic paralysis is also observed in children, especially of Asian descent. Thyroid hormone causes resorption of bone, hence resulting in increased porosity of cortical bone and reduction in volume of trabecular bone.
- ***Lipid metabolism:*** There is a low serum total cholesterol and high density lipoprotein (HDL) levels.
- ***Skin:*** Increased perspiration is seen in the skin. Onycholysis and increased hair loss might also be present. Presence of café-au-lait spots suggests McCune Albright syndrome.

Diagnostic Evaluation

The diagnosis of thyrotoxicosis is confirmed by constellation of classical clinical features and increased thyroid hormone levels. The diagnostic work-up can be divided in following headings -

a) Biochemistry- Thyroid function test

b) Serology- Antibodies assessment

c) Imaging- Ultrasound and radio-iodine uptake scan

a. *Biochemistry– Thyroid function test*

- TSH is the most sensitive and specific single blood test indicated in evaluation of hyperthyroidism.The diagnostic accuracy improves when free T4 is done along with TSH. TSH and free T4 share an inverse log linear relationship.
- When hyperthyroidism is overt, both free T4 and free T3 will be elevated. Low TSH with normal free T4 levels suggests subclinical thyrotoxicosis, which is uncommon in children.
- T3 toxicosis should be considered in the settings of normal free T4 and low TSH levels and clinical features of thyrotoxicosis. Assessment of T3 levels would be helpful in this situation.

b. *Serology- Antibodies assessment*

- After establishing that the patient is hyperthyroid, the next step is to work-up for the etiology.
- TSH receptor antibody (TSH-R-Ab) is typically po ive in Graves disease.
- Other autoimmune antibodies including anti O (thyroid peroxidase) antibodies and anti TG (thyroglobulin) bodies can be positive or negative.
- In case of Hashitoxicosis, the TSH-R-Ab will be nega and other antibodies (anti-TPO and anti-TG) will be positive.

c. *Imaging*

- Thyroid ultrasound is a convenient, non-invasive, rapid, and accurate tool.
- Vascular pattern can also be observed and helpful with the Doppler examination quantifying the thyroid vascularity.
- Graves disease is characterized by diffuse thyroid enlargement and hypo-echogenicity with increased vascularity with a typical pulsatile pattern.
- Multinodular goiter will show diffuse enlargement and hypoechogenicity.
- Solitary nodule, if it is a source of thyroid hormone, might also be seen in thyroid gland.
- Thyroid scan can also be performed with radio-iodine which will show high I-123 uptake in Graves disease and mildly elevated or normal uptake in Hashitoxicosis.
- Blunted I-123 uptake can be seen in iodine induced hyperthyroidism, factitious intake of thyroxine and also in sub-acute thyroiditis.

Algorithmic approach to etiological diagnosis of hyperthyroidism is shown in Fig. 3.

Management

a. *Medical treatment*

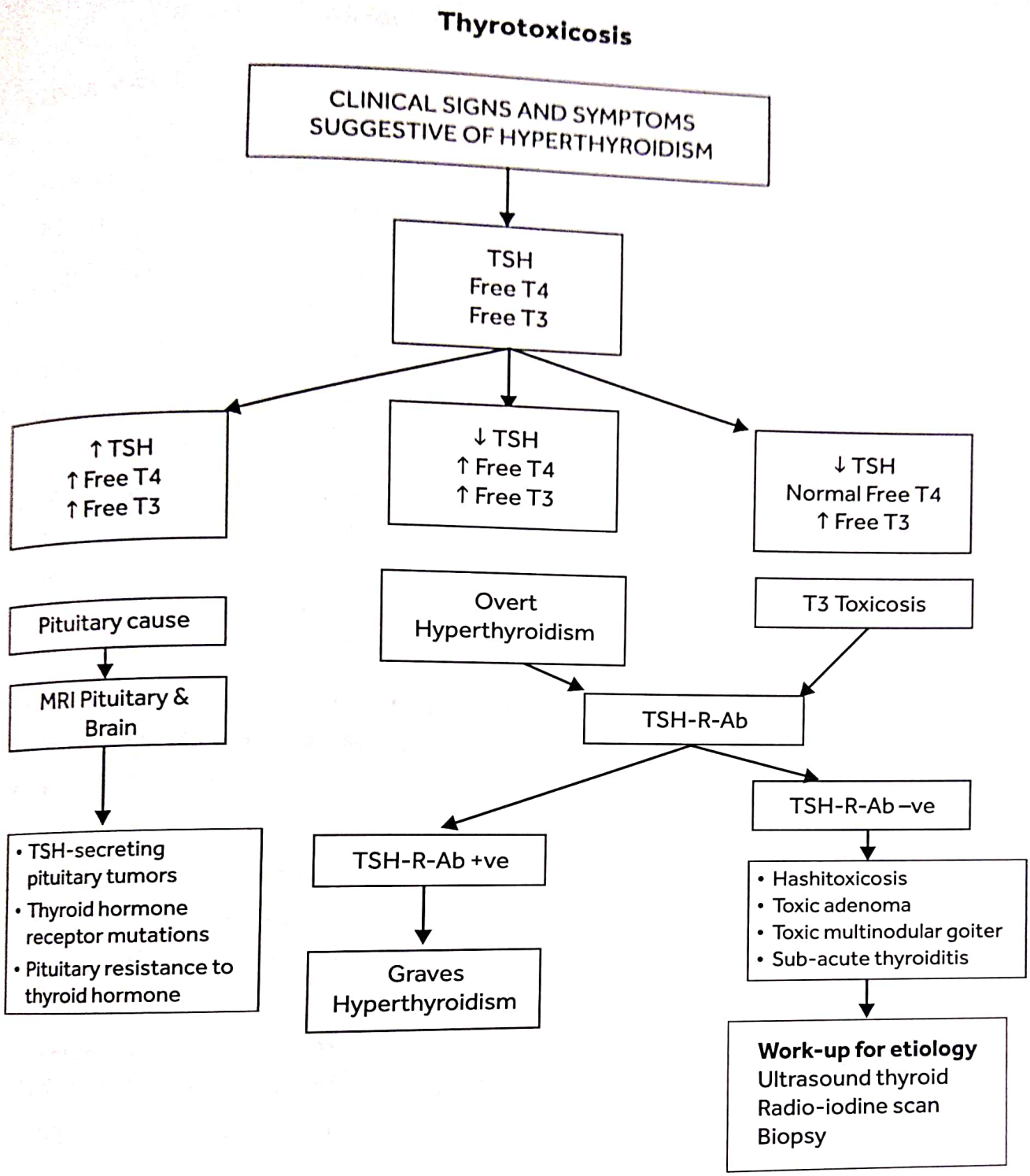

Fig. 3. Algorithmic approach to etiological diagnosis of hyperthyroidism. *MRI* Magnetic resonance imaging; *TSH* Thyroid stimulating hormone; *TSH-R-Ab* TSH receptor antibodies

- *Anti-thyroid drugs (ATDs)*
  - ❖ These drugs inhibit the synthesis of thyroid hormone.
  - ❖ The main drugs are thionamides including Propylthiouracil (PTU), Carbimazole (CBZ) and Methimazole (MMI).
  - ❖ Carbimazole is not the active metabolite but has to be

decarboxylated to Methimazole in liver which is the active metabolite.

- ❖ Thionamides inhibits coupling of iodothyronines, enzyme thioperoxides, reduce oxidation and organification of iodide.
- ❖ ATDs are the first line of treatment in pediatrics especially in children <5 y and between 5-10 y of age.
- ❖ PTU has a short half-life (90 min) requiring frequent administration and is also hepatotoxic especially in children. Hence, MMI (0.5 to 1 mg/kg/d) is preferred in children.
- ❖ Adverse effects of MMI include rash, arthralgia and urticaria which are most common. Patients should be warned about the adverse effect of agranulocytosis; which though rare, whenever child develops fever and sore throat a complete blood count is warranted and MMI should be withheld.
- ❖ The two methods of treatment are block and replacement regimen where ATD is given to completely suppress the thyroid biosynthesis inducing hypothyroidism and thyroid hormone is supplemented.
- ❖ In tapering dose method, MMI is initiated in such a way that thyroid biosynthesis is not completely suppressed. The dose of MMI is adjusted to keep free T4 and free T3 in the normal range and thyroxine is not added.
- ❖ The antithyroid drugs are continued for about two years, as maximum remission is expected in this duration

- *Beta-adrenergic blockade*
  - ❖ Propranolol is useful in controlling the adrenergic symptoms including palpitations and tremors.
  - ❖ It also helps in converting T4 to T3.
  - ❖ It is usually started along with MMI for initial symptomatic relief and once remission is achieved, it can be tapered and stopped.
- *Radio-iodine*
  - ❖ Radioactive iodine (RAI), also called as I-131, can be used to treat hyperthyroidism. RAI mainly gets accumulated in the thyroid gland and emits radiation which destroys the gland.

- ❖ In order to achieve thyroid ablation, the dose above 150 uCi of I-131 per gram of thyroid tissue needs to be administered. Lower dose administration of RAI predisposes to risk of thyroid malignancy.
- ❖ Thyroid storm is a potential adverse effect which can occur immediately post-treatment. Hence pre-treatment with MMI is recommended to prevent it.
- ❖ Long-term genetic damage is not known to be due to I-131 treatment.
- ❖ RAI is contraindicated in children younger than 5 y, as it poses to higher risk of thyroid malignancy in future.

b. Surgery

- When definitive therapy is required in children <5 y of age, surgery is the treatment of choice.
- In individuals with large thyroid gland (>80 g) the response to RAI may be poor and hence surgery is preferred as the 2nd line or definite therapy.
- Near total or total thyroidectomy is recommended and not sub-total thyroidectomy as it is associated with high relapse rate.
- The surgery is best done by an experienced high-volume surgeon in a well-equipped clinical setup.
- Post-surgery, lifelong thyroxine replacement is required.

Approach to management of hyperthyroidism is shown in Fig. 4.

Table 1 shows the choice of therapy in Graves disease.

Table 1. Choice of therapy in Graves disease

Therapy	< 5 y	5-10 y	>10 y
First-line therapy	Anti-thyroid drugs (Methimazole)	Anti-thyroid drugs (Methimazole)	Anti-thyroid drugs/ Radio-iodine
Second-line therapy	Surgery	Large goiter (>80 g)- Surgery Radio-iodine - If cumulative dose required is low.	Anti-thyroid drugs/ Radio-iodine
Third-line therapy	--	Surgery	Surgery

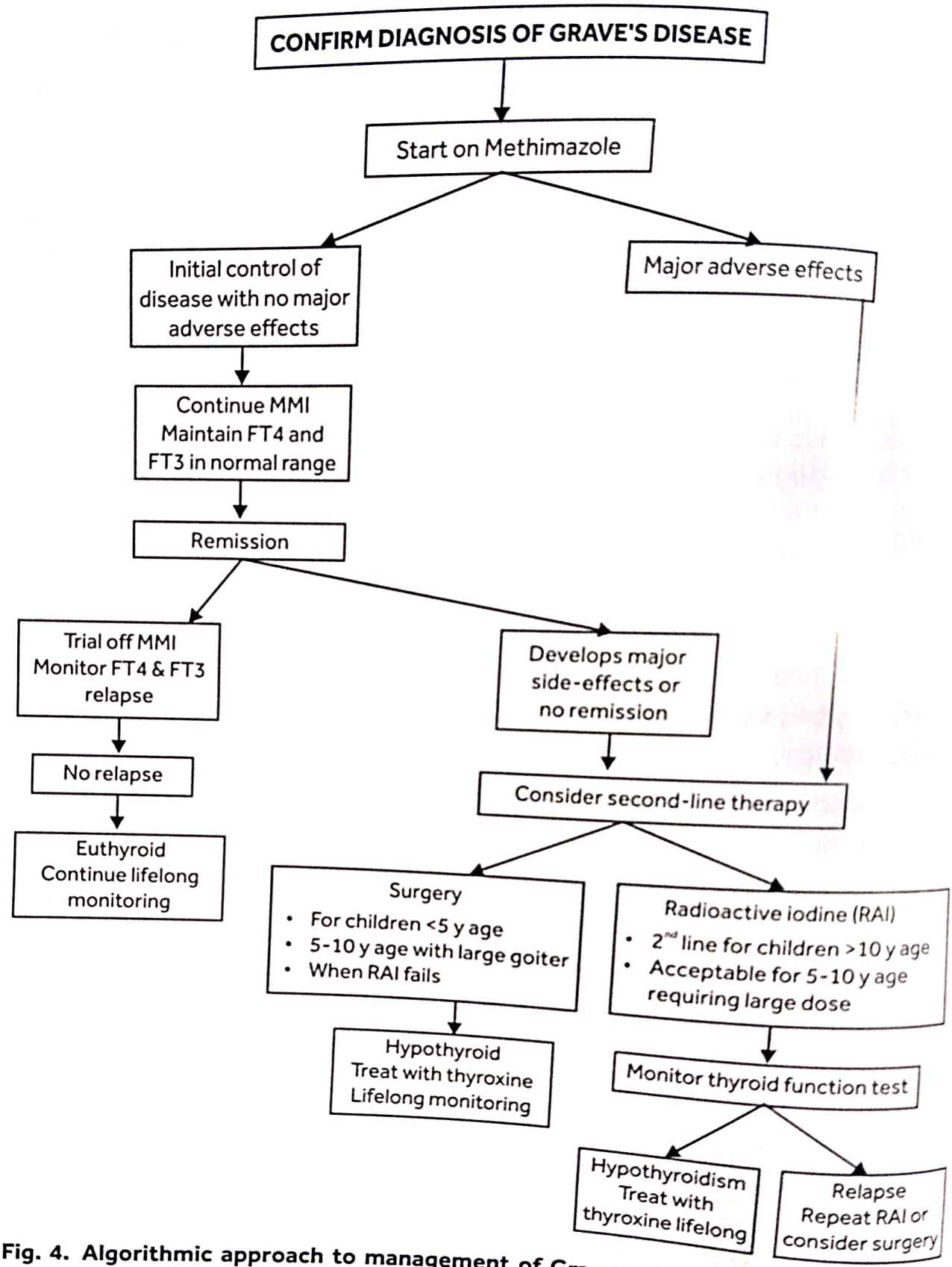

Fig. 4. Algorithmic approach to management of Graves disease.
MMI Methimazole

- Remission of hyperthyroidism is assessed in children at around 3 y of age and if the dose requirement is low in the range of 2.5 to 5 mg per day, a trial off MMI is given.

- Further monitoring is done as shown in the algorithm and if the trial fails, child can be restarted on MMI or definite therapy with RAI or surgery can be offered.

Prognosis

- Remission rate in children with Graves disease varies from 25 to 65 percent.
- Lower thyroid hormone concentrations at presentation, older age and euthyroid status at three months of ATD therapy are the predictors of remission.
- Definite therapy is needed in children who have adverse effect with ATD therapy or if relapse occurs and when a definite therapy is chosen by the patient/family.
- Life-long monitoring is needed for hypothyroidism when RAI is used or surgery is performed.

Neonatal Graves Disease

- It is seen in a small percentage of infants who are born to mothers with Graves disease.
- Graves disease in the mother can lead to hyper or hypothyroidism in the fetus and neonate depending on balance of the maternal inhibitory and stimulatory antibodies and ATD drugs.
- Neonates who are supposed to develop Graves disease are almost always hyperthyroid at or within a week of birth.
- In neonatal Graves disease there is a transplacental passage of maternal stimulatory antibodies (TSH-R-Ab).
- Serial measurement of in-utero ultrasonography of fetal thyroid size can be useful in manifesting neonatal hyperthyroidism. However, one must be careful in interpreting a fetal goiter as it might be seen in both hypothyroidism or hyperthyroidism.
- By 3-12 wk, neonatal Graves hyperthyroidism gets resolved as maternal TSH-R-Ab is metabolized and disappears from the infant's circulation.
- Rarely, neonatal hyperthyroidism is due to activating germline mutations of the TSH receptor or activating mutation of the alpha subunit of the G protein that stimulates adenylate cyclase.

- Clinical manifestations include — intrauterine growth restriction small for gestational age, premature birth, microcephaly, front bossing, triangular facies, warm and moist skin, hyperthermi irritability, wakefulness, hyperactivity, poor sleep, tachycardia, cardia arrhythmia, heart failure, hyperphagia but poor weight gain, increase bowel frequency, diffuse goiter (usually small occasionally can compres airway), stare and occasional exophthalmos.
- The algorithmic evaluation is shown in *Fig. 5*.

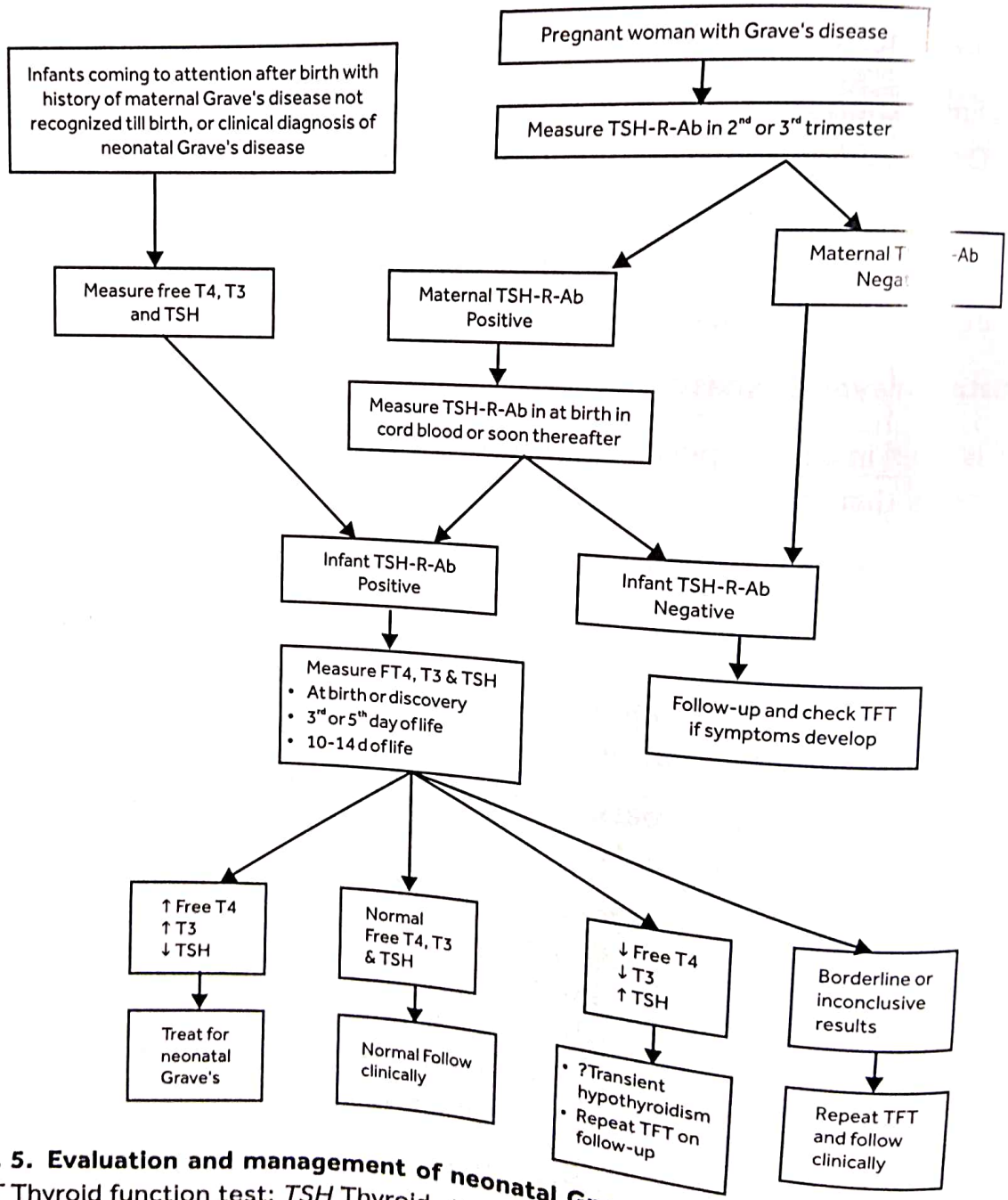

Fig. 5. Evaluation and management of neonatal Graves disease. *TFT* Thyroid function test; *TSH* Thyroid stimulating hormone; *TSH-R-Ab* TSH receptor antibodies

- Methimazole and Propranolol are used for the treatment in neonates.
- Iodine may be added in neonates who are not controlled with MMI and Propranolol.
- Glucocorticoids can be given in extremely ill neonates.
- Prompt diagnosis, early work-up and treatment leads to rapid improvement.
- It should be noted that neonatal Graves disease can be caused by maternal antithyroid drugs or by thyroid stimulating antibodies which cross the placenta. The antithyroid drugs can cause initial hypothyroidism followed by thyrotoxicosis due to the stimulating antibodies. This necessiates estimation of thyroid function at 2 to 3 wk of life in infants of Graves mother.

CASE VIGNETTES

Case 1: *A 14-y-old girl presented with weight loss and irritability.* On examination she had a large goiter with prominent eyes. Thyroid function test (TFT) showed fT4 of 40 pg/ml and TSH was undetectable. TSH-R-Ab was positive. Thyroid scan showed diffusely increased uptake of tracer. All the above findings are suggestive of Graves disease.

The girl was started on Methimazole and was asked to follow-up. She developed fever and sore throat about three weeks later and was investigated. Complete blood count (CBC) showed leukopenia with neutrophilic predominance. Methimazole was stopped and she was treated with oral antibiotics. Methimazole was restarted when symptoms subsided and CBC showed improvement.

Learning Points

- Graves disease should be considered in children with classical history, eye signs and goiter.
- Thyroid scan shows uniformly increased uptake of tracer.
- Methimazole is the drug of choice in children.
- Agranulocytosis should be considered in children on Methimazole with symptoms of sore throat.
- Antithyroid treatment should be temporarily withheld during the period of illness.

Case 2: *A 12-y-boy presented with history of tremors and weight loss for one month.* On examination he had no goiter or classical eye signs. BP was normal. TFT showed free T4 of 32 pg/ml with a low TSH (<0.03). Thyroid scan showed reduced uptake of tracer. The above findings are suggestive of thyroiditis.

Learning Points

- Thyroiditis should be considered in the setting of thyrotoxicosis with no classical eye signs and goiter.
- Thyroid scan shows reduced tracer uptake.
- These children can later end up getting hypothyroidism and hence need follow-up.

Case 3: *A six-day-old baby girl who was born to a mother with Graves disease was brought for opinion.* Mother was on anti-thyroid medications. TFT showed high TSH and low free T4 suggestive of hypothyroidism. The baby was asymptomatic. Repeat TFT done on day 16 of life showed low TSH (< 0.02 mU/L) and high free T4 (38 pg/ml).

Learning Points

- Maternal antithyroid drugs can cause transient hypothyroidism in infants which resolves in about two weeks.
- Thyroid function tests should be repeated after day 14 in infants born to mothers with Graves disease to diagnose delayed presentation of congenital thyrotoxicosis.

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Subject: Letter of Contribution in Cloherty and Stark's Manual of Neonatal Care, first South Asian Edition

Dear Dr Suryawanshi,

We express heartfelt appreciation to you for contributing to the chapter on Shock in our book *Cloherty and Stark's Manual of Neonatal Care, first South Asian Edition*, edited by Dr Naveen Jain, Senior Consultant, Department of Neonatology, KIMS Health, Trivandrum, Kerala India.

Your contribution to the book has been significant and aids us to serve the information needs of the scientific community, clinicians, and students with publications of high-quality content and services in health sciences. We recognize the value of your time and efforts to submit thoughtful contributions for the successful publication of the book.

Thank you for considering and trusting Wolters Kluwer as the publication platform for contributing your valuable work.

Sincerely,

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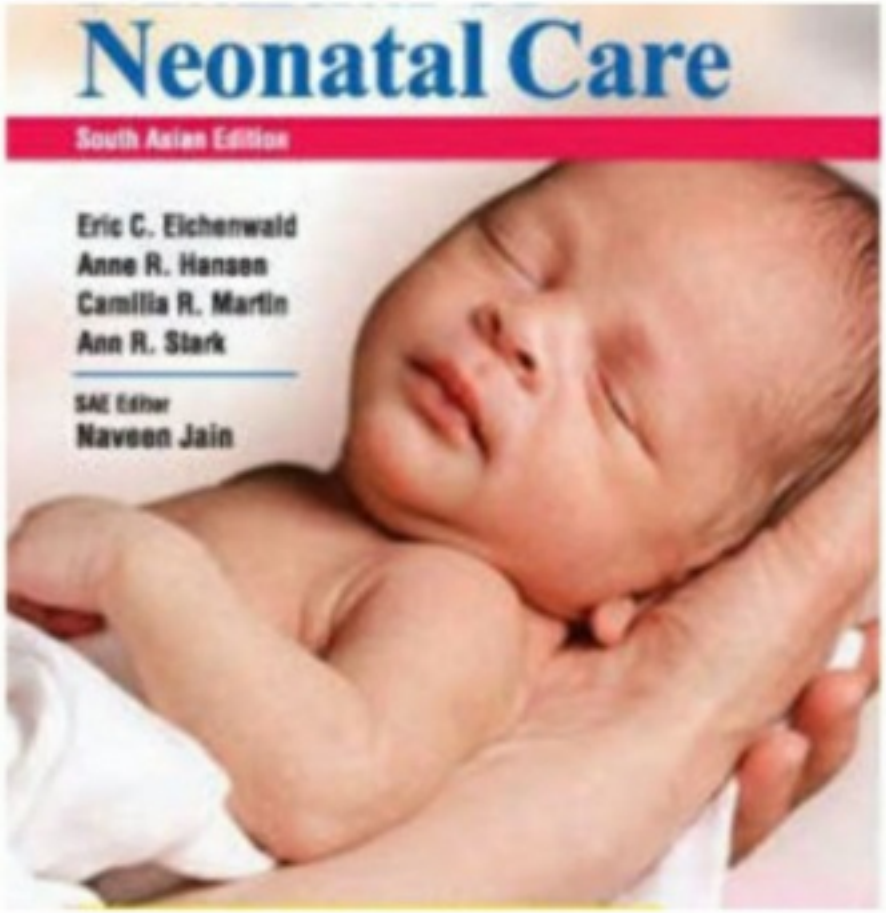

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Cloherty and Stark's Manual of Neonatal Care

South Asian Edition

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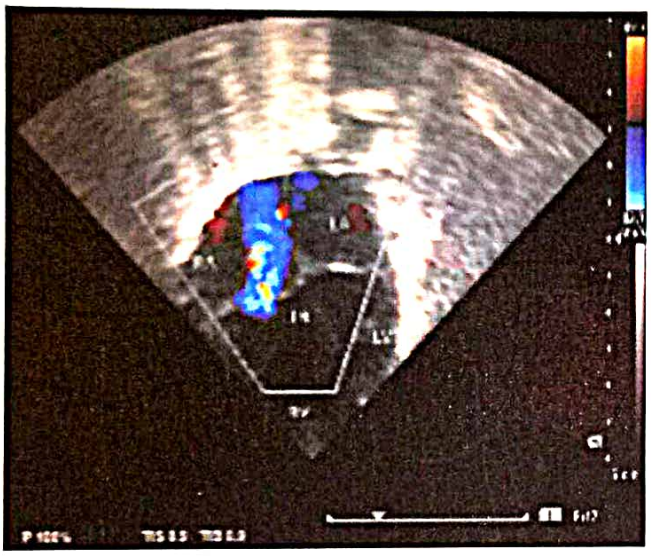
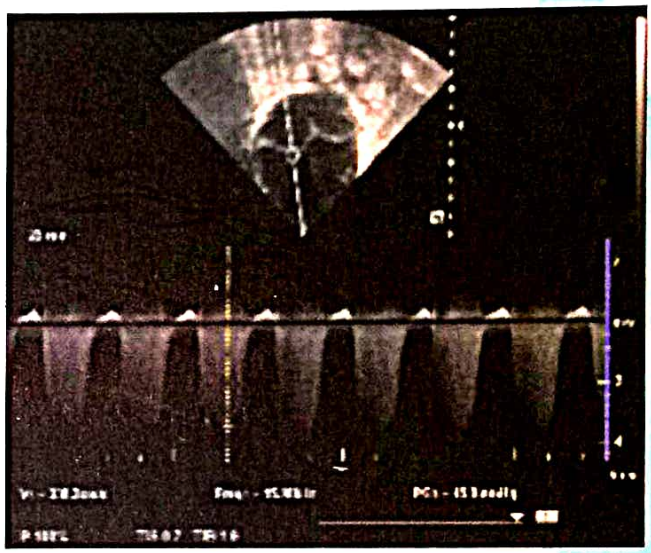
Atlas of Neonatal Functional Echocardiography





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Atlas of Neonatal Functional Echocardiography

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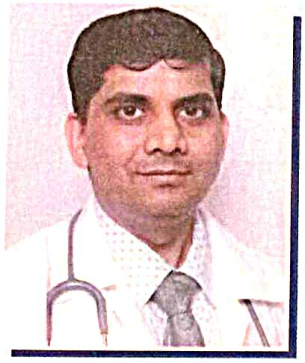


Pradeep Suryawanshi

Highlights

Atlas of neonatal functional echocardiography is a practical handbook for neonatal health care providers, post graduates, clinical fellows, pediatricians and neonatologist, covering topics related to functional echocardiography

Salient Features

Basic's of ultrasound machine
How to buy machine
Systemic approach for doing fECHO
Diagnosis and monitoring of various illness

Dr. Pradeep Suryawanshi is one of India's renowned senior neonatologists, currently based in Pune. He earned his MBBS from SBHGMC Dhule and MD Pediatrics from B.J. Medical College, Pune in the year 2000. He subsequently did his DCH and Fellowship in Neonatal Perinatal Medicine from University of Sydney, Australia from 2001 to 2007.

Throughout his academics, he was a meritorious student and a university topper with many feathers in his cap; he has been awarded many gold medals and distinctions. During his tenure in Australia, he received extensive training in neonatal functional Echocardiography & point of care neonatal ultrasound. Taking this forward to future generations, he is a pioneer in introducing functional Neonatal Echocardiography and Point of Care Neonatal Sonography in India.

Dr. Suryawanshi has received laurels from across the country for maintaining the highest standards of care in neonatal intensive care management. His diligence in his work and competence in procedural skills are unmatched. His unprecedented leadership qualities and enthusiastic teachings to his students continue to inspire all around him. He has made an immense contribution in making ultrasound as a bedside simple tool for appropriate early intervention in newborn care.

Presently, he is a Professor and Head of Neonatology at Bharati Vidyapeeth University Medical College, Pune and Head of Neonatology at Sahyadri Hospital, Pune and Noble Hospital, Pune. He is mentor for Department of Pediatrics at BLDE University Bijapur. He is also mentor at various hospitals all across the country (Satara, Kolhapur, Pandharpur, Karad, Jalgaon, Solapur, Barshi, Nagar and Indore). He is a dignified national faculty and Past Secretary of the Maharashtra chapter of the National Neonatology Forum (NNF). He has been awarded many regional and national awards for his excellent work and contributions to the field of newborn resuscitation.

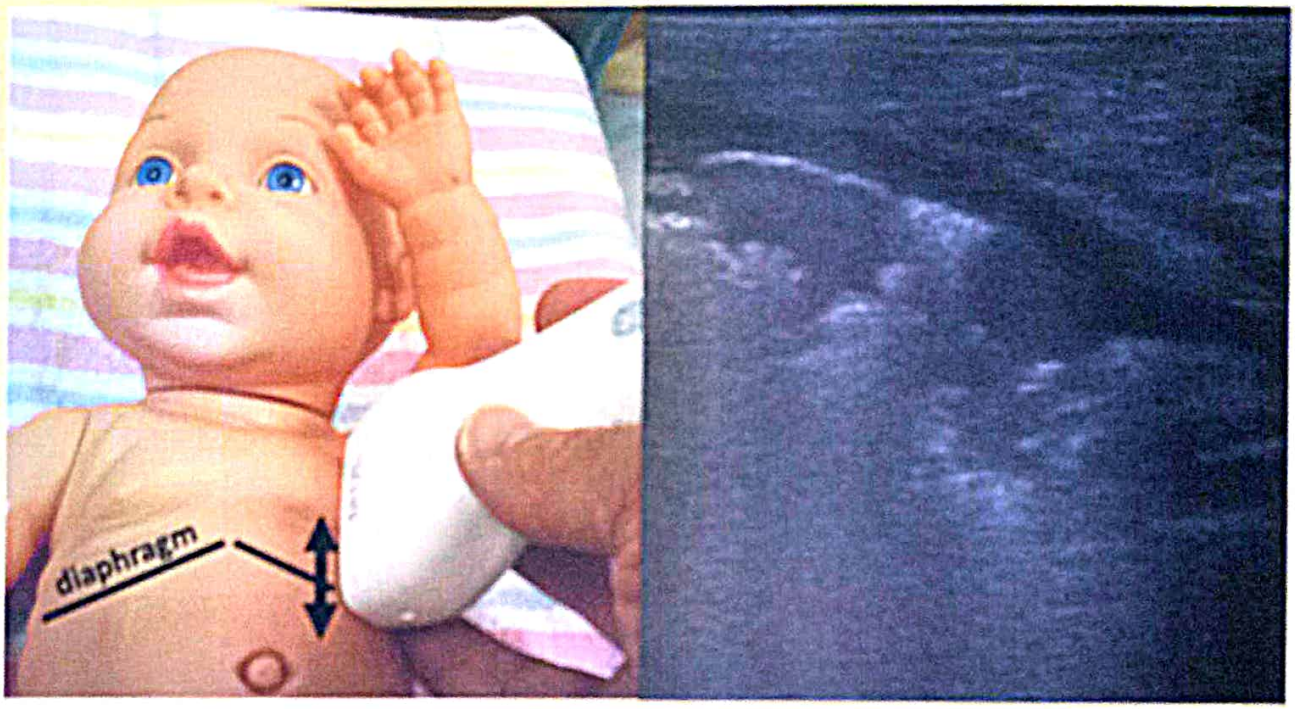
He is the Chief Editor of nationally recognised text books: Point of Care Neonatal Ultrasound & Neonatal Cardiology, Neonatal fEcho made easy, Newer insights in Perinatology, Atlas of POC Neonatal Cranial Ultrasound and Point of care Neonatal Lung Ultrasound. He is also a prime author of many chapters of national and international books and has authored many great articles, presentations and free papers in various journals all across the world.

Dr Suryawanshi has organised several high quality National and International conferences related to Neonatal Haemodynamic and point of care ultrasound and thus providing CME opportunity for many Paediatricians and Neonatologists. Dr Suryawanshi has made an outstanding contribution to pioneering Point of Care Neonatal Ultrasound, conducting 52 workshops nationally throughout India to train colleagues in this modality. He has been instrumental in conducting 92 Neonatal resuscitation workshops and 13 Perinatology workshops in Maharashtra state of India.

Bharati medical college is running successful DM Neonatology & fellowship courses (Bharati fellowship, Indian academic of Pediatrics fellowship & National Neonatology Forum Fellowship) in the neonatal intensive care unit under his guidance and supervision. Above all, he is a true mentor and an embodiment of courage, positivity and exuberant energy for all his students/fellows who are successfully running level III neonatal intensive care units all across the country.

He has been conferred the 2018 award of Fellowship of National Neonatology Forum (FNNF) and also International membership of Neonatologist Performed Echocardiography (NPE) by European Society of Pediatric Research. He has been conferred 2019 award of "FRCPCH" (Fellow of Royal College of Pediatrics and Child Health) by The Royal College of Pediatrics and Child Health, UK, in the year 2019.

Point of Care Neonatal Lung Ultrasound



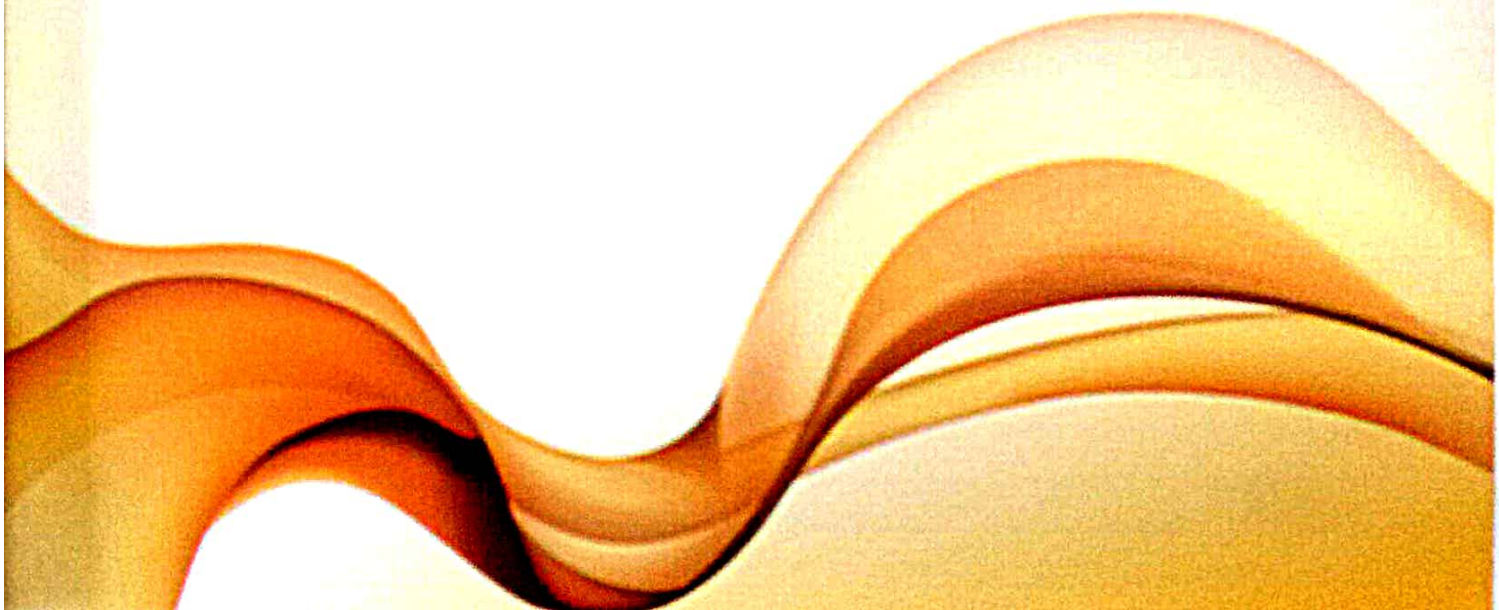
Pradeep Suryawanshi

Jan Klimek

Point of Care Neonatal Lung Ultrasound

Pradeep Suryawanshi

Jan Klimek



Highlights

Point of care neonatal lung ultrasound is a practical handbook for neonatal health care providers – Post graduates, Clinical Fellows, Pediatricians, & neonatologist covering common images in the field of point of care neonatal lung ultrasound.

Salient Features

Covers over 100 images
Basic technique of lung ultrasound
Important ultrasound findings
Easy to read & follow

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Dr Jan Klimek is a Senior Staff Specialist Neonatologist, currently employed by Westmead Hospital, Sydney, Australia.

Qualifications include MB, ChB, DA, DCH, MRCPCH, FRACP and CCPU (Neonatal).

Dr Klimek started his neonatal ultrasound journey in 1999 and 2000 under the tutorship of the late Dr Rex Betheras in the days when all neonatal ultrasounds were still firmly in the hands of radiologists and cardiologists. After the acquisition of the skills required for neonatal ultrasonography, Dr Klimek helped to provide a service of on-call cardiac ultrasound in Christchurch, New Zealand's South Island, which was then geographically isolated from the Pediatric Cardiology support offered in Auckland. During his three year period at this location, he set up regular fortnightly review meetings with the visiting cardiologists from Auckland, thus fine-tuning his skills and furthering his education in this field.

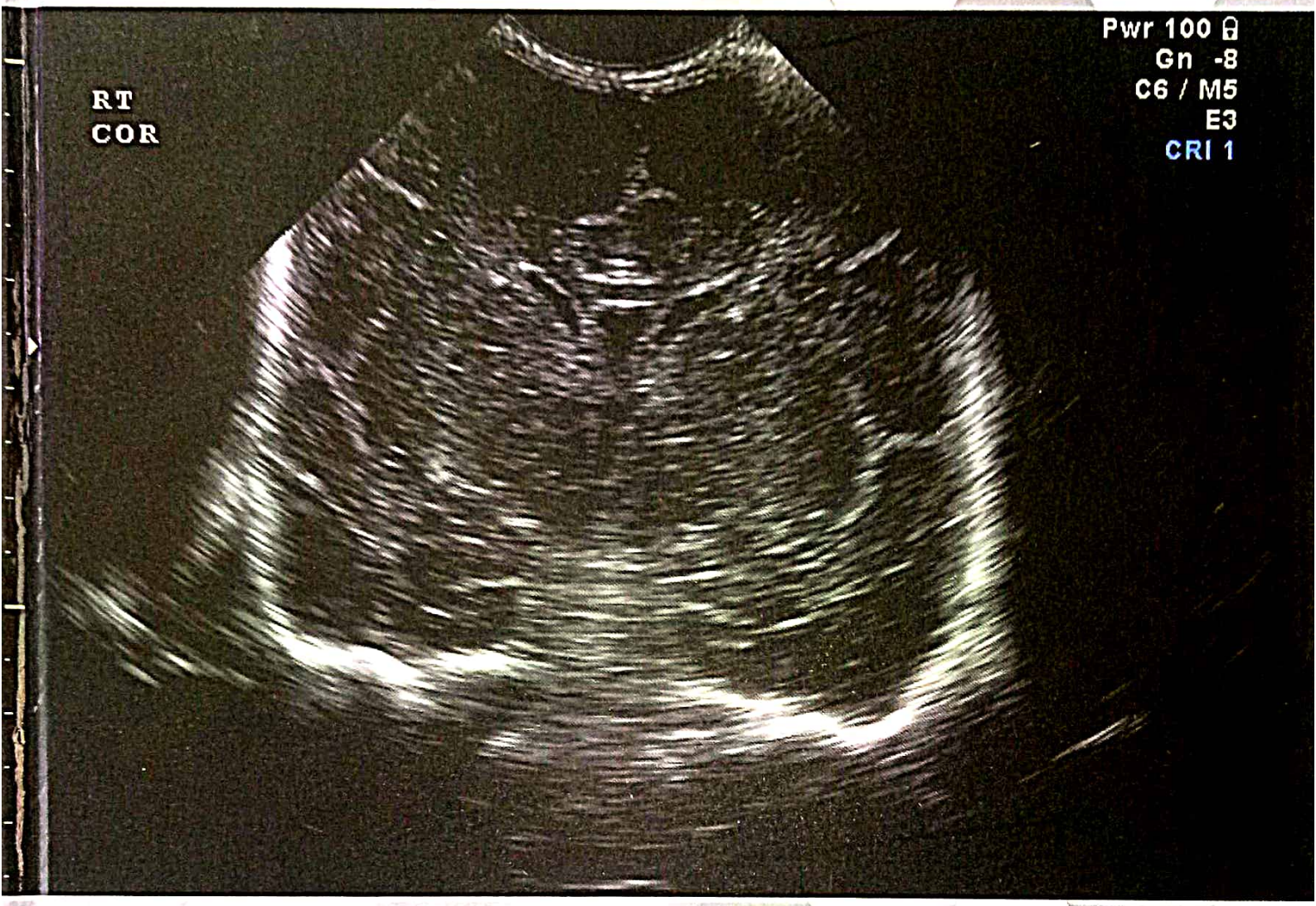
On returning to Australia, he started teaching his ultrasound skills and knowledge to neonatal trainees; the then-doctor (now Professor) Suryawanshi notably one of his first students.

With the advent of the growth of "Neonatal Ultrasound" and the Australian Society of Ultrasound in Medicine (ASUM) creating the category of a Certificate of Clinician Performed Ultrasound (CCPU), Dr Klimek was awarded the CCPU as a teacher in 2009. Dr Klimek then set up the basic CCPU course at his hospital; this still functioning today. He has been accepted as part of the national ASUM CCPU Committee since November 2018.

Today, Dr Klimek works in a neonatal unit together with currently five colleagues who hold the CCPU (Neonatal) and seven CCPU trainees at different levels of experience. Dr Klimek has been the primary neonatologist in this unit as regards CCPU teaching. He has had a number of trainees to date awarded with the CCPU (Neonatal). The neonatal unit is actively involved in performing and reviewing ultrasounds, with a regular fortnightly departmental review meeting. The neonatal unit is involved in a number of ultrasound-related projects and runs an annual basic neonatal CCPU course (since 2016) which satisfies the ASUM certification criteria.

Aside from his clinical duties as a Neonatologist, Dr Klimek also co-ordinates the neonatal Medical Student teaching. He has been awarded "Best Teacher" and "Excellence in Teaching" prizes at both hospitals he has worked in in NSW, Australia. He is a co-author in 10 publications.

Atlas of Point of Care Neonatal Cranial Ultrasound



Pradeep Suryawanshi

Atlas of Point of Care Neonatal Cranial Ultrasound

Pradeep Suryawanshi

Pradeep Suryawanshi

An Atlas of point of care neonatal cranial ultrasound is a practical handbook for neonatalhealth care providers – Post graduates, Clinical Fellows, Pediatricians, & neonatologist covering common images in the field of point of care neonatal cranial ultrasound.

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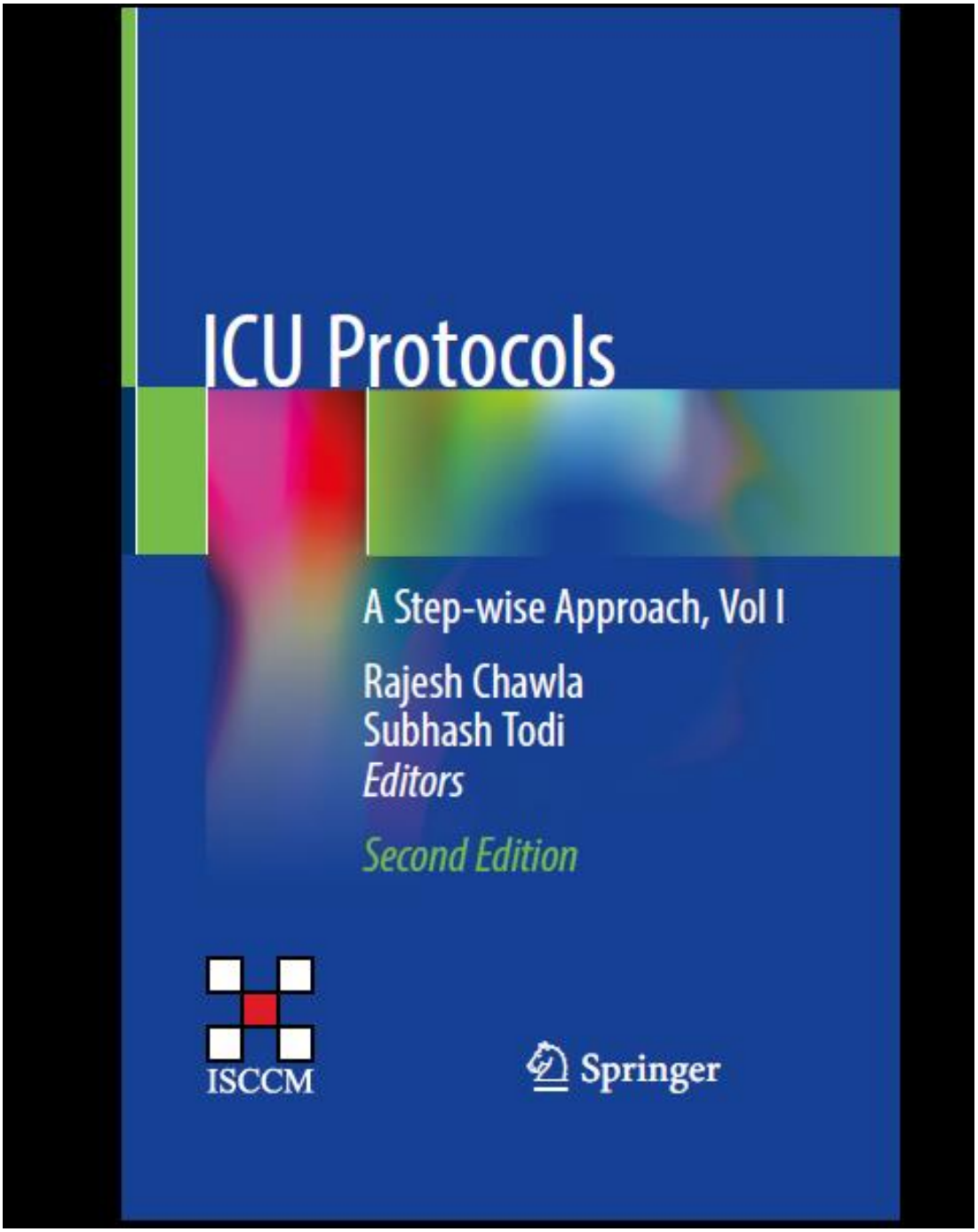
Currently Bharati medical college is running successful DM Neonatology & fellowship courses (Bharati fellowship, Indian academic of Pediatrics fellowship & National Neonatology Forum Fellowship) in the neonatal intensive care unit under his guidance and supervision.

Inspired by his positivity and exuberant energy, his guidance has helped many of his students/fellows to pursue oversea experience in neonates and also to run successful level III neonatal intensive care units all across the country.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An endeavour of Indian College of Critical Care Medicine under the auspices of Indian Society of Critical Care Medicine (ISCCM).

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Subarachnoid Hemorrhage

29

Shiva Kumar Iyer, Jignesh Shah, and Kiran Vadapalli

A 24-year male cricket player complained of sudden headache followed by a brief period of loss of consciousness while playing. On arrival at the emergency department, he was drowsy but answering questions and reported that he had the worst headache ever. Examination revealed a blood pressure of 150/62 mm Hg and has neck stiffness. Rest all neurological examination was unremarkable. He does not give any significant past history and denies any trauma or addictions. Emergency noncontrast CT head revealed diffuse subarachnoid hemorrhage occupying the basal cisterns and bilateral Sylvian fissures.

Subarachnoid hemorrhage (SAH) should be suspected in patients presenting with acute onset severe headache which they classically describe as the worst headache of their life. Most subarachnoid hemorrhages (SAH) are caused by rupture of intracranial saccular (berry) aneurysms. Other causes include trauma, vascular malformations, hemorrhagic infarctions and hypertensive hemorrhages.

Risk factors include cigarette smoking, hypertension, estrogen deficiency, coarctation of the aorta, hereditary diseases like polycystic kidney disease and Ehler-Danlos syndrome. The high morbidity and mortality associated with aneurysmal SAH (aSAH) mandate a high degree of suspicion to allow timely and appropriate treatment.

Step 1: Start Resuscitation

- Emergency airway protection is necessary for obtunded patients to avoid hypercarbia and rise in intracranial pressure. Indications for endotracheal intubation include a Glasgow Coma Scale (GCS) score ≤8, elevated intracranial pressure (ICP), hemodynamic instability, poor oxygenation or hypoventilation and requirement for heavy sedation or paralysis.

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Coma

32

Kayanoosh Kadapatti and Shiva Kumar Iyer

A 30-year-old male patient, who was found unconscious in his room, was brought to the emergency department. On examination, he was found to be tachypneic and febrile with normal blood pressure. He was not opening his eyes and was withdrawing arms on pain.

The comatose patient in the ICU poses a diagnostic and therapeutic challenge to the physician. A broad range of differential diagnoses necessitate a systematic approach and judicious use of investigation in these patients.

Step 1: Assess and Stabilize the Patient

- In any unexplained coma, caution should be taken to avoid cervical spine movement while managing airway.
- Intubate if GCS <8
- If there is hypoglycemia (<60 mg/dL), it should be urgently corrected with 50 mL of 25% dextrose intravenously.
- Thiamine 100 mg IV should be given prior to glucose to avoid Wernicke's encephalopathy, especially in patients with malnutrition and alcoholism.
- Control seizure, if present, with intravenous lorazepam.
- In patients who show features of increased intracranial pressure (ICP), 100 mL of 10% intravenous mannitol should be given (see Chap. 33, Vol. 1).
- Give prompt antibiotics in patients with signs suggestive of meningitis.

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Acute Febrile Encephalopathy

34

Jignesh Shah and Shiva Kumar Iyer

A 40-year-old male patient was admitted to hospital with a 2-day history of fever, headache, and increasing confusional state. He was protecting his airway, had a respiratory rate of 22/min with an oxygen saturation of 95% and was febrile without hypotension. On neurological evaluation, he was disoriented to time and place, was opening eyes on verbal command, had an incomprehensible speech, and was moving all limbs spontaneously. He had neck stiffness and fundi were normal.

A high index of suspicion should be maintained for a diagnosis of an infection involving the nervous system in any patient with fever and altered mental state. Time is essence in managing these patients as any delay could lead to irreversible brain damage (Fig. 34.1).

Step 1: Initiate Resuscitation and Assess Neurological Status

- In patients with neurological problems, assessment of airway and need for intubation is of paramount importance as these patients are at high risk of aspiration. Glasgow coma scale (GCS) below 8 usually requires airway protection (see Chap. 23, Vol. 2).
- Maintenance of adequate oxygenation and perfusion are equally important for preventing secondary brain injury.
- Checking the blood sugar level, arterial blood gases with electrolytes will help identify additional immediate priorities for resuscitation

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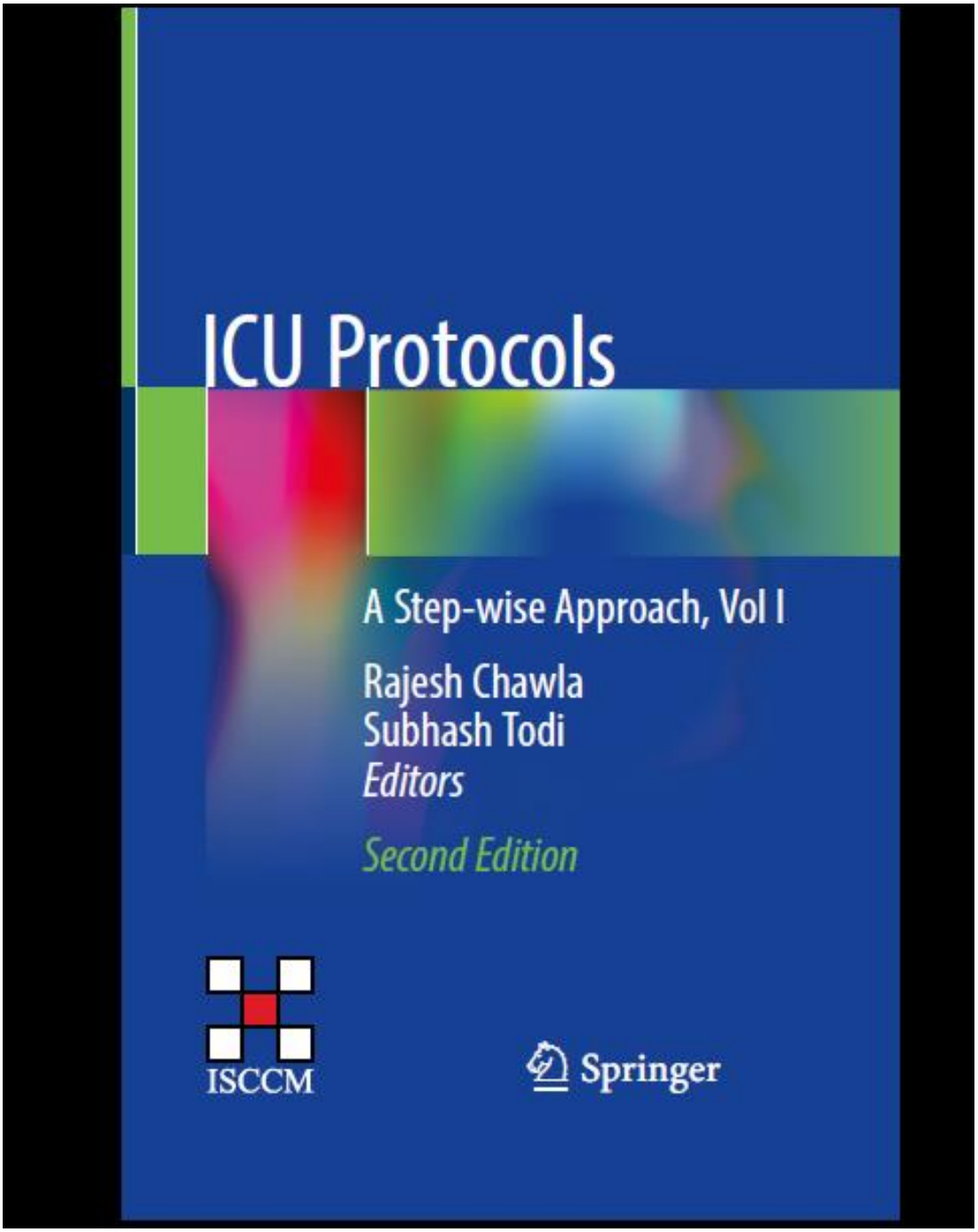
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Subarachnoid Hemorrhage

29

Shiva Kumar Iyer, Jignesh Shah, and Kiran Vadapalli

A 24-year male cricket player complained of sudden headache followed by a brief period of loss of consciousness while playing. On arrival at the emergency department, he was drowsy but answering questions and reported that he had the worst headache ever. Examination revealed a blood pressure of 150/62 mm Hg and has neck stiffness. Rest all neurological examination was unremarkable. He does not give any significant past history and denies any trauma or addictions. Emergency noncontrast CT head revealed diffuse subarachnoid hemorrhage occupying the basal cisterns and bilateral Sylvian fissures.

Subarachnoid hemorrhage (SAH) should be suspected in patients presenting with acute onset severe headache which they classically describe as the worst headache of their life. Most subarachnoid hemorrhages (SAH) are caused by rupture of intracranial saccular (berry) aneurysms. Other causes include trauma, vascular malformations, hemorrhagic infarctions and hypertensive hemorrhages.

Risk factors include cigarette smoking, hypertension, estrogen deficiency, coarctation of the aorta, hereditary diseases like polycystic kidney disease and Ehler-Danlos syndrome. The high morbidity and mortality associated with aneurysmal SAH (aSAH) mandate a high degree of suspicion to allow timely and appropriate treatment.

Step 1: Start Resuscitation

- Emergency airway protection is necessary for obtunded patients to avoid hypercarbia and rise in intracranial pressure. Indications for endotracheal intubation include a Glasgow Coma Scale (GCS) score ≤8, elevated intracranial pressure (ICP), hemodynamic instability, poor oxygenation or hypoventilation and requirement for heavy sedation or paralysis.

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Coma

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Kayanoosh Kadapatti and Shiva Kumar Iyer

A 30-year-old male patient, who was found unconscious in his room, was brought to the emergency department. On examination, he was found to be tachypneic and febrile with normal blood pressure. He was not opening his eyes and was withdrawing arms on pain.

The comatose patient in the ICU poses a diagnostic and therapeutic challenge to the physician. A broad range of differential diagnoses necessitate a systematic approach and judicious use of investigation in these patients.

Step 1: Assess and Stabilize the Patient

- In any unexplained coma, caution should be taken to avoid cervical spine movement while managing airway.
- Intubate if GCS <8
- If there is hypoglycemia (<60 mg/dL), it should be urgently corrected with 50 mL of 25% dextrose intravenously.
- Thiamine 100 mg IV should be given prior to glucose to avoid Wernicke's encephalopathy, especially in patients with malnutrition and alcoholism.
- Control seizure, if present, with intravenous lorazepam.
- In patients who show features of increased intracranial pressure (ICP), 100 mL of 10% intravenous mannitol should be given (see Chap. 33, Vol. 1).
- Give prompt antibiotics in patients with signs suggestive of meningitis.

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Acute Febrile Encephalopathy

34

Jignesh Shah and Shiva Kumar Iyer

A 40-year-old male patient was admitted to hospital with a 2-day history of fever, headache, and increasing confusional state. He was protecting his airway, had a respiratory rate of 22/min with an oxygen saturation of 95% and was febrile without hypotension. On neurological evaluation, he was disoriented to time and place, was opening eyes on verbal command, had an incomprehensible speech, and was moving all limbs spontaneously. He had neck stiffness and fundi were normal.

A high index of suspicion should be maintained for a diagnosis of an infection involving the nervous system in any patient with fever and altered mental state. Time is essence in managing these patients as any delay could lead to irreversible brain damage (Fig. 34.1).

Step 1: Initiate Resuscitation and Assess Neurological Status

- In patients with neurological problems, assessment of airway and need for intubation is of paramount importance as these patients are at high risk of aspiration. Glasgow coma scale (GCS) below 8 usually requires airway protection (see Chap. 23, Vol. 2).
- Maintenance of adequate oxygenation and perfusion are equally important for preventing secondary brain injury.
- Checking the blood sugar level, arterial blood gases with electrolytes will help identify additional immediate priorities for resuscitation

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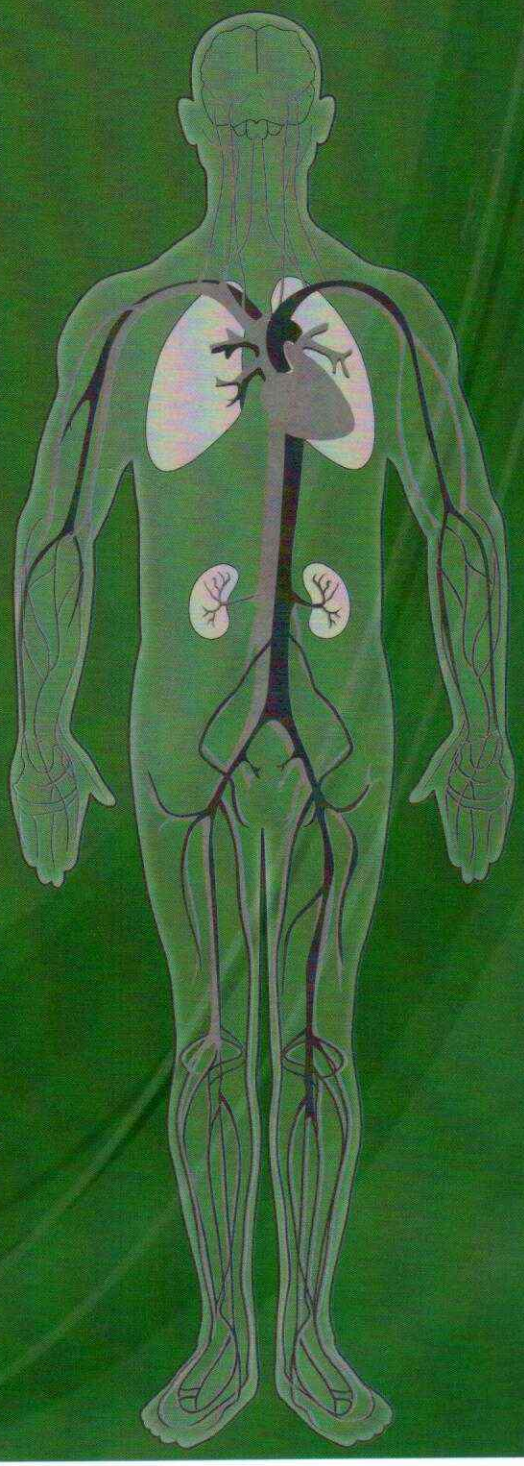

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CHAPTER 9.11

Communication in the Intensive Care Unit

Shivakumar Iyer

"The single biggest problem in communication is the illusion that it has taken place".

George Bernard Shaw

INTRODUCTION

Communication in the intensive care unit (ICU) has been rated as one of the important concerns by family members of patients admitted in the ICU.[1] Families rely on honest and accurate information about the disease process and its likely course for decision-making in the ICU. Unfortunately, the evidence suggests that healthcare providers are found wanting in this regard. Observational studies indicate that up to one-third of family members are not happy with communication in the ICU.[2]

The factors that have been implicated include inadequate time given, lack of consistent information, and conflicting information by healthcare providers. Poor communication has been shown to affect family satisfaction, clinical decision-making, and psychological outcomes of family members.[3] Family dissatisfaction may manifest as anger, violence, and litigation which results in greater stress and burnout in healthcare providers. Many strategies have been suggested in order to improve family satisfaction in ICU.[4]

PRINCIPLES OF COMMUNICATION

The root of the word communication from Latin is "communicare" which means to share or receive. Communication can be defined as "a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior".[5] Good communication therefore requires a shared verbal language and an understanding of the components of nonverbal behavior. Both these components are also culturally and geographically determined and will therefore vary from place to place. Nonetheless, there are certain common principles of good communication.

The four principles elucidated by the I Medicine Committee on Quality of Health Care are:

1. Obtaining and grasping the patient's viewpo
2. Taking into account the patient's psychologic social reality
3. Arriving at a joint understanding of the patie problem and looking at solutions in the co patient's preferences and values
4. Respecting patient's autonomy and empo patient through shared decision-making.[6]

The Kalamazoo consensus statement descr tasks that need to be done during the medical e

1. Building the doctor–patient relationship
2. Opening the discussion
3. Gathering information
4. Understanding the patient's perspective
5. Sharing information
6. Reaching agreement on problems and plans
7. Providing closure.

TOOLS AND MODELS FOR GOOD COMMUNICATION

The Cardiff Six-point Toolkit is a useful aid fo good communication in end of life and palli communication **(Box 1)**.[8]

Comfort

Putting the patient at ease before starting the i extremely important. It includes ensuring a qu

Box 1: Cardiff Six-point Toolkit.

1. Comfort
2. Question style
3. Language
4. Listening/Use of silence
5. Reflection/Acknowledgment
6. Summarizing

Workbook on Renal Replacement Therapy in ICU

Valentine Lobo
Sunitha Binu Varghese
Jignesh K Shah

Foreword
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Workbook on Renal Replacement Therapy in ICU

by Sunitha Binu Varghese, Valentine Lobo, Jignesh N Shah

This workbook focuses on renal replacement therapy in ICU. The incidence of acute kidney injury in critically ill patients is increasing steeply. Acute kidney injury in this setting is associated with high morbidity and mortality. There is no doubt that renal replacement therapy for the most severe forms of acute kidney injury can be life saving. The objective of this synthetic review is to present current evidence supporting best practices in renal replacement therapy for critically ill patients with acute kidney injury. This book consists of 19 chapters, which include acute kidney injury, biomarkers in acute kidney injury, renal replacement therapy: nomenclature and terminology, indications and timing of RRT in AKI, anticoagulation on RRT, acute peritoneal dialysis in critical care, chronic kidney disease patient in ICU, drug dosing on renal replacement therapy, extracorporeal therapies in sepsis, extracorporeal therapies in poisoning, nutrition for acute kidney

Neuroscience Research Progress

Dizziness

Prevalence, Risk Factors and Management

Francesco Martines • Pietro Salvago
Editors

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DIZZINESS

PREVALENCE, RISK FACTORS AND MANAGEMENT

FRANCESCO MARTINES
AND
PIETRO SALVAGO
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Chapter 3

CLINICAL APPLICATION OF VIDEO HEAD IMPULSE TEST

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ABSTRACT

Video head impulse test (vHIT) is the modern instrumental development in the field of vestibular assessment that uses high acceleration head impulse with light weighted goggles to test all the six semicircular canal [1-3]. This technological development is based on the principle of Head Impulse Test (HIT), which was initially used to examine the vestibulo-ocular reflex pathway in individuals who were unable to give response or in coma. HIT examines vestibulo-ocular reflex pathway wherein the patients are instructed to gaze at the target even while the thrust is given to the head in pitch, yaw, and roll axes. In case of a peripheral vestibular lesion associated with semicircular canal, vestibulo-ocular reflex pathway is affected, which leads to generation of saccades.

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However, these saccades generated during the head jerk are virtually difficult to observe with naked eyes [4, 5]. Moreover, the traditional head impulse test was done only for lateral semicircular canals, hence the clinicians were not able to know the lesions of the vertical canals.

This inability of HIT is solved by a recent advancement of video head impulse test (vHIT) which works on the same principle as HIT at same amplitude and high acceleration. vHIT can measure overt and covert saccades (which cannot be detected by naked eye). With the brief but high velocity head impulses, vHIT examines all six SCCs separately [6, 7]. The vHIT has been authenticated by simultaneous comparison with the scleral search coil across both the healthy as well as pathological vestibular population such as Meniere's disease [8], vestibular neuritis [9], vestibular migraine [10] and in case of benign paroxysmal positional vertigo [11] with good sensitivity and specificity. A very considerable clinical literature is described by the fact that the well- known caloric test detects the functioning of only two horizontal SCCs at a very low and brief frequency range of around 0.002 to 0.004 Hz which is beyond the frequency range the semicircular canals experience in day to day life [12].

The vHIT has been reported to be beneficial over caloric test in examining various clinical vestibular conditions in children, younger and older adults. vHIT has been found to be useful in diagnosis of lesions of vestibulo ocular reflex pathways in individuals with stroke, vestibular neuritis, peripheral vestibulopathy, Meniere's disease, individuals with BPPV and individuals with auditory Neuropathy Spectrum disorders [9, 13-15].

Keywords: head impulse test, vestibular disorders, vestibular assessment, vestibulo-ocular reflex

INTRODUCTION

HEAD IMPULSE TEST

Vestibular disorders are one of the most common anomalies reported across all age groups which need detailed medical interview, neurological evaluation, physical examination, and vestibular evaluation [16-20]. Moreover, identification of the condition is the most vital in determining its prognosis. However, there is difficulty in categorizing all balance related illness due to the unavailability of appropriate clinical tools in evaluating all

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vestibular end organs and its networks. These vestibular end organs comprise five entities: three semicircular canals i.e., lateral, anterior, and posterior, basically regulating angular acceleration and two otoliths i.e., utricle and saccule, executing linear acceleration. The three-dimensional gaze and postural stability in human are maintained with the help of three primary vestibular reflexes, out of which angular vestibulo-ocular reflex (VOR) helps retaining the stability of gaze by keeping the eye in same velocity but opposite in direction to that of the head rotation. In addition, the six semicircular canals (constituting both sides of the head), arranged in three orthogonal planes, are important for the detection of head movements in three dimensions. Thus, depending on the provision of angular acceleration, coplanar canals (left anterior vs right posterior semicircular canals – LARP, right anterior vs left posterior semicircular canals – RALP, and right horizontal vs left horizontal semicircular canals) present in each side of the head, come into action and function together in push and pull manner [21].

While fixating a subject onto the target, these abrupt impulsive head rotations can be generated with passive head-only impulses by clinician, active head-only impulses by the subject itself, passive head-only impulses by electromechanical rotation and passive whole-body impulses by electromechanical rotation [22-25]. However, the passive head impulses are reported to be a reliable bedside test in comparison to active head impulses which give higher VOR gain and frequent clustered refixation saccades during than after the head rotation. These passive head impulses by clinician are small, brisk, and unpredictable than the active head impulses and are valid procedure for examining the functioning of semicircular canals [4].

Mechanism of Head Impulse Test (Neural to Physiological Response)

Head movements of normal individuals can have high accelerations of more than 4000°/s [26]. It results in a fast onset response with eye movement of about 8ms from the incidence of head movement to fixate the gaze

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accordingly [27]. These head movements result in fluid displacement, giving rise to the deflection of cupula between the coplanar axes of semicircular canals [28]. For example, when the head turns towards right side, it gives rise to the displacement of the hair cells towards kinocilium at horizontal semicircular canals resulting in the depolarization of the right hair cells and therefore, excitation. Similarly, the displacement away from kinocilium results in the hyperpolarization of the left hair cells and inhibition. These variations in the firing rate get diffused along the vestibular nerve followed by the superior and medial vestibular nuclei as well as cerebellum. Excitation results in the transmission of impulses to the oculomotor nuclei through the white matter tracts at brainstem and the activation of right medial rectus muscle (ipsilateral) and left lateral rectus muscle (contralateral). Antagonistically, inhibitory impulses result in the relaxation of right lateral rectus (ipsilateral) and left medial rectus (contralateral) giving rise to the horizontal compensatory eye movements to the left. This quick onset response is the resultant of type I receptors and irregular afferents present at the central area at crest of crista [29].

Similarly, in case of stimulation to the anterior canal, for example, when the head is bent down, excitatory stimulations are transmitted from the labyrinth via ipsilateral superior vestibular nucleus to the superior rectus muscle (ipsilateral) and inferior oblique muscle (contralateral) which are subdivisions of contralateral oculomotor nucleus. Antagonistically, inhibitory impulses result in the relaxation of inferior rectus muscle (ipsilateral) via divisions of ipsilateral oculomotor nucleus and superior oblique muscle (contralateral) via contralateral trochlear nucleus. This gives rise to the upward deflection of both eyes. Likewise, when the head is bent upward, it results in the excitation of the posterior semicircular canal. This gives rise to the excitatory signals from the labyrinth to the inferior rectus (contralateral) via contralateral oculomotor nucleus and superior oblique (ipsilateral) via contralateral crossed trochlear nucleus. However, the inhibitory impulses give rise to the relaxation of the superior rectus (contralateral) via contralateral oculomotor nucleus and the inferior oblique via ipsilateral oculomotor nucleus resulting in downward deflection of both eyes [30].

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Clinical Applications of Head Impulse Test

The HIT can be performed in a well-lit room as there is no need of dark room to subside the visual field. Therefore, with its very abrupt head thrust of more than 150°/s, one can perform a HIT even during the active attacks of vertigo. Moreover, these head impulses are natural stimulators generating angular momentum and thus, the activation of semicircular canals than any other artificial modes of stimulation yet not well understood [31, 32].

Earlier study by Aw et al. reported the presence of saccades when the high velocity head movement was made towards the lesioned peripheral side [33]. This technique is known as Head Impulse Test (HIT), which was originally used to examine bed-ridden or coma patients. Brisk, brief, and unpredictable stimulation of the test is too rapid for assessing oculomotor control systems. Hence, HIT purely examines the VOR reflex pathway wherein the patient is directed to gaze at the target even while the jerk is given to head in pitch, yaw, or roll axis. The central mechanism acts to maintain the gaze in a stationary target with compensatory saccades and the examiners need to be well trained in detecting those saccades with naked eyes.

Limitations of Head Impulse Test

In the HIT, an unpredictable abrupt jerk is given about 15° and therefore, the presence of instantaneous compensatory response is checked, if any. In a healthy individual, for each head thrust given, the eye movement response will compensate in maintaining gaze stability to the target. However, a patient with vestibular dysfunction will not be able to maintain these quick eye responses to the head impulse given and will lead to catch-up saccades at the end of each head jerk. These visible overt catch-up saccades are the clinical sign of canal paresis in these individuals [34].

Nevertheless, the HIT being a subjective test with not any objectifiable record of patient's response, has the major drawback of not able to profile any clinical signs of canal paresis during the test procedure. Parameters such

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as VOR gain, which is ideally considered 1.0 in a healthy adult, will be reduced in patients with vestibular dysfunction along with catch-up saccades. Moreover, some of the catch-up saccades, also known as covert saccades are virtually difficult to detect with naked eyes in HIT, making it clinically less feasible and therefore suggesting the crucial need to have an objective tool to record a fast eye movement response with adequate resolution to understand VOR gain, covert and overt saccades [4, 5]. This imperative requirement is solved with the development of an advanced Video Head Impulse Test (vHIT), which works in the same principle as HIT.

VIDEO HEAD IMPULSE TEST

Ten years of continuous research in the field of vestibular research has come up with a high-tech objective replica of HIT, also known as vHIT. The vHIT system has been recognized as the standard test protocol in understanding the functioning of semicircular canals [3]. It is a quick, innocuous, and easily repeatable test that provides quantitative time series records of all three orthogonal planes of semicircular canals exclusively and therefore, is useful in examining the canals function before and after the intervention [6, 7]. It has been authenticated by simultaneous comparison with the scleral search coil across both the healthy as well as pathological vestibular populations such as Meniere's disease [8], vestibular neuritis [9], vestibular migraine [10] and also in case of benign paroxysmal positional vertigo [35-41].

Over the years, vHIT has been found to have good sensitivity in detecting vestibular loss that ranges from almost normal to complete canal paresis [42, 43]. Moreover, it has disclosed the presence of variations in saccadic timing and pattern that may be associated with the adequacy of vestibular compensation mechanism. Along with overt saccades for maintaining the gaze in the target, some patients may even utilize covert saccades for obscuring retinal slip which could have occurred due to VOR inadequacy [44]. These brief covert saccades can be recorded with vHIT and

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thus, its importance in compensation of vestibular loss can be well understood [45-47].

Instrumentations of Video Head Impulse Test

With laptop running manufacturers' vestibular software, the vHIT can be administered in a regular lit room. Frenzel glasses with clean face cushions need to be tightened aptly to prevent slippage such that the camera can track participants' pupil movement. The vHIT instrument has two laser pointers projected onto the wall, placed at the distance of 1 metre from the participant seated adjustable for calibration. The instrument is calibrated with the instruction to track laser pointer moving alternatively at two targets without the head kept fixed. Once calibrated, participant is instructed to fix the gaze at a target 'dot' even when the head thrust is given to achieve the VOR gain at different planes [3].

The head thrust of around 40 times is often given for each plane (pitch, roll, and yaw planes) in a randomized manner at an angle of 10-20 degrees with peak head velocity of 200°/s and peak acceleration of 2000 to 6000°/s^2. During the testing, head is accelerated sufficiently such that the semicircular canal on the side of stimulation gets excited while the other side leads to inhibition of the afferents. The head impulse in the horizontal axis leads to the stimulation of horizontal semicircular canals. Similarly, when the head is rotated at 45° to the trunk and therefore, the thrust is given downward, it stimulates the anterior semicircular canal lying opposite to the side of rotation. In addition, the thrust given upward stimulates the posterior semicircular canal at the side of rotation [48]. While examining the vertical semicircular canals, participants should fix their eyes to the target kept in front while the thrust is in the plane of the canals being stimulated. The presence of vestibular lacunae with total or partial loss of semicircular canal functioning leads to unmatching of eye velocity curve to that of head velocity and gives rise to corrective saccades i.e., overt and covert saccades to preserve the gaze stability [15, 49-51]. Moreover, one needs to be careful

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in aligning head appropriately before the stimulation as it may affect the VOR gain and corrective saccades [52].

Recording Procedures of Video Head Impulse Test

The vHIT follows two different recording procedures based on the location of target which is moved during the rotation of head or not. They are:

- Head Impulse Protocols (HIMPs)
- Suppression Head Impulse Test Protocols (SHIMPs)

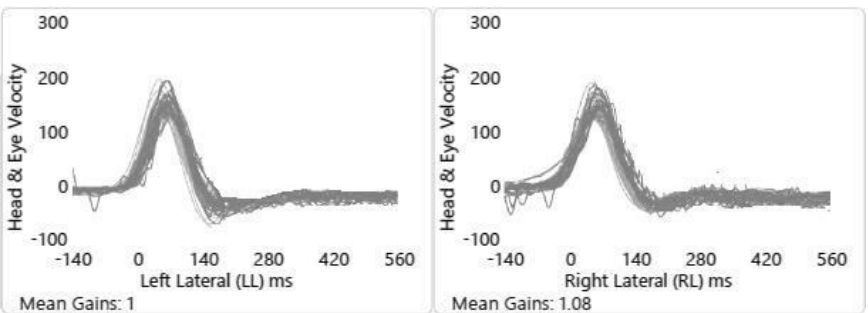

Figure 1. Shows VOR gain in HIMP paradigm in lateral plane.

Head Impulse Protocols (HIMPs)

HIMPs follows the traditional HIT procedure wherein the instruction is given to maintain the gaze at a fixed target spot kept at 1 metre distance on the wall even when the abrupt, unpredictable head thrust is given. HIMPs testing provides absolute data on the functions of semicircular canals which are less credible in caloric testing as the thermal stimulation may get affected reaching canals in the presence of different cofounding variables such as the thickness of temporal bone, skull size, etc. Moreover, being simple and intuitive, the HIMPs can be easily applied even in young children [53]. In

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addition, HIMPs are found to be useful in examining patients amid acute attacks of vertigo and help discriminate whether the pathology is peripheral and its variants or central in nature [54-57].

Over the years, HIMPs have exposed the possibilities to have reduced VOR gain in single or both canals of the pair [58]. These results have enlightened more on the functioning of the semicircular canals and help explain certain possibilities for having vestibular symptoms with symmetrical normal caloric test results [59]. Moreover, HIMPs have been predominantly utilized for assessing the canal functioning in patients undergoing ototoxic medications such as gentamicin [3, 60], that selectively damage the type I vestibular receptors, vital for the initiation of head impulse responses [61]. Additionally, HIMPs are found to have true sensitivity and specificity of 1.0 as studied in a group of individuals with surgically sectioned vestibular nerve. However, examining the sensitivity and specificity of the test against caloric measure is merely going to provide us with the information on the difference in site of stimulation between the tests, resulting in variable response [62].

Suppression Head Impulse Test Protocols (SHIMPs)

SHIMPs is the recent modification of the HIMPs that utilizes the same vHIT technology while measuring eye and head velocity for the given head impulse. One key variation in SHIMPs is that the participant needs to fixate a head-fixed target wherein the target of laser spot moves along with the head [63]. Therefore, SHIMPs is relatively easier and intuitive as compared to HIMPs as the participant needs to track the moving target for every passive unpredictable head thrust. However, the test results are exactly inverse to that of the standard HIMPs wherein the patients with vestibular loss have no saccades and the healthy participants have large saccadic response at the end of the thrust, also known as anti-compensatory saccade [62]. The comparison of SHIMPs with search coils suggests it to be the valid indicator of vestibular dysfunction and complementary to the HIMPs

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paradigm [63]. The SHIMPs measure two parameters of vestibular function i.e., VOR gain, and saccadic velocity which are useful clinical indicators.

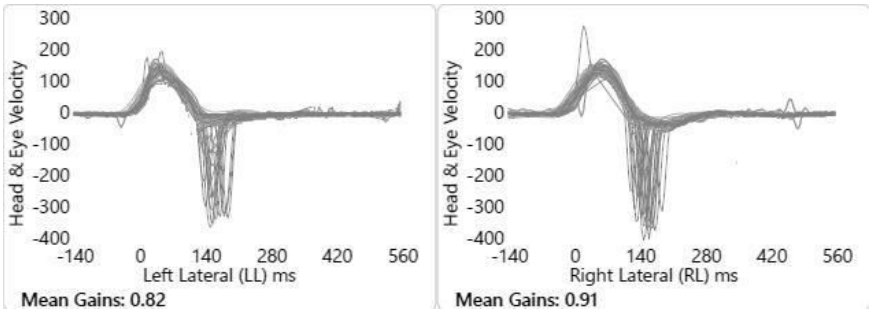

Figure 2. Shows VOR gain and anticompensatory saccade in lateral plane.

For every brief abrupt head impulse, both the HIMPs and SHIMPs stimulate semicircular canal and thereby, compensatory eye movements. HIMPs paradigm stresses on maintaining gaze on the fixed target. However, VOR drives eyes off the target in SHIMPs paradigm. Therefore, the suppression of VOR is seen in healthy participants at around 80 ms from the onset of the head impulse [64]. These compensatory saccades are found to be absent in an individual with complete vestibular loss as they lack VOR to drive the eyes off the target. This suggests the size of the saccade (saccadic velocity) generated by SHIMPs paradigm to be comparable with the VOR gain [65]. For instance, when the head is turned right with active VOR, the gaze is maintained in space by the rotation of eyes to the left. Therefore, as the target is to the right by the end of head impulse, a healthy participant needs to make a large corrective saccade towards the right to maintain gaze at the target. In case of the patient with complete vestibular dysfunction, lack of VOR results in generation of no such corrective saccade. Furthermore, in patients with unilateral vestibular loss, large anti-compensatory saccades are observed for head thrust towards the healthy side and absent or minor one in the affected side [66]. Hence, with its intuitive task, SHIMPs can be well utilized in bedside evaluation where a large anti-compensatory saccade suggests normal functioning of semicircular canals. However, as the compensatory saccades can be affected by the peak head velocity and the

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degree of overshoot at the termination of head thrust, one must be careful during the administration and interpretation of SHIMPs [65].

Precautions Required While Recording Video Head Impulse Test

vHIT is an objective vestibular assessment tool, operated manually by skilled clinicians. However, there should be an understanding of its basics and therefore, cautiousness regarding the possible factors which may alter its diagnostic accuracy such as:

Head Impulse Velocity

Rotation-based tests of vestibular system have their own drawbacks. The head turn in one side results in complementary stimulation of semicircular canals on both sides. In addition, the physiological reports suggest that the neural input from both canals of the same plane responds at the low head velocities [44, 45]. This is more evident in individuals with unilateral vestibular loss wherein with high velocity acceleration of around 150˚/s, the contribution of healthy ear drastically reduces [66].

Stimulus Axis versus Sensor Axis

The vHIT consists of three-dimensional inertial sensor (IMU) and light-weighted goggles. During the assessment, these goggles need to be installed appropriately to the skull as the stimulation applied at the head gets transduced through them. In addition, the stimulation plane should match with the right sensing plane of these goggles, i.e., if the goggles are installed inappropriately, the head velocity sensor axis does not match with the stimulus axis of the head impulse and thus, results in artificial variations in

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VOR gain. Therefore, both the stimulus and sensor axes should be aligned precisely enough for acute measurement of VOR reflex [67, 68].

Geometrical Concerns

During the vHIT assessment, though head turn is the main stimulus, the axis of head rotation rarely lies around the eye being evaluated. Therefore, along with the head turn response, there is a presence of varying within-space translation of the eye along with the gain-changing effect of target distance. The geometrical differences present between the participants with a head carried forward and a stiff neck or those with an upright flexible neck are usually considerable as these effects bring small variations in the test result. However, one should keep these in mind to optimize the results with adjustment in the test setting [66].

Analysis Parameters of Video Head Impulse Test

Based on the Hex plot, the vHIT response can be analysed across three different parameters such as:

- VOR gain
- VOR gain asymmetry
- Refixation saccades

VOR Gain

VOR gain is the most important parameter of the vHIT test and is nothing but the proportion of eye velocity to head velocity from the initiation till its termination of the head impulse. It is measured across three planes of semicircular canals and is ideally considered one. It is calculated by dividing the area curve of eye velocity with no any saccades over the area curve of

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head velocity. Both head and eye velocity curves range from 60ms prior to the peak head and eye acceleration till the head velocity reaches 0°/s back to rest [5, 7]. Therefore, the result is considered normal, if the estimated gain is within the mean and ±2 standard deviation from that of 95% of the population along with no corrective saccades observed [69]. Generally, the VOR gain of ≥ 0.8 is considered normal [50] and clinically utilized across various peripheral vestibular disorders [5, 7, 56, 57, 63] and has reported reduced VOR gain. These are suggestive of the fact that irrespective of the site of lesion (whether the pathology is restricted in the inner ear or vestibular nerve), there is an abnormal reduced gain.

VOR Gain Asymmetry

VOR gain asymmetry is the amplitude-based parameter, calculated by dividing the difference between the VOR gains across orthogonal planes and thus, multiplied by 100. It checks for any intrasensory conflict across RALP, LARLP, and lateral planes of semicircular canals [70, 71]. This sensory unevenness sends variable neural inputs from respective orthogonal planes to the cortical balance system. Such dilemmatic circumstances could generate difficulty in appropriate postural alignment of the body even while the entire head is stimulated with similar acceleration [72, 73]. The asymmetry ratio is well-defined parameter suggesting abnormal vestibular response in cVEMP and oVEMP tests [74]. However, the VOR gain asymmetry is less mentioned across vHIT studies except for a few [71, 75, 76], indicating the need for examining its sensitivity across various clinical conditions.

Refixation Saccades

Refixation saccades, also known as compensatory or corrective saccades, occur when there is variation of the coplanar canals between the stimulated and nonsimulated sides, thereby generating compensatory eye

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movement to sustain the gaze at the target even during the head impulse [21]. With its higher peak eye velocity, these saccades can be distinguished from physiologically induced saccades. Generally, the refixation saccades are of very high velocity which may degrade the retinal image, thereby suppressing the image with its onset until the period of occurrence [77]. These suppressions support in elimination of those smeared retinal images caused due to inadequate slow-phase eye velocity and are mostly seen in vestibular pathologies [44].

Refixation saccades can be classified as the covert and overt as per its time of occurrence. Covert saccades are those that arise prior to the end of the head impulse with a peak eye velocity of 2498/s ± 51 and an average latency of 146 ms ± 28. However, overt saccades occur after the termination of head impulse with peak eye velocity of 1488/s ± 81 and an average latency of 245 ms ± 48. With its late onset, overt saccades are presumed to have central visual trigger mechanism. In contrast, the programming mechanism for covert saccades is still unclear [69]. Yet, the refixation saccades are considered a good indicator of impaired semicircular canals, suggestive of inability to maintain the gaze for the given head impulse [5, 69].

CLINICAL APPLICATIONS OF VIDEO HEAD IMPULSE TEST

Benign Paroxysmal Positional Vertigo

Benign paroxysmal positional vertigo (BPPV) is an inner ear disorder that results from the migration of otoconia into the semicircular canals (canalolithiasis) or their adherence to the cupula (cupulolithiasis). Video head impulse test should show no abnormality in the VOR gain in individuals with BPPV as this disease is a mechanical in nature [78].

Various studies have reported equivocal findings in video head impulse test in individuals with different canals BPPV. In the anterior canal BPPV, gain of the VOR is found within the normal limits for all the semicircular canals both in the affected side and in the contrary. In addition, the mean VOR gain is not significantly different between similar semicircular canals

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in both the ears in individuals with anterior canal BPPV [79]. Moreover, the asymmetry ratio of the VOR gain in individuals with anterior canal BPPV is not significantly different from that of anterior canal BPPV and normal individuals [79]. In posterior canal BPPV, however, the VOR gain is reduced gain in 55.17% of patients in the posterior canal in video head impulse test evaluation [80]. However, in the posterior canal BPPV, the VOR gain of the other semicircular canals are normal. In addition, there is an absence of any corrective saccade (i.e., both covert and overt) in these individuals. Free-floating particles in the posterior semicircular canal that disturb endolymphatic flow lead to VOR and gaze stabilization deficiency [80]. There are other studies that report no differences in the VOR gain between normal individuals and individuals with posterior canal BPPV before and after the canal repositioning maneuver [81]. Similarly, Castellucci et al. reported the reduced VOR gain in individuals with posterior canal BPPV and thereby, hypothesized that the debris alters the endolymphatic dynamics in individuals with BPPV and cupular mechanics results in high-frequency VOR deficit for the involved canal [82]. This condition occurs whenever the otoconial mass is present in the distal portion of the non-ampullary arm of the posterior canal.

Vestibular Neuritis

Vestibular neuritis is characterized by an acute unilateral vestibular loss with sudden vertigo, nausea, and vomiting [83, 84]. Several studies have utilized the video head impulse test in evaluating the deficits of the vestibular nerve in individuals with vestibular neuritis. Bartolomeo et al. reported that the specificity of the video head impulse test in patients with vestibular neuritis is 100% from that of 0 to 40% vestibular deficits shown by the caloric test. Also, the caloric deficit higher than 62.5% is always associated with abnormal VEMP [9]. Moreover, Bartolomeo et al. suggested to avoid the use of caloric test if video head impulse test shows abnormal findings in patients with vestibular neuritis [9].

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The video head impulse test detects an apparent deficit of the lateral semicircular canal in cases with vestibular neuritis. The caloric test also shows a lateral canal deficit in the same set of patients for whom there is evidence of pathology in the lateral semicircular canal [85]. In addition, video head impulse test findings in vestibular neuritis suggest that there could be isolated pathology of the superior vestibular nerve confined only to the nerve supplied to the lateral semicircular canal. Although the anterior and the lateral canals are innervated by the same superior vestibular nerve, video head impulse test results show the pathology confined only to the branch of the superior vestibular nerve supplied to the lateral canals [86].

VOR gain has been used as an essential parameter to characterize the VOR deficits in individuals with vestibular neuritis. The results from the previous study show reduction in VOR gain in individuals with vestibular neuritis [9, 85, 86]. The decrease in VOR gain could be due to the inability of the damaged vestibular nerve in generating the action potential. However, the VOR gain in individuals with vestibular neuritis also depends upon the hand placement technique during the video head impulse test. The mean horizontal VOR gain is lesser for jaw hand placement during the vHIT compared to the head hand position. The jaw hand position can increase the accuracy of vHIT in determining the lesion side [87].

It has been reported that the VOR gain is an excellent parameter to evaluate the VOR deficit at an early stage of vestibular neuritis; however, the sensitivity reduces during follow up evaluation [9, 88, 89]. The sensitivity of the VOR gain in identifying vestibular deficits in patients with vestibular neuritis reduces to 48% compared to the caloric test, which identifies vestibular deficits in 69% of the vestibular neuritis patients at the follow-up evaluation [9]. Similar findings have also been reported in vestibular neuritis patients using the traditional head impulse test wherein the sensitivity of head impulse test has been reported to be 94.4% within one week of symptom, which decreases to 46.2% at 1 year after the onset of symptoms [88]. In another study, Yang et al. also reported that in the acute stage of vestibular neuritis, the abnormal rate of vHIT gain values is 87%, which reduces to 62% at the 1-month follow-up [90]. It has been suggested

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that the central compensation might be responsible for the recovery of VOR gain in vestibular neuritis patients [90].

Meniere's Disease

The patients with Ménière's disease (MD) always present with clinical features of cochleovestibular dysfunction such as hearing loss, tinnitus, and vertigo [91, 92]. The abnormality rate of video head impulse test (vHIT) in patients with Meniere's disease is about 25%, and the sensitivity of the vHIT along with a caloric test in identifying vestibular pathology in Meniere's disease is about 55% [35]. The VOR gain abnormality has been reported in many patients with Meniere's disease [35, 93]. In addition, the vertigo attack is often associated with a quick change in VOR gain on the side of the affected ear. There is a reduction of VOR gain in the paralytic nystagmus phase and the VOR gain becomes normal in the recovery phase [93]. Manzari et al. also reported that VOR gain is enhanced before the Meniere's attack, then decreases during the Meniere's attack but remain above the normal limit [54]. Few studies suggest normal VOR gain in patients with Meniere's disease [32, 94]. Other studies suggest VOR gain to be abnormal in 45-73% of the patients with Meniere's disease [69, 95, 96]. The discrepancies in various results can be attributed to the differences in severity, with abnormal vHIT test results emerging later in the disease course than abnormal caloric reflex.

Discrepancy has also been absorbed between the test results of caloric and vHIT [32, 69, 97] and can be explained by the neurophysiology of the crista [97]. In the peripheral vestibular system, there are two types of nerve fibers, irregular nerve fibers, and regular nerve fibres. These regular nerve fibers are responsible for selective processing of the caloric test stimulus and the vHIT test stimulus [97]. The neurons with regular firings are innervated to type II hair cells in crista ampullaris, whereas the neurons with irregular firings are innervated to type I hair cells of the crista ampularis. It is possible that there can be selective damage to the Type I or type II hair cells in individuals with Meniere's disease such that the disagreement can appear

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between the caloric and vHIT test findings [97]. Similar discrepancy has also been reported in individuals with delayed endolymphatic hydrops [98].

Auditory Neuropathy Spectrum Disorders

Auditory Neuropathy spectrum disorders (ANSD) are characterized by the presence of otoacoustic emissions/cochlear microphonics along with absent or abnormal auditory brainstem responses. Most of the studies in the literature have described the auditory deficits in individuals with ANSD; however, a significant proportion of the individuals also have deficits of the vestibular system [38, 83, 99-101]. In the literature, there are only a few studies that have reported video head impulse test findings in ANSD. The results of the studies show that the VOR gain is reduced for all the six semicircular canals in almost all the individuals with ANSD [15]. In addition, the presence of both covert and overt saccades are often reported in these individuals with ANSD. However, no correlation has been observed between the duration of the condition and the VOR gain values as well as pure tone thresholds and the VOR gain values. Moreover, no association has been revealed between the VOR gain values and the presence or absence of saccades in any of the semicircular canals in these individuals [15]. Sinha et al. also reported no association between caloric test and the video head impulse test in individuals with ANSD [102]. It was reported to have hypofunctional caloric responses along with reduced vestibulo-ocular reflex (VOR) gain and presence of refixation saccades in two individuals with ANSD (ANSD). However, one of the ANSD participant also had hypofunctional caloric response along with normal VOR gain and absent refixation saccade. Hu et al. also reported abnormal caloric test in 70% of the individuals with ANSD [103]. However, most of the ANSD participants showed normal VOR gains with no overt corrective saccades, and exhibited normal anti-compensatory saccades in the SHIMPs paradigm. Thus, the findings of the video head impulse test along with other test indicate a vestibular pathology in individuals with ANSD and the vestibular evaluation for all the individuals with ANSD must be done along with the auditory tests.

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Vestibular Schwannomas

Vestibular schwannomas (VS) are benign tumors that originate from the Schwann cells of the vestibulocochlear nerve. Various studies have calculated the sensitivity of the vHIT test in detecting the VOR pathology in individuals with vestibular schwannoma. These studies have reported a sensitivity of 36% to 80% in detecting the VOR deficit in individuals with vestibular schwannoma [19, 40, 76, 104, 105]. The VOR gain is one of the most important parameters that has been evaluated in individuals with vestibular schwannoma. The VOR gain is found to be reduced in 35-59% of the subjects on the tumor side [76, 106]. The reduction in VOR gain in these individuals can also depend upon the tumor size. VOR gain deficits range from 13.0–34.8% for schwannoma less than 15 mm to over 70.0% for schwannoma exceeding a 29 mm diameter [106]. As the video head impulse test, along with other vestibular tests, suggests a significant relationship between tumor size and the vestibular test results, which implies a potentials role of these tests as a monitoring tool when MRI is not accessible [106].

The asymmetry ratio is abnormal in 50-68% of the subjects diagnosed with vestibular schwannoma [75, 76]. The asymmetry ratio could be higher in individuals with vestibular schwannoma because of the VOR gain deficit on the tumor side. Saccades are present in almost all the patients with vestibular schwannoma and are indicated as a much better parameter than VOR gain for detecting VOR deficit in vestibular schwannoma [75, 76, 106]. Blödow et al. found saccades associated with VS in 19 patients, of which 11 exhibited both covert and overt saccades, seven isolated overt and one isolated covert [69]. However, there are other studies to show that the distribution of saccades is even between isolated overt saccades and the combination of overt and covert saccades [76]. Also, there is a significant relationship between the asymmetry ratio of the VHIT gain and the occurrence of saccades. The presence of saccades is more prevalent in individuals with more gain asymmetry [76]. Also, the occurrences of saccades are associated with more severe canal paresis in individuals with vestibular schwannoma.

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There are some reports on the dissociation between caloric and vHIT test results in identifying the VOR gain deficits [76, 107]. Such dissociations between the caloric test and vHIT test could result from the size of the tumor, site of the tumor, and extent to which the tumor is compressing the different vestibular nerve fibers [76, 107]. It is postulated that the copular neuroepithelium reacting for rapid stimuli in vHIT test could have a different sensitivity for the tumor compression compared to that arising from the slow reacting neuroepithelium responsible for the neuronal firing responsible for caloric test [76]. However, the caloric test is superior to vHIT in detecting the abnormal function of horizontal canal VOR [69]. The caloric test reflects low-frequency VOR changes, and vHIT reflects high-frequency VOR changes. The combination of both the test reveals the abnormal function of both the high frequency and well as low-frequency VOR deficit. It has been recommended that vHIT should be administered along with a caloric test in individuals with vestibular schwannoma [69].

Central Disease Mimicking Peripheral Vertigo

There are patients with isolated cerebellar infarction who have clinical features suggesting vestibular neuritis. The frequency of such patients visiting emergency medical services is about 10% [108, 109]. Two types of cerebellar infarction have clinical features identical to vestibular neuritis: isolated prolonged spontaneous vertigo with imbalance as a sole manifestation of cerebellar infarction and isolated prolonged spontaneous vertigo with imbalance as an initial manifestation of cerebellar infarction followed by delayed neurologic deficits two days after the onset [108]. Mantokoudis et al. reported that the vHIT sensitivity is superior to MRI in the first 48 hours to differentiate peripheral lesions (VOR presents a lowered gain) from central lesions, where VOR gain is normal [47]. Also, VOR gain and compensatory saccades differ between pontine cerebellar stroke and vestibular neuritis. In individuals with vestibular neuritis, VOR gain is reduced along with large amplitude saccades whereas, the VOR gain in AICA stroke is reduced bilaterally with small amplitude stroke. In PICA

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stroke, there is a contralesional gain bias with the smallest saccades, saccades smaller than vestibular neuritis, and AICA stroke [110].

Older Adults

In older adults, VOR gain has been reported to be significantly reduced across all the six semicircular canals [111-113]. The VOR gain declines every decade as the age increases [49]. The decline in the number of receptor cells and the primary afferents of vestibular system could be the reason for reduction in VOR, gain values with age. In healthy young adults, there are a very considerable number of receptors in each canal, and this number declines with age [20, 40, 114-116].

Li et al. suggested the relationship between VOR gain and age to be non-linear [117]. As the age increases, there is a considerable reduction in VOR gain especially in older adults above 80 years of age. Matiño-Soler et al. reported significant reduced VOR gain in individuals above 70 years of age [118]. Kim & Kim reported significant reduction in VOR gain of the horizontal canal above 70 years and in the vertical canal above 80 years of age [119]. Jay et al. reported a significant decline in VOR gain in the age groups 58–67 and 68–77 years [120]. Agrawal et al. also reported not much change seen in the VOR gain up to the age of 50 years; however, the mean VOR gain is reduced in individuals beyond 60 years [113]. In contrary, few studies have also reported no change in vestibulo-ocular reflex gain reduction for the increment in age. MacDougall et al. reported that vHIT have not referenced the variation of normal horizontal VOR velocity gain concerning age [3]. McGarvie et al. found that the horizontal canal gain and anterior canal gain did not vary largely with age except the average gain for the posterior canal [31]. Shizhen also reported that the gain of vHIT six semicircular canals, VOR has excellent age stability, and the age difference will not affect the vHIT result [121].

The cerebellum controls the oculomotor response measured, and studies on the VOR has shown how essential is the cerebellum is for “restoring” the VOR in the face of “challenges,” such as magnified vision or may be age

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[114]. The cerebellar repair may be the reason for such relatively inconsequential effect of age. The reduction in VOR gain could start at the age of 40 Years [122]. The reduction in VOR gain is consistent with the histopathologic reports presenting remarkable age-related deterioration in the number of vestibular sensory hair cells in human temporal bones [123-125] and also with the loss of neurons in the human vestibular nucleus complex after the age of 40 years [126].

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BIDIRECTIONAL RELATIONSHIP OF PERIODONTITIS & METABOLIC SYNDROME

By - DR NEELAM GAVALI/KAKDE (B.D.S, M.D.S)

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By
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CHAPTER: 1

INTRODUCTION

Periodontitis is common chronic infections of the adult population characterized by an exaggerated gingival inflammatory response against a pathogenic bacterial microflora, resulting in clinical attachment loss, alveolar bone loss, and eventually tooth loss.

The primary etiological agent in periodontal disease is bacterial plaque.

The toxins and the enzymes produced by the bacterial plaque elicit inflammatory and immunologic changes in the periodontal tissues at both cellular and molecular levels.

Periodontal pathogen, Porphyromonas gingivalis which release lipopolysaccharide, increases Tumour necrosis factor-α which induces the insulin resistance and atheromatous changes.

Periodontitis is also associated with systemic alterations like low-grade inflammation, dyslipidemia, glucose intolerance, endothelial dysfunction.

The term metabolic syndrome (MetS) which was first coined by Haller and Hanefeld in 1975 , is characterized as a combination of underlying risk factors that when occurring together, culminate in adverse outcomes, including type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD) and thus an approximately 1.6-fold increase in mortality.

The metabolic syndrome is a constellation of metabolic derangements such as insulin resistance, hyperinsulinemia, abdominal obesity, impaired glucose tolerance, dyslipidemia, hypertension, and a proinflammatory and prothrombotic state (Reaven GM, 1988).

The major risk factors for developing MetS are physical inactivity and a diet high in fats and carbohydrates.These are often related to the individual's life style (overweight, sedentary habits), or existing pathological conditions (e.g. obesity and hypercholesterolemia)(Lakka et al. 2002)

The hyperinsulinemia-artherosclerotic cardiopathy association is high in rate also after a correction of triglycerides, apolipoprotein B, LDL cholesterol, and HDL cholesterol levels.

Therefore, high insulin plasmatic concentrations in non-diabetic individuals who can be classified as 'insulin-resistant' – were associated with an ischemic cardiopathy increase, independently from the lipid profile (although a lipid profile alteration in proatherogen sense has a synergic effect with hyperinsulinemia) (Després et al. 2000).

In metabolic syndrome there is an elevation in circulating proinflammatory cytokines and a procoagulant state exists with elevation of C-reactive protein and fibrinogen.

Both periodontitis and metabolic syndrome are associated with systemic inflammation and insulin resistance with elevation in WBC count as a result of body's defence mechanism.

Considering chronic inflammation as the basis for the association between periodontal disease and metabolic syndrome they can be linked through a common patho physiological pathway.

Periodontal disease and metabolic syndrome has bidirectional association (Y. Shimazaki 2007)

Not only systemic diseases have impact on oral health but oral diseases like periodontal diseases have wide ranging systemic effects.

In susceptible individuals, periodontal infection acts as an independent risk factor for systemic diseases and may be involved in the basic mechanism of these conditions.

The pathogenic bacteria alone is not sufficient to create an disease rather the disease initiation and progression also depends on host susceptibility.

In a person affected by MetS, a hyperglycaemia status triggers cellular damage with repercussions at the systemic level and also on periodontal tissue. Periodontal diseases of diabetic origin are a clear example of this (Bensley et al. 2011).

New studies focus on the aetiology of periodontal diseases and the role of oxidative stress, starting a cascade of molecular signals from inflammation mediators, which cause loss of attachment, reabsorption of alveolar bone, and, ultimately, tooth loss, through activation of osteoclasts (Pietropaoli et al. 2010).

As a source of oxidative stress, the MetS could provide an alternative etiological explanation to the development of periodontal disease, as suggested by Bullon et al. (2009).

Periodontitis is a chronic inflammatory disease caused by periodontal pathogens in presenceof local factors which is significantly associated with the frequency of tooth brushing, regular dental visits, smoking and drinking habits (Y. Shimazaki, 2007).

The consequence of chronic periodontal infection is the synthesis of inflammatory cytokines and chemokines by local periodontal tissue or circulating inflammatory cells.

The inflammatory cytokines such as interleukin-6, Tumour necrosis factor-α, elevated C-reactive protein level evokes systemic inflammation which contributes to insulin resistance and causes hyperglycemia,which in turn induces the expression of proinflammatory mediators and increases the risk of oral infection and cardiovascular disease among patients with periodontitis Chen LP,Chaing CK,Chan CP et al(2006).

Thus a triangular vicious circle among periodontitis, systemic inflammation and hyperglycemia is perpetuated. (Kirk EP, Klien S 2009).

CHAPTER:2

DEFINITIONS OF METABOLIC SYNDROME

A number of expert groups have attempted to develop a unifying definition for the MetS.

The most widely accepted of these definitions have been produced by the World Health Organization (WHO), The European Group for the Study of Insulin Resistance (EGIR) and the National Cholesterol Education Program—Third Adult Treatment Panel (NCEP ATP III).

All groups agreed on the core components of the MetS: obesity, insulin resistance, dyslipidaemia and hypertension.

WHO (1999) [1] suggested a working definition of metabolic syndrome (MS), which was to be improved in due course of time. WHO defined MS as glucose intolerence, impaired glucose tolerance (IGT) or diabetes mellitus (DM), and/or insulin resistance, together with two or more of the components listed below:

1. Raised arterial pressure, i.e., ≥140/90 mm of Hg

2. Raised plasma triglyceride (≥ 150 mg/dl) and/or low HDL-C (<35 mg/dl in men and <39 mg/dl in women)

3. Central obesity, i.e., waist/hip ratio (WHR) >0.9 in men and >0.85 in women and/or body mass index (BMI) >30 kg/m^2

4. Microalbuminuria, i.e., urinary albumin excretion rate ≥ 20 μgm/minute or albumin/creatine ratio ≥ 30μgm/mg.

The European Group for Study of Insulin Resistance (EGIR) (1999)[2] proposed a modification of the WHO

definition, using the term insulin resistance syndrome rather than MS.

According to the EIGR definition the diagnostic criteria included elevated plasma insulin (>75th percentile) plus two other factors from among the following:

1. Abdominal obesity: waist circumference (WC) ≥94 cm in men and ≥80 cm in women

2. Hypertension: ≥140/90 mm of Hg or on antihypertensive treatment

3. Elevated triglycerides (≥150 mg/dl) and/or reduced HDL-C (<39 mg/dl for both men and women)

4. Elevated plasma glucose: impaired fasting glucose (IFG) or IGT, but no diabetes.

EGIR focused more on abdominal obesity than did WHO, but in contrast to WHO, EGIR excluded patients with type 2 DM from their syndrome because insulin resistance was viewed primarily as a risk factor for diabetes.

National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) (2001)[3] **:** Defined a subject has the MS if he or she has three or more of the following criteria:

1. Abdominal obesity: WC ≥102 cm in men and ≥88 cm in women

2. Hypertriglyceridemia: ≥150 mg/dl (1.695mmol/l)

3. Low HDL-C: <40 mg/dl in men and <50 mg/dl in women

4. High blood pressure (BP): >130/85 mmHg

5. High fasting glucose: >110 mg/dl

This definition differs from the WHO definition on several fronts.

The NCEP ATP III did not believe that insulin resistance is mandatory for the development of MS and hence suggested the term MS instead of the previously used term ‘insulin

resistance syndrome.' This definition recognizes central obesity as the culprit and hence body mass index (BMI,) which is a parameter for generalized obesity, has not been included in this definition.

The NCEP ATP III definition is much more practically applicable. The NCEP ATP III considers the proinflammatory state and prothrombotic state as components of MS though these have not been included among the criteria necessary to define MS.

The American Association of Clinical Endocrinologists (AACE) (2002) [4] too preferred using the term insulin resistance syndrome over MS. The major criteria they considered were Impaired glucose tolerance (IGT), elevated triglycerides, reduced HDL-C, elevated BP, and obesity. They did not specify any particular number of criteria for diagnosis, rather they left it to clinical judgment.

They suggested that factors like family history of atherosclerotic cardiovascular disease or type 2 DM, polycystic ovary syndrome, and hyperuricemia be considered while exercising clinical judgement.

Patients with type 2 DM were excluded from the definition of insulin resistance syndrome. The various components suggested by the AACE are as follows:

1. *Some degree of glucose intolerance:*

• IFG/IGT

2. *Abnormal uric acid metabolism:*

• Plasma uric acid concentration

• Renal uric acid clearance

3. *Dyslipidemia:*

• Triglycerides

• HDL-C

• LDL particle diameter (small, dense LDL-particles)

• Postprandial accumulation of TG-rich lipoproteins

4. *Hemodynamic changes:*

• Sympathetic nervous system activity

• Renal sodium retention

• Blood pressure (~50% of patients with hypertension are insulin resistant)

5. *Prothrombotic factors:*

• Plasminogen activator inhibitor-1

• Fibrinogen

6. *Markers of inflammation*

• C-reactive protein, white blood cell count, etc.

7. *Endothelial dysfunction:*

• Mononuclear cell adhesion

• Plasma concentration of cellular adhesion molecules

• Plasma concentration of asymmetric dimethyl arginine

• Endothelial-dependent vasodilatation

ADA lowered the fasting plasma glucose threshold used to identify individuals with IFG from 110 mg/dl to 100 mg/dl. Subsequently, the NCEP ATP III has also suggested that the fasting plasma glucose concentration for diagnosing MS be lowered to 100 mg/dl.

Researchers worldwide preferred using the NCEP ATP III definition because it was relatively simple and clinically applicable.

The International Diabetes Federation (IDF) (2005)[5] released a global consensus definition for Metabolic Syndrome, along with race and gender-specific WC cutoffs.

This definition identified central obesity as an essential component of MS and defined MS as central obesity (based

on race- and gender-specific WC cutoffs) plus any two of the following four parameters:

- Raised triglycerides: ≥150 mg/dl (1.7 mmol/l) or history of specific treatment for this lipid abnormality.
- Reduced HDL cholesterol: < 40 mg/dl (1.03 mmol/l) in males and < 50 mg/dl (1.29 mmol/l) in females or history of specific treatment for this lipid abnormality.
- Raised blood pressure: systolic BP ≥130 mm Hg or diastolic BP ≥85 mm Hg or on treatment for previously diagnosed hypertension.
- Raised FPG: ≥ 100 mg/dl or previously diagnosed type 2 DM

The race- and gender-specific WC cutoffs suggested are:

Country/Ethnic group	Waist circumference cutoff	
	Male	Female
Europids In the USA, the ATP III values (102 cm male; 88 cm female) are likely to continue to be used for clinical purposes	≥94 cm	≥80 cm
South Asians Based on a Chinese, Malay, and Asian-Indian population	≥90 cm	≥80 cm
Chinese	≥90 cm	≥80 cm
Japanese	≥90 cm	≥80 cm
Ethnic South and Central Americans	Use South Asian recommendations until more	

	specific data are available
Sub-Saharan Africans	Use European data until more specific data are available
Eastern Mediterranean and Middle East (Arab) populations	Use European data until more specific data are available

CHAPTER:3

PATHOPHYSIOLOGY OF METABOLIC SYNDROME

1: Insulin Resistance and Glucose Intolerance:

Metabolic Syndrome is also popularly known as Insulin resistance syndrome. This syndrome is a group of disorders like insulin resistance, impaired glucose intolerance. Insulin resistance is the primary mediator of metabolic syndrome (Lann D, LeRoith D (2007).

It is defined as a pathophysiological condition in which a normal insulin concentration does not adequately produce a normal insulin response in the peripheral target tissues such as adipose, muscle, and liver.

Insulin is a pleiotropic molecule that affects the amino acid uptake, protein synthesis, proteolysis, adipose tissue triglyceride lipolysis, lipoprotein lipase activity, very low density lipoprotein (VLDL) triglyceride secretion, muscle and adipose tissue glucose uptake, liver glycogen synthesis, and endogenous glucose production[7].

Physiological insulin signalling occurs following the binding of insulin to the insulin receptor, a ligand-activated tyrosine kinase.

Insulin promotes glucose uptake in muscle, fat, and liver cells and can influence lipolysis and the production of glucose by hepatocytes. Insulin is an antiatherogenic hormone and this metabolic effect involves the activation of phosphatidylinositol (PI) 3-kinase.

Binding of insulin results in a tyrosine phosphorylation of downstream substrates and activation of two parallel pathways:

1: The phosphatidylinositol phoinositide 3-kinase (PI3K) pathway.

2: The mitogen activated protein (MAP) kinase pathway.

The PI3K pathway is affected, while, the MAP kinase pathway functions normally in insulin resistance. This leads to a change in the balance between these two parallel pathways.

Inhibition of the PI3K pathway leads to a reduction in endothelial NO production, resulting in an endothelial dysfunction, and a reduction in GLUT4 translocation, leading to a decreased skeletal muscle and fat glucose uptake.

By contrast, the MAP kinase pathway is unaffected, so there is a continued endothelin-1 (ET-1) production, an expression of vascular cell adhesion molecules, and a mitogenic stimulus to vascular smooth muscle cells.

Although hyperinsulinemia may compensate for insulin resistance to some biological actions of insulin, that is, maintenance of normoglycemia, however, it may cause an overexpression of insulin activity in some normally sensitive tissues.

In these ways, an insulin resistance leads to the vascular abnormalities that predispose to atherosclerosis. Although insulin-resistant individuals need not be clinically obese, they commonly have an abnormal fat distribution that is characterized by a predominant upper body fat.

Characteristics of the insulin-sensitive phenotype include a normal body weight, without abdominal or visceral obesity, being moderately active, and consuming a diet low in saturated fats. Under this condition, pancreatic beta cell secretes more insulin (i.e., hyperinsulinemia) to overcome the hyperglycemia among insulin-resistant individuals.

This accentuation of some insulin actions coupled with a resistance to other actions of insulin results in the clinical manifestations of MetS.

An inability of the pancreatic beta cells over time to produce a sufficient insulin to correct the worsening tissue insulin resistance leads to hyperglycemia and overt T2DM.

Regardless of the relative contributions of visceral fat and abdominal subcutaneous fat to insulin resistance, a pattern of abdominal (or upper body) obesity correlates more strongly with the insulin resistance and the MetS than does lower body obesity.

In case of insulin resistance, PI 3- kinase path is impaired and insulin is no longer antiatherogenic (Wang et al 2004).

Obesity, mainly abdominal adiposity is one of the main reasons for insulin resistance. Non-esterified fatty acids (NEFA) are released from excess adipose tissues, which increase insulin resistance.

In case of Insulin resistance there is increased lipolysis from the adipose tissue which increases the free fatty acids, further inhibiting the anti-lipolytic effect of Insulin. (Eckel et al 2005).

Visceral or omental fat appears to be the most detrimental and contributes most to the development of lipotoxicity in peripheral tissues by the secretion of adipocytokines. (Gill et al 2005).

Metabolic Syndrome is associated with a high amount of intra-abdominal fat, low adiponectin levels, and elevated levels of cytokines (interleukin 1RA and interleukin 1beta). (Salmenniemi et al 2004).

Hyperinsulinemia can increase the production of very low-density lipoprotein triglycerides and thus raise triglycerides. Insulin resistance can raise blood pressure (Grundy, 2004).

Additional contributors to insulin resistance include abnormalities in insulin secretion and insulin receptor signaling, impaired glucose disposal, and proinflammatory cytokines.

To compensate for defects in insulin activity, insulin secretion or clearance needs to be modified to sustain normal glucose levels.

Hyperglycemia is the end result if these mechanisms fail (Eckel et al 2005). Since insulin resistance increases a person's risk for developing cardiovascular disease and Type 2 diabetes, several researchers have proposed measures of insulin resistance in obese individuals with and without Metabolic Syndrome.

Reilly et al (2004) believed that insulin assays or alternative biomarkers of insulin resistance may facilitate cardiovascular risk prediction in individuals with Metabolic Syndrome.

2: Central Obesity:

According to the new criteria of IDF, Metabolic syndrome can also be called as ―central obesity syndrome‖ (Gary 2006). The importance of the term Metabolic syndrome is that it helps identify people at risk of Cardiovascular disease and Type 2 Diabetes (Ford 2005).

Central obesity is a high cardiovascular disease risk factor.

Central obesity is more metabolically active then peripheral fat.

The "obesity epidemic" is principally driven by an increased consumption of high calorie unhealthy food intake and reduced physical activity.

Adipose tissue is a heterogeneous mix of adipocytes, stromal preadipocytes, immune cells, and endothelium, and it can respond rapidly and dynamically to alterations in nutrient excess through adipocytes hypertrophy and hyperplasia.

With obesity and progressive adipocytes enlargement, the blood supply to adipocytes may be reduced with consequent hypoxia.

Hypoxia has been studied to be an etiology of necrosis and macrophage infiltration into adipose tissue that leads to an

overproduction of biologically active metabolites known as adipocytokines which includes glycerol, free fattyacids (FFA), proinflammatory mediators (tumor necrosis factor alpha (TNFα) and interleukin-6 (IL-6)), plasminogen activator inhibitor-1 (PAI-1), and C-reactive protein (CRP). This results in a localized inflammation in adipose tissue that propagates an overall systemic inflammation associated with the development of obesity related comorbidities.

Adipocytokines combine the endocrine, autocrine, and paracrine signals to mediate the multiple processes including insulin sensitivity, oxidant stress, energy metabolism, blood coagulation, and inflammatory responses which are thought to accelerate atherosclerosis, plaque rupture, and atherothrombosis.

Pladevall, et al. 2006 & Steele et al 2004, recommended that waist circumference should be routinely measured to assess individuals for increased risk for insulin resistance related cardiovascular disease, Metabolic Syndrome and Type 2 diabetes and to target individuals for health promotion interventions.

Though Insulin resistance is known to be the major risk factor for the development of metabolic syndrome but it is suggested that obesity provides the connection between the insulin-resistant, dyslipidemic and hypertensive factors (Wingard et al 1996).

Visceral fat releases their metabolic products directly into portal circulation, which carries blood straight to the liver. Therefore free fatty acids are poured into the liver. Free fatty acids also accumulate in the pancreas, heart and other organs. This leads to organ dysfunction, producing impaired regulation of insulin, blood sugar and cholesterol as well as abnormal heart functions. This is known as lipotoxicity (Havard College 2006). Thus it can be evaluated that abdominal obesity by use of computed tomography (CT) or magnetic resonance imaging (MRI) can measure the amount of visceral fat.

The National Cholesterol Education Programme Adult Treatment Panel III suggested cut off of 102 cm (40 in) and 88 cm (35 in) for males and females as a marker of central obesity. Parikh et al 2006 proposed that Index of central obesity, which is the ratio of waist circumference and height, was a better substitute than the widely used waist circumference. Central obesity is correlated with both insulin resistance and Type 2 Diabetes Millitus (Gabriely et al 2002).

3: Hypertension

One of the key symptoms of metabolic syndrome is hypertension. It is one of the silent symptom which may remain undetected for long.

It is an important risk factor for development of cardiovascular disease. All the hemodynamic and metabolic disorders of essential hypertension and insulin resistance are closely related.

Essential hypertension is frequently associated with several metabolic abnormalities, of which obesity, glucose intolerance, and dyslipidemia are the most common (Ferranini et al 1991).

Obesity may be the strongest risk factor for uncontrolled hypertension. Studies have shown that obesity provides a connection between hypertension, insulin resistance and dyslipidemia. (Wingard et al 1996). Three factors are found in clustering of metabolic variables ie insulin resistance, hypertension and dyslipidemia.

Both general and central obesity was associated with insulin resistance and hypertension and only weakly linked to dyslipidemia (Anderson PJ et al 2001). The results of Farmingham Heart Study estimate the risk of excess weight was the cause of hypertension in 78% of men and 65% of women (Morse et al 2005).

Studies also suggest that both hyperglycemia and insulin activate the RAS (Renin-Angiotensin System) by increasing the expression of angiotensinogen, AII, and the AT1

receptor, which, in turn, may contribute to the development of hypertension in patients with insulin resistance (Malhotra et al 2001).

There is also evidence which supports a strong relation between hypertension and obesity, which may involve insulin and leptin as well as sympathetic nervous system.

4: Dyslipidemia:

Dyslipidemia is characterised by a wide range of qualitative lipid abnormalities reflecting perturbations in the structure, metabolism, and biological activities of both atherogenic lipoproteins and antiatherogenic , high-density lipoprotein(HDL-C) which includes an increase of lipoproteins containing apolipoprotein B (apoB), elevated triglycerides, increased levels of small particles of LDL, and low levels of HDLC.

Insulin resistance leads to an atherogenic dyslipidemia in several ways. First, insulin normally suppresses lipolysis in adipocytes, so an impaired insulin signalling increases lipolysis, resulting in increased free fatty acids levels. In the liver, FFAs serve as a substrate for the synthesis of TGs. FFAs also stabilize the production of apoB, the major lipoprotein of very low density lipoprotein (VLDL) particles, resulting in a more very low density lipoprotein production.

Second, insulin normally degrades apoB through PI3K-dependent pathways, so an insulin resistance directly increases very low density lipoprotein production.

Third, insulin regulates the activity of lipoprotein lipase, the rate-limiting and major mediator of VLDL clearance. Thus, hypertriglyceridemia in insulin resistance is the result of both an increase in VLDL production and a decrease in VLDL clearance.

VLDL is metabolized to remnant lipoproteins and small dense LDL, both of which can promote an atheroma formation. The TGs in VLDL are transferred to HDL by the cholesterol ester transport protein (CETP) in exchange for

cholesterol esters, resulting in the TG-enriched HDL and cholesterol esters rich VLDL particles.

Further, the TG-enriched HDL is a better substrate for hepatic lipase, so it is cleared rapidly from the circulation, leaving a fewer HDL particles to participate in a reverse cholesterol transport from the vasculature.

Thus, in the liver of insulin-resistant patients, FFA flux is high, triglycerides synthesis and storage are increased, and excess TG is secreted as VLDL. For the most part, it is believed that the dyslipidemia associated with insulin resistance is a direct consequence of increased VLDL secretion by the liver. These anomalies are closely associated with an increased oxidative stress and an endothelial dysfunction, thereby reinforcing the proinflammatory nature of macrovascular atherosclerotic disease.

A study by Brown et al (2001) in the Kaiser Permanente Northwest population, reported the correlation between fasting lipids, HbA1c in 11938 persons with diabetes.

The study compared persons with no, one and two high-cardiovascular diseases (CVD) risk lipid abnormalities, the HbA 1c was 7.3, 7.5 and 7.9%, triglycerides 150, 210 and 318 mg/dl and HDL 54, 40 and 37 mg/dl respectively. This suggested a poorer glycemic control with dyslipidemia in type 2 diabetes.

Another study by Lamarche et al (1997), reported that the presence of small, dense LDL particles may be associated with an increase of subsequently developing Ischemic heart disease. LDL particle size shows no correlation with the LDL cholesterol, but it is strongly correlated with triglyceride and HDL cholesterol concentrations and with the cholesterol–to–HDL cholesterol ratio.

In fact elevated triglycerides and low levels of HDL cholesterol characterize dyslipidemia in Metabolic Syndrome.

In the presence of insulin resistance and hyperinsulinemia, the circulating free fatty acids result in the formation of triglycerides. Sniderman et al (2003) in a symposium on approaches to lipid-lowering treatment in persons with diabetes presented the analysis of hypertriglycerides apo B.

It was concluded that the true target in the treatment for diabetes should be apo B rather than LDL cholesterol. Without measurement of apoB molecule, one cannot distinguish with hypertriglyceridemia and large particles whose apoB is normal.

5: ProInflammatory State:

A proinflammatory state is characterized by elevated circulating cytokines and acute-phase reactants (e.g., CRP).

Yudgin et al (1999) noted that low-grade inflammation is associated with insulin resistance and endothelial dysfunction and that adipose tissue generates inflammatory cytokines that may link insulin resistance with vascular disease.

The origin of the inflammatory state and of endothelial dysfunction was adipocyte-generated inflammatory cytokines, which correlate strongly with insulin resistance.

Circulating signal molecules from fat could include Free Fatty Acids, adiponectin, IL-6 (particularly at the liver, where IL-6 increases CRP production), resistin, leptin, and TNF-α.

This study has sought associations of levels of C-reactive protein and interleukin-6 with measures of obesity and of chronic infection as their putative determinants.

The study also related levels of C-reactive protein and interleukin-6 to markers of the insulin resistance syndrome and of endothelial dysfunction.

Metabolic syndrome and obesity are a kind of stress that leads to activation of inflammatory pathways.

The causation of inflammation is multifactorial. The inflammation in metabolic syndrome is not accompanied by

infection, autoimmunity or massive tissue injury. In fact the inflammation is low grade chronic inflammation.

A few studies have confirmed the positive association between obesity indices and inflammatory markers, mainly CRP (C - reactive protein) in women (Shemesh 2007), but also other inflammatory markers, both in women and men (Mortensen 2009).

Increased concentrations of inflammatory mediators, such as, C-reactive protein, tumor necrosis factor-alpha, interleukin-6 and others have been found in the obese.

Adipose tissue has been found to express most of these inflammatory markers. Obesity was the most important feature associated with C-reactive protein. (Dandona et al 2005).

6: Prothrombotic state:

A prothrombotic state signifies anomalies in the procoagulant factors, that is, an increase in fibrinogen, factor VII and factor VIII as well as the antifibrinolytic factor (PAI-1), platelet abrasions, and endothelial dysfunctions. Grundy et al 2004, has shown that a fibrinogen, an acute-phase reactant protein like CRP, rises in response to a high-cytokine state.

It is characterized by increased plasma plasminogen activator inhibitor (PAI)-1 and fibrinogen, also associates with the metabolic syndrome. Fibrinogen, an acute-phase reactant like C reactive protien, rises in response to a high-cytokine state. Thus, prothrombotic and proinflammatory states may be metabolically interconnected. (Grundy et al 2004).

The study of plasminogen activator inhibitor-1 helps in better understanding of association between hemostatic markers and metabolic syndrome.

A study was conducted by Aso et al (2005) to determine whether plasma concentrations of thrombin-activatable fibrinolysis inhibitor (TAFI) in patients with type 2 diabetes were associated with components of metabolic syndrome

(MetS), including high-sensitivity C-reactive protein (hs-CRP), plasminogen activator inhibitor (PAI)-1, and LDL cholesterol.

The result indicated positive correlation between LDL cholesterol and plasma TAFI with type 2 diabetes mellitus.

Co-existence of metabolic syndrome and hypercholesterolemia accelerates inflammation and elevated TAFI and PAI-1, inhibits fibrinolysis. PAI-1 is an important risk factor for metabolic syndrome.

Three other biomarkers, CRP, IL6, and fibrinogen associate also importantly with the MetS cluster. These 4 biomarkers can contribute in the metabolic syndrome risk assessment (Kraja AT et al 2007).

7: Chronic Stress and Glucocorticoid (GC) Action.

Chronic hypersecretion of stress mediators, such as cortisol, in individuals with a genetic predisposition exposed to a permissive environment, may lead to the visceral fat accumulation as a result of chronic hypercortisolism, low growth hormone secretion, and hypogonadism.

GCs increase the activities of enzymes involved in fatty acid synthesis and promote the secretion of lipoproteins; induce the hepatic gluconeogenic pathway; promote the differentiation of preadipocytes to adipocytes, which could lead to an increased body fat mass; inhibit an insulin-stimulated amino acid uptake by adipocytes; and increase lipolysis or lipid oxidation which leads to the peripheral insulin resistance.

A correlation was observed between plasma cortisol levels, total urinary GC metabolites, and the number of features of the MetS among these patients. Both the secretion rate and the peripheral clearance of cortisol in these patients were positively correlated with the systolic blood pressure, and fasting glucose and insulin.These hormonal alterations may lead to a reactive insulin hypersecretion, an increasing visceral obesity, and sarcopenia, resulting in dyslipidemia, hypertension, and T2DM.

Systemic Effects of Metabolic Syndrome:

Renal: Microalbuminuria, hypofiltration, hyperfiltration, glomerulomegaly, focal segmental glomerulosclerosis, and chronic kidney disease [(F. Locatelli, P et al 2006).

Hepatic: Increased serum transaminase, nonalcoholic steatohepatitis (NASH), nonalcoholic fatty liver disease (NAFLD), hepatic fibrosis, and cirrhosis (100 K. D. Bruce et al 2009).

Skin: Acanthosis nigricans, lichen planus, systemic lupus erythematosus, burn-induced insulin resistance, psoriasis, androgenetic alopecia, skin tags, skin cancer, and acne inversa [T. Padhi and Garima 2013)

Ocular: Nondiabetic retinopathy, age related cataract-nuclear, cortical, posterior subcapsular; central retinal artery occlusion, primary open angle glaucoma, oculomotor nerve palsy, and lower lid entropion (R. Chopra, A. Chander, and J. J. Jacob 2012)

Sleep: Obstructive sleep apnea (OSA) (J. C. M. Lam and S. M. I. Mary 2010)

Reproductive system: Hypogonadism, polycystic ovarian syndrome (PCOS), and erectile dysfunction (A. Dokras et al 2005).

Cardiovascular system: Coronary heart disease (CHD), myocardial infarction (MI), and stroke (E. Standl 2005)

Cancers: Breast, pancreas, and prostrate (Y. Handelsman 2009).

CHAPTER: 4

GENETICS OF METABOLIC SYNDROME

The great variations in the susceptibility and age of onset in individuals with a very similar risk profile suggest a major interaction between genetic and environmental factors. It is recognized that some people who are not obese by traditional measures nevertheless are insulin resistant and have abnormal levels of metabolic risk factors. Considerable individuals and ethnic variations also exist in the clinical pattern of metabolic risk factors in obese/insulin resistant subjects.

It is likely that the expression of each metabolic risk factor falls partially under its own genetic control, which mainly influences the response to different environmental exposures. For example, a variety of polymorphisms in genes affecting lipoprotein metabolism are associated with the worsening of dyslipidemia among obese people.

Similarly, a genetic predisposition to the defective insulin secretion when combined with insulin resistance can raise the plasma glucose to abnormal levels.

According to the thrifty genotype hypothesis proposed by Neel in 1962 , individuals living in a harsh environment with an unstable food supply would maximize their probability of survival if they could maximize a storage of surplus energy.

Genetic selection would thus favour the energy-conserving genotypes in such environments. However, the selected genetic variations that were present during malnutrition would become unfavourable when nutrition improved. This

hypothesis assumes that the common genetic variants of thrifty genes predispose to MetS.

Another thrifty phenotype hypothesis was introduced by Hales and Barker in 1992.

According to this hypothesis, babies who experienced an intrauterine malnutrition may have adapted to a poor nutrition by reducing energy expenditure and becoming "thrifty."

Support for this hypothesis comes from the observed associations of low birth weight with later development of insulin resistance and T2DM in several populations.

There is differing opinion on the definitions and relatively low power of studies to detect the subtle effects of genetic variation, therefore genetics of metabolic syndrome is difficult to dissect.

The proposed candidate genes for metabolic syndrome are involved in energy storage and often support the thrifty phenotype (Speakman J R, 2006).

When the energy storing genetic variants are exposed to the westernized environment and abundance of high calorie food and physical inactivity, they may have become detrimental and cause the phenotype with metabolic disturbances observed in metabolic syndrome, including obesity and glucose intolerance.

Clustering of genes in families suggest a genetic component.

Candidate genes have a number of common variants which influence fat and glucose metabolism, these along with environmental factors can increase the susceptibility to the syndrome.

Among these, the genes for β3-adrenergic receptor, hormone-sensitive lipase, lipoprotein lipase, IRS-1, PC-1, skeletal muscle glycogen synthase, etc. appear to increase the risk of the metabolic syndrome. In addition, novel genes

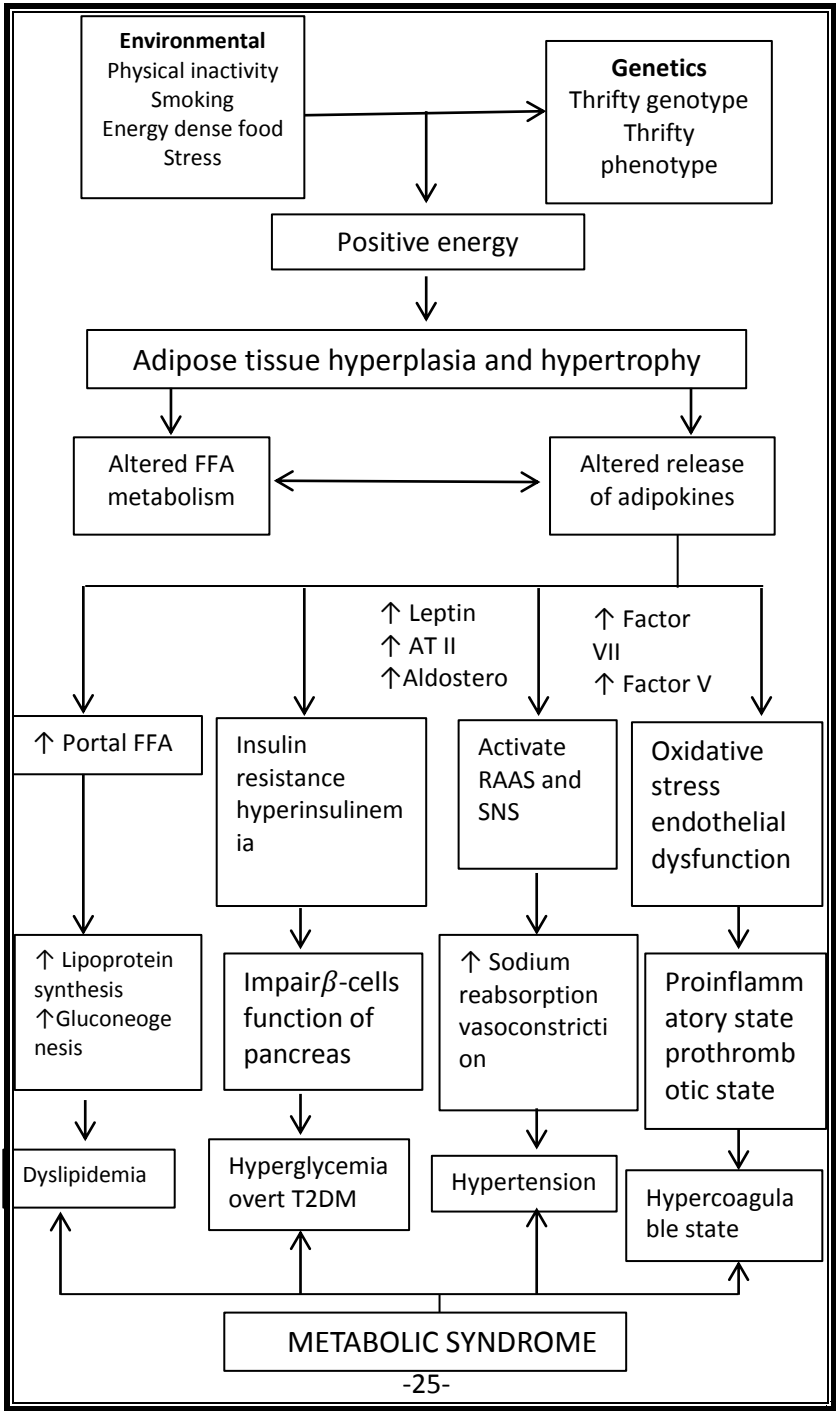
may be identified by genome-wide searches. Among genes contributing to the metabolic syndrome, genes regulating lipolysis and thermogenesis still remain prime candidates (Groop L, 2000).

To date, no unifying genetic factors predisposing to metabolic syndrome have been clearly identified. Several genes have however been associated with at least two factors of metabolic syndrome and are therefore considered to be most promising candidate genes.

The adrenergic b- receptors (ADRB1,ADRB2 AND ADRB3) have been associated with obesity, hypertension and glucose intolerance and can therefore be considered as good candidates for predisposing to development of Metabolic syndrome (Bengtsson, K. et al 2001, Dionne, I.J. et al, 2002).

Several potential candidate genes have been suggested by their biologic relevance, such as genes in systems of energy balance, nutrient partitioning, lipid and insulin metabolism, lipolysis, thermogenesis, fuel oxidation, and glucose uptake in skeletal muscle.

These candidate genes include but are not limited to peroxisome proliferator-activated receptor (PPAR γ), adiponectin, CD36, β-adrenergic receptors, insulin receptor substrates (IRS), 11 β-hydroxysteroid dehydrogenase type 1 (11β-HSD1), CRP, tumor necrosis factor-α (TNF-α), calpain-10 (CAPN10), upstream transcription factor 1, and skeletal muscle glycogen synthase (Song Q, 2006).


Environmental
Physical inactivity
Smoking
Energy dense food
Stress
Genetics
Thrifty genotype
Thrifty phenotype
Positive energy
Adipose tissue hyperplasia and hypertrophy
Altered FFA metabolism
Altered release of adipokines
↑ Leptin
↑ AT II
↑Aldostero
↑ Factor VII
↑ Factor V
↑ Portal FFA
Insulin resistance hyperinsulinemia
Activate RAAS and SNS
Oxidative stress endothelial dysfunction
↑ Lipoprotein synthesis
↑Gluconeogenesis
Impairβ-cells function of pancreas
↑ Sodium reabsorption vasoconstriction
Proinflammatory state prothrombotic state
Dyslipidemia
Hyperglycemia overt T2DM
Hypertension
Hypercoagulable state
METABOLIC SYNDROME

Schematic presentation of MetS:(FFA: Free fatty acid, ATII: Angiotensin II, PAI-1: Plasminogen activator inhibitor-1, RAAS: Renin angiotensin aldosterone system, SNS: Sympathetic nervous system) (Jaspinder Kaur : 2014, Article ID 943162

http://dx.doi.org/10.1155/2014/943162)

CHAPTER: 5

BIOMARKERS OF METABOLIC SYNDROME AND PERIODONTAL DISEASES

Leptin :-

Leptin is an nitric oxide (NO) dependent vasodilator but also increases the peripheral vascular resistance and the sympathetic nerve activity (T. Shirasaka et al 2003). It is an adipokine mainly involved in the regulation of satiety and energy intake (D. C.W. Lau 2005). Levels of leptin in the plasma increase during the development of obesity and decline during the weight loss. It is expressed in levels proportionate to adipose mass, and though it is produced mostly by adipocytes, it is also produced by vascular smooth muscle cells, cardiomyocytes, and by placenta in pregnant women.

The functional leptin receptor is in the hypothalamus and the brain stem where it functions to increase energy expenditure and reduce appetite and neuroendocrine function.

The receptor is also found in other organs such as the heart, liver, kidneys, and pancreas; it is also present in the smooth muscle and endothelium of heart, brain vasculature, and myometrium

Most overweight and obese individuals have an elevated level of leptin that do not suppress appetite, or in other words, leptin resistance.

Leptin resistance is thought to be a fundamental pathology in obesity. Besides its effect on appetite and metabolism, leptin acts in the hypothalamus to increase the blood

pressure through activation of the sympathetic nervous system (SNS). (M. Carlyle, O. B. Jones, J. J. Kuo, and J. E. Hall, 2002).

High circulating levels of leptin are reported to explain much of the increase in the renal sympathetic tone observed in obese human subjects (N. Eikelis, M. Schlaich, A. Aggarwal, D. Kaye, and M. Esler, 2003).

Leptin-induced increase in renal sympathetic activity and blood pressure is mediated by the ventromedial and dorsomedial hypothalamus.

The concentration of plasma leptin is correlated with adiposity, and hyperlepidimia is indeed considered an independent cardiovascular disease risk factor (R.V. Considine et al 1996).

Leptin has a functional receptor (Ob-Rb), in the myocardium, and studies have shown a direct link between leptin and myocardial structural remodeling. There is controversy as to whether leptin causes or protects from left ventricular hypertrophy (LVH) as research has shown mixed results, though more suggest it contributes to LVH. Independent of conventional risk factors, studies have shown that leptin can predict myocardial infarction.

Leptin also affects vascular structure by promoting hypertension, angiogenesis, and atherosclerosis.

Leptin's role as a biomarker for metabolic syndrome has been researched in different populations.

Elevated leptin is associated with obesity, insulin resistance, myocardial infarction, and congestive heart failure. Yoshinaga et al found that leptin was the most sensitive marker for predicting metabolic syndrome (and cardiovascular risk) in elementary school children.

Lee et al found that leptin was elevated in postmenopausal women with metabolic syndrome. They found a positive correlation with leptin and abdominal obesity (one of the

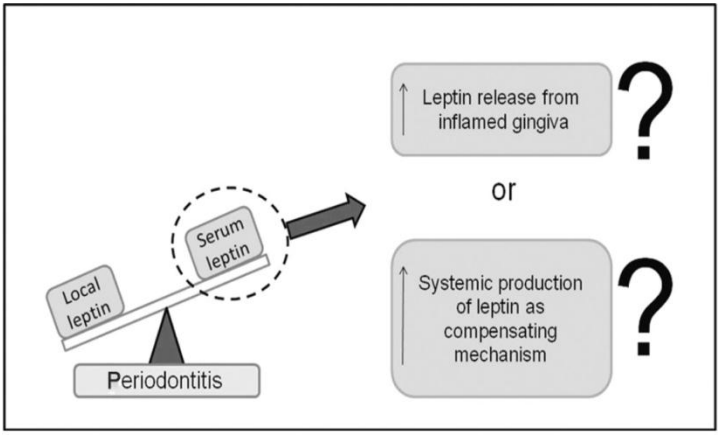
components of metabolic syndrome), and with the number of components of metabolic syndrome present.

A study of a Lebanese population, which focused on nondiabetic males over fifty years old, also found elevated leptin levels associated with metabolic syndrome.

This study found that leptin was strongly correlated with waist size, but was only weakly correlated with lipid profile, which disappeared with BMI adjustment.

Similar findings of elevated leptin associated with metabolic syndrome, independent of BMI, were found in a Korean population. In this study by Yun et al, serum leptin levels increased as the components of metabolic syndrome increased, regardless of obese and non-obese weight status, implying that reduction of leptin levels may be protective, regardless of weight loss.

Contrary to this, Martins et al, found a direct positive association between leptin and obesity, hyperinsulinemia and insulin resistance, but was only weakly related to other components of metabolic syndrome.



Increased serum leptin levels are seen in periodontitis.

Two putative explanations have been proposed.

First, gingival inflammation would result in vasodilation, which might increase the net rate of leptin removal from the gingiva and increase serum leptin levels.

The second hypothesis states that serum leptin levels rise as a body defense mechanism to counteract periodontal inflammation (according to Karthikeyan and Pradeep, 2007b).

Leptin negatively regulates the appetite and weight, mainly through a central mechanism involving the hypothalamus.

It also can interact with other hormones, such as insulin (Margetic et al., 2002; Guzik et al., 2006).

Obesity appears to be a condition of relative leptin resistance, with an elevated circulating level of leptin reported due to an enlarged fat mass (El-Haschimi et al., 2000). Moreover, there is some evidence that leptin is involved in the pathogenesis of atherosclerotic vascular disease (Wolk et al., 2004).

A decreasing leptin level in GCF and gingival tissue is associated with a more deteriorated periodontal status (Johnson and Serio, 2001), and smokers also show reduced GCF leptin levels (Bozkurt et al., 2006), suggesting a protective role of leptin for the periodontium.

The relationship between GCF and serum levels of leptin has been recently reported (Karthikeyan and Pradeep, 2007). GCF leptin levels are proportional to Body Mass Index (BMI).

In periodontitis, there is a significant negative correlation between GCF and serum leptin concentration, and these changes are significantly associated with increasing clinical attachment loss.

By contrast, a study of periodontitis and MetS (Borges et al., 2007) found a higher serum leptin level in healthy and chronic gingivitis individuals than in those with initial/moderate or advanced periodontitis.

Adiponectin:

Adiponectin, like leptin, is an adipose-derived plasma protein with widespread effects. However, unlike leptin, it is secreted exclusively from adipocytes. The different forms of adiponectin include low molecular weight trimer, middle molecular weight hexamer, and high molecular weight (HMW) (Lara-Castro C, Fu Y, Chung BH, Garvey WT 2007).

The HMW form is believed by many to be the more active form and has the most favorable metabolic effects on insulin sensitization and protection against diabetes.

Adiponectin has many functions, including anti-atherogenesis, insulin sensitization, lipid oxidation enhancement, and vasodilatation.

Therefore, it stands to reason that it is related to metabolic syndrome given its impact on all of these components.

It suppresses almost all processes involved in atherosclerotic vascular change: the expression of adhesion molecules in vascular endothelial cells, adhesion of monocytes to endothelial cells (via TNF-α inhibition), vascular smooth muscle cell proliferation and migration, and foam cell formation (via oxidized LDL inhibition) (Matsuzawa Y et al 2004);.

It has insulin-sensitizing activities, with high levels exerting a protective effect against type 2 diabetes in diabetes-prone individuals and low levels being an independent risk factor for future development of type 2 diabetes.

Levels of adiponectin are low in subjects with essential hypertension and in the obese, but adiponectin levels can be increased with weight loss.

A study of Japanese adults by Ryo et al showed that adiponectin levels were negatively correlated with waist circumference, visceral fat, serum triglycerides, fasting plasma glucose, fasting plasma insulin, and systolic and

diastolic blood pressure in males and females, and positively correlated with high density lipoprotiens. As the mean number of metabolic syndrome components increased, plasma adiponectin levels decreased.

They found that men had lower levels of adiponectin than women, since it may be part of the reason why women have a lower risk of coronary artery disease.

Gannage et al found adiponectin to be inversely correlated with metabolic syndrome, independent of BMI as other studies have also shown in the past.

Santaneimi et al studied a Finnish population and found decreasing adiponectin levels correlated with an increasing number of components of metabolic syndrome in both sexes, and this was once again independent of BMI.

Overall, the literature shows that adiponectin is inversely related to metabolic syndrome and the number of components present. However, many believe HMW adiponectin to be the more active form and Falahi et al suggest that HMW adiponectin may even be the most reliable biomarker for metabolic syndrome diagnosis.

Hara et al found that the ratio of HMW adiponectin to plasma adiponectin was an even better predictor of insulin resistance and metabolic syndrome.

Therefore, adiponectin, and preferably HMW adiponectin, should be considered on a panel of biomarkers for metabolic syndrome diagnosis.

Adiponectin levels remain relatively constant in normal circumstances (Trujillo and Scherer, 2005), but are decreased in obesity, insulin resistance, and diabetes, and in cardiovascular disease with increasing severity (Matsuzawa et al., 2004).

This reduction appears to precede these disorders, and low adiponectin levels have been shown to predict the development of insulin resistance and type 2 diabetes

(Spranger et al., 2003; Yamamoto et al., 2004). Thus, adiponectin has a key role in the development of MetS.

By an in vitro approach, adiponectin acts as a potent negative regulator of the osteoclast formation induced by Aggregatibacter actinomycetemcomitans lipopolysaccharide (LPS).

Therefore, adiponectin could exert an anti-inflammatory effect in periodontitis sites, and thereby have a negative influence over the onset and progression of periodontitis (Yamaguchi et al., 2007).

In humans, two recent studies (Furugen et al., 2008; Saito et al., 2008) have found that serum adiponectin levels tended to decrease in Japanese persons with periodontitis, not significantly.

Adiponectin levels were negatively correlated with mean attachment loss, but not mean probing depth or percentage of sites bleeding on probing.

Another study (Iwamoto et al., 2003) found that serum adiponectin levels did not change significantly after periodontal t Adiponectin is inversely associated with CVD risk factors such as blood pressure, low density lipoprotein cholesterol (LDL-C), and TGs.

Moreover, Pischon et al. have shown adiponectin to be a strong inverse independent risk factor for CVD.

Further, Fumeron et al. concluded that hypoadiponectinemia is associated with insulin resistance, hyperinsulinemia, and the possibility of developing T2DM, independent of fat mass.

The anti-inflammatory molecule, adiponectin, is negatively associated with the body weight, WC, TGs, fasting insulin, insulin resistance (HOMA-Homeostasis Model Assessment), BMI, and blood pressure, whereas a positive association exists between adiponectin and HDL-C (A. M. Xydakis, C. C. Case, P. H. Jones et al. 2004).

Its expressions and secretions are reduced by TNFα, possibly through a stimulated production of IL-6, which also inhibits adiponectin secretion.

Adiponectin is seen to be "protective," not only in its inverse relationship with the features of MetS but also through its antagonism of TNFα action (N. Ouchi, S. Kihara, Y. Arita et al 2000).

Leptin: Adiponectin Ratio

Studies have determined that the leptin: adiponectin ratio (LAR) is more beneficial than either alone. Falahi et al showed that a high LAR is a better biomarker than leptin or adiponectin alone for the diagnosis of metabolic syndrome.

A study of Japanese patients found that LAR was significantly and positively associated with the number of components of metabolic syndrome present, and the ratio was independently associated with each component of metabolic syndrome.

Cicero et al found the LAR to be strongly associated with metabolic syndrome, especially in males. The association was weaker in females since they had more elevated adiponectin levels, which is thought to be protective against metabolic syndrome.

Others postulate that the ratio difference between males and females is due to the difference in glucose and lipid metabolism.One limiting factor with using just adiponectin or leptin is that the difference between adiponectin and leptin tends to be small in the fasting vs postprandial state.

Therefore, one of the benefits of using the LAR is that it has the potential to assess insulin sensitivity and metabolic syndrome in the no fasting state.

Ghrelin:

Ghrelin is a neuroendocrine hormone secreted primarily by the stomach that stimulates appetite directly via activation of the GH secret agogue receptor 1a (GHSR-1a) in the

hypothalamus, and indirectly by increasing expression of orexigenic peptides, such as neuropeptide Y (NPY) (Varela L et al 2011).

It may also be protective of vasculature by antagonizing the effects of vasoconstrictors, such as endothelin 1, and promoting the effects of vasodilators, such as nitric oxide (NO). Furthermore, it can help to promote lipolysis via stimulation of hypothalamic AMP-activated protein kinase (AMPK).

Research into the vasoprotective and lipolytic properties of ghrelin is emerging and presents two pathways by which ghrelin can exert a protective effect against metabolic syndrome.

Metabolic syndrome is associated with lower levels of ghrelin, and progressively lower ghrelin levels are associated with increasing metabolic syndrome severity. Ghrelin levels have been shown to be higher in females than males. Low ghrelin levels have been associated with the components of metabolic syndrome including obesity, insulin resistance, and hypertension.

In obese patients, ghrelin levels are lower in insulin resistant patients compared to insulin sensitive obese patients.

Plasma ghrelin levels are also decreased in the healthy offspring of type 2 diabetes patients suggesting a genetic component to ghrelin regulation.

Ghrelin is implicated in endothelial function by preventing proatherogenic changes and improving vasodilation.

Tesauro et al assessed vascular function by measuring forearm blood flow in metabolic syndrome and control patients. They showed that exogenous ghrelin significantly reduced the vasoconstrictor effects of endothelin 1 and enhanced the vasodilator effects of NO in metabolic syndrome patients, but did not have a significant effect on vascular tone in control patients.

Given ghrelin's relation to each of the components of metabolic syndrome, to metabolic syndrome itself, and the potential to note abnormal levels in healthy individuals with genetic predispositions, it would be an effective biomarker for metabolic syndrome.

Plasminogen Activator Inhibitor – 1:

Plasminogen Activator Inhibitor-1 (PAI-1) is the primary of four serine peptidase inhibitors that functions to modulate extracellular matrix remodeling and fibrinolysis. It binds to and deactivates tissue plasminogens (tissue type plasminogen activator (tPA), urokinase plasminogen activator (uPA)).

Tissue type plasminogen activator is thought to be responsible for intravascular plasminogen activation, with fibrin regulating its activity, and uPA is responsible for plasminogen activation on migrating cells, with the uPA receptor regulating its activity on different cells.

Thus, PAI-1 can inhibit intravascular fibrinolysis and cell-associated proteolysis.

Under physiologic conditions, PAI-1 is secreted into the circulation or extracellular space by endothelial cells, adipocytes, vascular smooth muscle cells, platelets, or hepatocytes. Under pathologic conditions however, PAI1 is induced by many pro-inflammatory and pro-oxidant factors.

For example, when TNF-α, transforming growth factor beta (TGF-β), angiotensin II, glucocorticoids, and insulin are elevated, adipocytes are stimulated to increase PAI-1 levels.

Hypoxia and Reactive oxygen species(ROS) also increase PAI-1 levels. Elevated levels of PAI-1 consequently effect vasculature, inflammatory signaling, adiposity, and insulin resistance.

Aberrant PAI-1 levels are associated with several pathological diseases. For example, high levels are

positively correlated with thrombotic vascular conditions such as myocardial infarction and deep vein thrombosis. This is thought to be related to the inhibition of fibrin degradation and vessel wall remodeling.

It is thought to be a strong risk factor for coronary artery disease and some suggest it can be used as an independent risk factor for cardiovascular risk.

It has also been implicated in cancer angiogenesis and metastasis, wound healing, bacterial infections, rheumatoid arthritis, and chronic kidney disease.

The link between PAI-1 and metabolic syndrome has been long established with elevated levels being strongly correlated such that the more severe the metabolic syndrome, the higher the PAI-1.

Kraja et al showed that PAI-1 was strongly associated with the components of metabolic syndrome, including BMI, triglycerides and insulin resistance. Interestingly, several groups have found that PAI-1 levels are not associated with dyslipidemia but rather with the distribution phenotype of adipocytes: visceral adipose tissue primarily and ectopic fat in the liver.

PAI-1 can serve as a biomarker for ectopic fat storage. Like several of the other metabolic syndrome biomarkers, differences between the sexes have been noted, with the relationship being stronger in males than females.

PAI-1 levels decrease with calorie restriction, weight loss, decrease in body fat, and when insulin resistance improves.

Treatment with insulin-sensitizing drugs decreases PAI-1 in patients with diabetes and to some extent in otherwise healthy obese individuals.

Uric Acid:

Uric acid is an endogenously produced terminal degradation product of purine catabolism, formed by the liver and

excreted by the kidneys primarily and intestines secondarily.

Uric acid has antioxidant capacities extracellularly and can be responsible for 2/3 of the total plasma antioxidant capacity, where it chelates metals and scavenges oxygen radicals.

However, intracellularly, it has pro-inflammatory and pro-oxidant activity. It has been shown that uric acid is a circulating marker for oxidative damage in conditions like ischemic liver, atherosclerosis, diabetes, and chronic heart failure.

As a pro-oxidant, under ischemic conditions or as a result of tissue damage, uric acid oxidizes lipids, which results in inflammation that disrupts reverse cholesterol transport.

It also decreases the availability of nitric oxide, which results in less vasodilation and more reactive oxygen species (ROS). This, coupled with its ability to stimulate monocytes to produce TNF-α, creates a pro-inflammatory state found in metabolic syndrome.

Though its role in pathological diseases is not completely understood, uric acid likely causes systemic inflammation.

Hyperuricemia is a well-known risk factor for atherosclerotic events like myocardial infarction and stroke, and is associated with other cardiovascular risk factors like hypertension and dyslipidemia. Ishizaka et al also found a positive correlation between uric acid and BMI, blood pressure, and triglycerides, and a negative correlation with HDL-C.

Silva et al shows that uric acid levels are significantly elevated in males with abdominal obesity and females with abdominal obesity, low HDL-C, and hypertension.

Hyperuricemia is a marker of insulin resistance, as some studies have shown that decreasing insulin resistance by diet or medications decreases uric acid levels.

Among dietary causes of hyperuricemia, excess consumption of fructose via added sucrose or high-fructose corn syrup is of particular interest, as this dietary component has also been implicated in metabolic syndrome.

According to Khitan and Kim, fructose metabolism is initiated by an enzyme called ketohexokinase (KHK), also known as fructokinase. This ATP-dependent step in fructose metabolism lacks a negative feedback mechanism, so in the event of excessive fructose consumption, ATP is rapidly depleted and many of the dephosphorylated adenosine compounds are catabolized, resulting in increased uric acid.

Johnson et al demonstrated a link between fructose-induced hyperuricemia and an increased incidence of metabolic syndrome and some of its features, including obesity, hypertension, and insulin resistance.

Ishizaka et al investigated the relationship between uric acid and metabolic syndrome and found there to be a graded increase in the prevalence of metabolic syndrome with increasing uric acid in both sexes, though there are differences in the levels between males and females.

Levels of uric acid increase with age: in women of childbearing age, levels are lower, but increase to similar levels as males in post-menopausal conditions. Several studies have shown that uric acid levels are significantly elevated in individuals with metabolic syndrome, increases with the number of components of the condition, and are an indicator of worse cardiovascular risk profile. It is estimated that individuals with a high uric acid have an odds ratio of 1.6-fold higher for developing metabolic syndrome.

The close relationship between uric acid and the presence of metabolic syndrome has been demonstrated in children, adolescents,and adults.

Through a search of the published literature to date, uric acid appears to be the only metabolic syndrome biomarker studied in the West Virginian population.

Soukup et al studied salivary uric acid as a biomarker for metabolic syndrome and found the relationship to metabolic syndrome and each of its components similar to that of serum uric acid.

Similar to other studies, Soukup et al noted a stronger association between uric acid levels and metabolic syndrome in females than in males. This is a noninvasive and cost-effective method to diagnose and monitor metabolic syndrome.

Interleukin-6:

Interleukin-6 (IL-6) is a pro-inflammatory cytokine that plays a role in the natural inflammatory response.

It is often secreted by M1 macrophages as part of the normal inflammatory response against infection and injury. In metabolic syndrome, adipocyte dysfunction is frequently present and is associated with an increase in M1 macrophage population within adipose tissue.

This can result in increased secretion of IL-6 and other pro-inflammatory cytokines from adipose tissue. These pro-inflammatory cytokines can then act through a number of cell signaling pathways, including mTOR and Protein Kinase C (PKC) to induce insulin resistance.

Through its inflammatory properties it has been implicated in the endothelial cell damage within blood vessels that leads to vascular dysfunction and atherosclerosis.

Furthermore, IL-6 can cause aberrant insulin receptor activation, resulting in abnormal insulin signaling cascades, abnormal insulin action, and abnormal glucose metabolism.

Studies have shown that elevated levels of IL-6 are associated with metabolic syndrome and increasing levels are associated with more severe metabolic syndrome

(assessed by hypertriglyceridemia, hypertension, and fasting glucose levels). Similar to other biomarkers, IL-6 is also associated with each of the components of metabolic syndrome. In a study on postmenopausal women, elevated IL-6 was also associated with abdominal obesity, low HDL, and high triglycerides.

Indulekha et al found elevated IL-6 was associated with insulin resistance. In vivo animal studies have shown the effect of IL-6 on insulin signaling: the administration of IL-6 to mice resulted in impaired insulin signaling in muscle and liver tissue, leading to hyperglycemia and insulin resistance.

IL-6's close association with metabolic syndrome and each of its components suggests that it is an important factor in the progression of metabolic syndrome and would be a good addition to a biomarker panel.

Tumor Necrosis Factor-Alpha:

Tumor Necrosis Factor-Alpha (TNF-α) is a pro-inflammatory cytokine that is secreted by visceral adipose tissue, a common characteristic of metabolic

syndrome. Because metabolic syndrome is often characterized by adipocyte dysregulation, and these dysregulated adipocytes tend to secrete TNF-α, IL- 6, and other pro-inflammatory adipokines at higher levels, the central obesity often encountered in metabolic syndrome could be a risk factor for elevated TNF-α levels.

Furthermore, elevated TNF-α levels are associated with insulin resistance via its aberrant activation of the mTOR and PKC signaling pathways.

Its contribution to the various characteristics of metabolic syndrome suggest that TNF-α may be a significant contributor to the development and progression of its associated disease processes.

In a study of middle-aged adults with metabolic syndrome, elevated levels of TNF-α and other pro-inflammatory cytokines were associated with insulin resistance and hypertriglyceridemia. The TNF-α, IL-6, and leptin levels in these patients were higher than those levels in the control group, indicating that these cytokines directly correlated with metabolic syndrome.

It was hypothesized by Balasoiu et al that early detection of a patient's inflammatory status, including TNF-α and IL-6, could be useful in monitoring and early intervention for metabolic syndrome and its comorbidities [81]. In another study of metabolic syndrome patients with coronary artery disease (CAD), TNF-α levels were found to be significantly higher than the controls [82]. Indulekha et al also found elevated TNF-α levels to be significantly correlated with the presence of metabolic syndrome, and more so in those with insulin resistance.

Musialik et al demonstrated elevated levels of soluble TNF-α receptor (sTNFα-R), which is associated with increased TNF-α activity, in patients with metabolic syndrome with hypertension.

Because it exerts such widespread systemic effects, TNF-α may contribute to the various disease processes associated with metabolic syndrome and its components.

Interleukin-10:

Interleukin-10 (IL-10) is a predominantly anti-inflammatory cytokine that plays a role in modulating systemic inflammation.

Secreted by monocytes or M2 macrophages, one of its functions is to help promote normal tissue remodeling following an inflammatory response. One of the methods by which IL-10 moderates the inflammatory response is by inhibiting NADPH oxidase, and therefore the oxidative stress resulting from this enzyme.

This has been associated with aberrant insulin receptor substrate (IRS) activation and impaired insulin signaling.

Furthermore, the insulin signaling pathway can be dysregulated by abnormal levels of the pro-inflammatory cytokines IL-6 and TNF-α. IL-10 can restore normal insulin signaling by inhibiting NADPH oxidase-induced oxidative stress or by antagonizing the actions of IL-6 and TNF-α.

Regarding the role IL-10 plays in insulin signaling, a cross-sectional population study of elderly adults demonstrated that low levels of IL-10 are associated with insulin resistance and type 2 diabetes.

Furthermore, the study found that IL-10 levels inversely correlated with levels of total cholesterol, LDL, triglycerides, blood glucose and hemoglobin A1c, and positively correlated with HDL levels.

Additionally, in a study on mice treated with IL-6 to induce insulin resistance, in vivo administration of IL-10 demonstrated protection from the impaired insulin signaling that resulted from IL-6 administration, thereby restoring insulin sensitivity and normal glucose metabolism in liver and muscle tissue. Because it antagonizes the pro-inflammatory actions of IL-6 and TNF-α, which are both associated with metabolic syndrome and its comorbidities, IL-10 appears to exert a protective effect against increases in these cytokines.

The significance of IL-10 in relation to metabolic syndrome as a whole, rather than its components, however, is a little more complicated.

A study of obese children, found IL-10 levels to be elevated in metabolic syndrome, even after BMI was taken into account. Calcaterra et al proposed the elevated levels to be due to the first phase of a complex mechanism in the development of metabolic syndrome in children.

Esposito et al studied obese and non-obese women and found IL-10 to be elevated in obese women compared to

non-obese women but IL-10 levels were significantly lower in both obese and nonobese women with metabolic syndrome.

Others have also shown IL-10 levels to be significantly decreased in those with metabolic syndrome in both males and females. Some have shown that

IL-10 levels are significantly correlated with other cytokines like IL-6 and TNF-α. Adiponectin is correlated with IL-10 in patients with metabolic syndrome and not the general population.

This suggests that if both IL-10 and adiponectin are low, the risk of metabolic syndrome is likely greater. The use of multiple biomarkers in a panel would likely increase thesensitivity and specificity.

Oxidized LDL:

Oxidized LDL (OxLDL) is a product of lipid oxidation and can serve as a marker of oxidative stress.

Lipid oxidation contributes to the generation of reactive oxygen species (ROS). These products form components of OxLDL. Lipid oxidation products, ROS, and OxLDL in low concentrations can serve as signaling compounds for pathways of cellular antioxidants, including Heme Oxygenase (HO-1) and glutathione.

However, if the antioxidant capacity of the cell is dysfunctional, as is often seen in metabolic syndrome, then these compounds contribute to an oxidative cascade that eventually leads to cell damage and apoptosis.

This widespread cell damage and death can contribute to the vascular dysfunction commonly seen in metabolic syndrome, while the dysfunctional OxLDL can further contribute to dyslipidemia, presenting a risk factor for cardiovascular diseases, which are common morbidities associated with metabolic syndrome.

OxLDL contributes to atherosclerosis by invading and damaging the blood vessel endothelium. In addition to cardiovascular disease, elevated levels of OxLDL in adults are associated with obesity and insulin resistance, two common components of metabolic syndrome.

Levels of OxLDL are significantly elevated in metabolic syndrome patients and these elevated levels are further associated with reduced arterial elasticity, a risk factor for the development of CAD.

Other studies on children associated elevated levels of OxLDL with increased adiposity and insulin resistance. This study suggested that oxidative stress, measured by OxLDL levels, could be a contributing factor to insulin resistance, and that these changes can present early in life.

Additionally, a longitudinal study of young adults measured at baseline, 15 years later, and 20 years later demonstrated a significant positive correlation between OxLDL levels and the incidence of metabolic syndrome that arose between the 15-year and 20-year follow-ups.

The study also associated elevated Ox-LDL levels with central obesity, hyperglycemia, and hypertriglyceridemia, all of which are components of metabolic syndrome.

Free fatty acids:

Upper body subcutaneous adipocytes generate a majority of circulating FFA while an intra-abdominal fat content has been positively correlated with the splanchnic FFA levels which may contribute to the liver fat accumulation commonly found in abdominal obesity(J. M. Miles et al 2005).

Further, an acute exposure of skeletal muscle to the elevated levels of FFA induces insulin resistance by inhibiting the insulin-mediated glucose uptake, while, a chronic exposure of the pancreas to the elevated FFA impairs a pancreatic β-cell function (G. Boden 2001). FFAs increase fibrinogen and PAI-1.

PAI:

A serine protease inhibitor is secreted from intra-abdominal adipocytes, platelets, and the vascular endothelium (D. C.W. Lau,2005).

It exerts its effects by inhibiting the tissue plasminogen activator (tPA) and thus is considered as a marker of an impaired fibrinolysis and atherothrombosis.

Plasma PAI-1 levels are increased in abdominally obese subjects [58] and inflammatory states [59], thus, increasing the risk of an intravascular thrombus and adverse cardiovascular outcomes (H. P. Kohler et al 2000).

TNFα:

It is a paracrine mediator in adipocytes and appears to act locally to reduce the insulin sensitivity of adipocytes.

Evidence suggests that TNF-α induces adipocytes apoptosis [43] and promotes insulin resistance by the inhibition of the insulin receptor substrate 1 signalling pathway.

The paracrine action would further tend to exacerbate the FFA release, inducing an atherogenic dyslipidemia.

Plasma TNFα is positively associated with the body weight, WC, and triglycerides (TGs), while, a negative association exists between the plasma TNFα and High density lipoprotein–cholesterol (HDL-C).

Interleukin-6:

It is released by both adipose tissue and skeletal muscle in humans [52]. It has both an inflammatory and an anti-inflammatory action. IL-6 receptor is also expressed in the several regions of the brain, such as the hypothalamus, in which it controls an appetite and energy intake (K. Stenlof et al 2003).

It is a systemic adipokine, which not only impairs insulin sensitivity but is also a major determinant of the hepatic production of CRP.

IL-6 is capable of suppressing lipoprotein lipase activity. It has been shown to be positively associated with BMI, fasting insulin, and the development of T2DM and negatively associated HDL-C

Paraoxonase:

Paraoxonase-1 (PON-1) is a multipurpose antitoxic and antioxidant enzyme and is believed to contribute to the antioxidant and anti-inflammatory properties of HDL.

In particular, it can reduce lipid peroxidation and protect LDL and tissue from oxidative stress. Levels of PON-1 activity correlate with systemic antitoxic and antioxidant capacity, whereas oxidative stress and lipid peroxidation are associated with the onset and progression of metabolic syndrome and some of its comorbidities, particularly vascular dysfunction (resulting from OxLDL).

In low concentrations, OxLDL and ROS serve as signaling compounds in cellular antioxidant pathways, which serve to improve cellular protection mechanisms in the face of oxidative stress.

However, if these antioxidant pathways are overwhelmed from excessive oxidative stress, the oxidative cascade can progress to cell damage and death, resulting in tissue damage, particularly in vascular endothelial tissue.

Because of its antioxidant properties, PON-1 may play a role in managing the normal oxidative signaling pathway, and it could serve as a useful biomarker in assessing antioxidant capacity, and by extension, the propensity for systemic inflammation and vascular dysfunction.

In a study of lean, overweight and obese adolescents, decreased levels of PON-1 were associated with central obesity and metabolic syndrome.

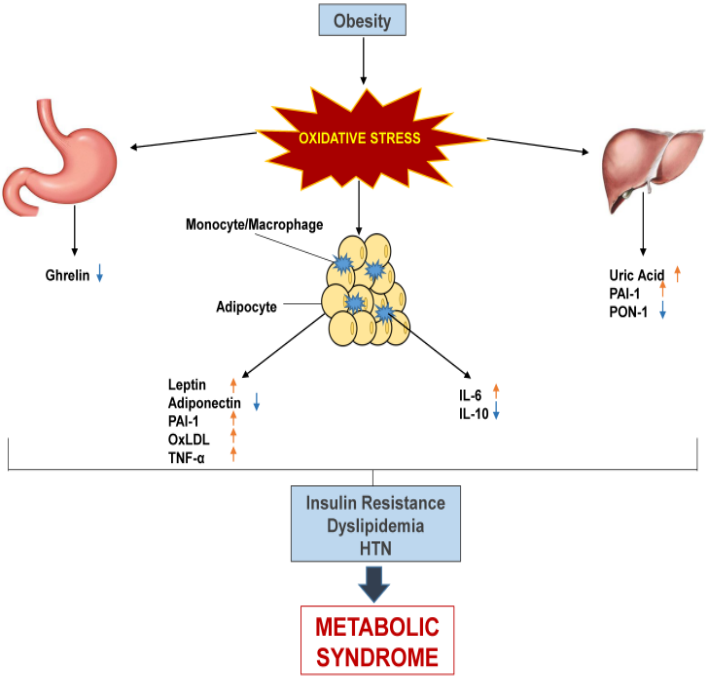
Additionally, lower levels of PON-1 were associated with hypertension, hypertriglyceridemia, insulin resistance, impaired glucose tolerance, and increased oxidative stress.

Another study of women withand without metabolic syndrome showed a negative correlation between PON-1 levels and the presence of CAD in metabolic syndrome patients.

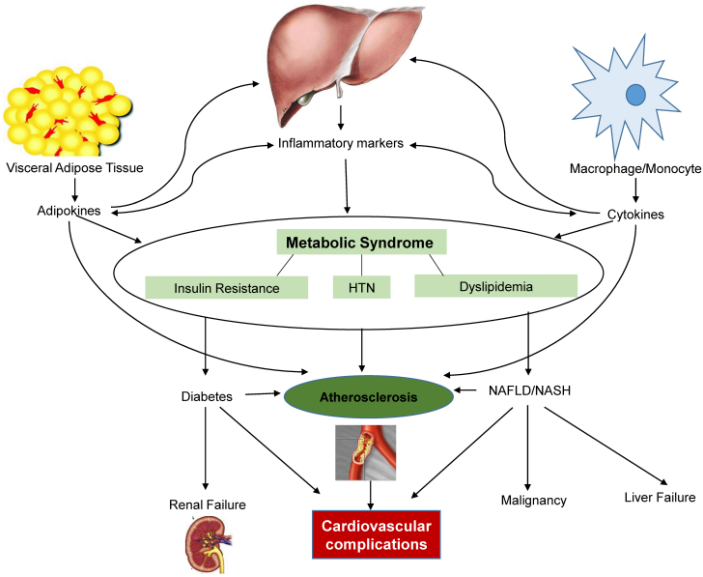
CAD is a significant comorbidity in metabolic syndrome, and lower levels of PON-1 could be suggestive of a diminished effectiveness of HDL to attenuate CAD development and progression.

Martinelli et al also found that decreased PON-1 levels were associated with metabolic syndrome, with an inverse correlation between PON-1 levels and the severity of metabolic syndrome and its comorbidities.

The literature suggests that PON-1, via its antioxidant properties, could play an important role in attenuating the components of metabolic syndrome that arise and progress as a result of oxidative stress.



Schematic Representation of Panel Of Biomarkers In Metabolic Syndrome (Krithika Srikanthan, Int. J. Med. Sci. 2016, Vol. 13)



Interaction of adipokines, cytokines, and inflammatory markers that contribute

to the development of metabolic syndrome and its complications. HTN-Hypertension,

NAFLD/NASH- Nonalcoholic fatty liver disease/nonalcoholic steatohepatitis (Krithika Srikanthan, Int. J. Med. Sci. 2016, Vol. 13)

CHAPTER- 6

ASSOCIATION OF METABOLIC SYNDROME WITH PERIODONTAL DISEASES

METABOLIC SYNDROME AND PERIODONTITIS:

Obesity plays a central role in metabolic syndrome and is an important risk factor for diabetes mellitus and arteriosclerotic diseases. Many studies have reported that obesity is also associated with periodontal disease and in particular, a strong association between visceral fat obesity and periodontitis has been demonstrated.

Moreover, longitudinal studies reporting an increased risk of periodontal disease progression among obese people suggest the possibility that obesity affects periodontal status.

Adipose tissue secretes various adipocytokines, including adiponectin, leptin, and human tumor necrosis factor-α (TNF-α), as physiologically active substances, and the abnormal production of adipocytokines associated with obesity and metabolic syndrome leads to insulin resistance and arterial stiffening.

An increase in TNF-α in blood due to obesity triggers periodontal disease via promotion of inflammation in periodontal tissue, and TNF-α produced due to periodontal tissue inflammation induces insulin resistance, which works negatively in the context of blood glucose metabolic regulation.

It has been shown that the serum leptin concentration is higher in obese individuals than in thin individuals, and in individuals with periodontal disease, the level of leptin is low in gingival crevicular fluid and high in serum.

Moreover, the serum leptin concentration in individuals with periodontitis has been shown to correlate with interleukin-6 (IL-6) and C-reactive protein (CRP), and treatment of periodontitis decreased serum leptin, IL-6, and CRP56, suggesting that the association between metabolic syndrome and periodontal disease involves adipocytokines playing a role as a mediator.

It has been suggested that diabetes mellitus and periodontal disease have a bi-directional relationship.

The diagnostic criteria for metabolic syndrome include hyperglycemia, and in patients with type 2 diabetes mellitus, those who apply to two of the four items of the NCEPATP III diagnostic criteria other than hyperglycemia have been shown to have a high periodontitis risk.

Moreover, individuals with more extensive periodontitis showed a greater increase in HbA1c over a five year period, and this tendency was particularly prominent in those with a high CRP value. These results suggest that chronic inflammation caused by periodontal disease may induce abnormal glucose metabolism, consequently leading to diabetes mellitus.

With regard to the mechanisms underlying the association between metabolic syndrome and periodontal disease, the formation of oxygen free radicals, oxidative stress, lipid peroxidation products, and advanced glycation end products have been indicated to play an important role.

In fact, one study using a mouse model of diabetes mellitus showed that alveolar bone resorption, which occurs as a complication of diabetes mellitus, is possibly caused by local periodontal oxidative stress.

On the other hand, periodontal treatment for periodontitis patients with type2 diabetes mellitus was effective in improving metabolic regulation, such as a decrease in blood glucose levels or HbA1c. Adiponectin decreases blood glucose by improving insulin resistance, which is one of the

characteristics of type 2 diabetes mellitus, and is also said to improve lipid metabolism abnormalities.

Periodontal treatment in patients with type 2 diabetes mellitus, therefore, not only improves their periodontal status but also leads to decreased HbA1c and increased serum adiponectin.

In these contexts, it might be possible to decrease the risk of diabetes mellitus by performing anti-inflammatory periodontal treatment in individuals with abnormal glucose metabolism or metabolic syndrome.

It is a well established fact that the primary etiological agent in periodontal disease is bacterial plaque. The toxins and the enzymes produced by the bacterial plaque elicit inflammatory and immunologic changes in the periodontal tissues at both cellular and molecular levels.

Periodontitis is a common chronic infection of the adult population characterized by an exaggerated gingival inflammatory response against a pathogenic bacterial microflora, resulting in alveolar bone loss and eventually tooths loss.

Periodontitis is associated with systemic alterations like low-grade inflammation Dyslipidemia, glucose intolerance, endothelial dysfunction.

Lipopolysaccharide derived from periodontal pathogen, Porphyromonas gingivalis which increases the circulating tumor necrosis factor-α which induces the insulin-resistance and atheromatous changes.

In metabolic syndrome there is an elevation in circulating proinflammatory cytokines and a procoagulant state exists with elevation of C-reactive protein and fibrinogen.

Both periodontitis and metabolic syndrome are associated with systemic inflammation and insulin resistance with elevation in WBC count as a result of body's defence mechanism.

Considering chronic inflammation as the basis for the association between periodontal disease and metabolic syndrome they can be linked through a common patho physiological pathway.

PERIODONTAL DISEASE AND OBESITY:

Obesity is defined by the body mass index as greater than 30.0kg /m². Cytokines and hormones from the fat tissue plays an important role in the pathogenesis.

Tumor necrosis factor-alpha, leptin, adiponectin and resistin modulates the periodontal response.

Leptin controls the appetitie, regulates the immune response and the production of inflammatory cytokines. The obesity is associated with the reduction of the sensibility to the effects of the leptin which stimulates the immunological system.

In periodontitis there is a negative correlation among the levels of leptin in the gingival crevicular fluid. Adipocytes secreting proinflammatory cytokines may be the molecules linking to the pathogenesis of periodontal infection.

Cytokines and hormones from the fat tissue may play an important role.

The fat tissue, especially the visceral type, acts as an important endocrine organ secreting several bioactive substances, such as adipocytokines. Among the most important ones are the tumor necrosis factor-alpha, leptin, adiponectin and resistin, which may modulate the periodontal response.

The obesity is associated with the reduction of the sensibility to the effects of

the leptin, which stimulates the immunological system since it increases the production of cytokines and the phagocytosis by the macrophages.

It is a specific hormone of the adipocyte acting as a signaling molecule in the hypothalamus to complete the feedback of the lipostatic theory of weight control.

In periodontitis, there is a negative correlation among the levels of leptin in the gingival crevicular fluid (GCF), significantly associated with the increasing of the loss of clinical insertion.

Two explanations have been proposed for the increase of the serum levels of leptin in periodontitis: firstly, the gingival inflammation would result in vasodilatation, which would increase the serum levels of leptin; secondly, the serum levels of leptin would increase as a defense mechanism of the body, to fight the periodontal inflammation.

In the inflammatory periodontal disease, the leptin regulation still needs to be further studied, especially regarding to the epidemiological association between obesity and periodontitis.

Other substance secreted by the fat tissue is the adiponectin. Unlikely to other hormones from the fat tissue, the levels of adiponectin are reduced in people with obesity, insulin resistance or diabetes type 2, acting as an inhibitor of the inflammatory process.

Experimental models have suggested that adiponectin plays a mediator role in inflammatory diseases, acting as a predictor of the insulin resistance and of the diabetes type 2.

Resistin is a specific hormone from the fat tissue recently discovered and it directly induces the insulin resistance in the muscle and liver.

Resistin had its role in periodontitis proved by two studies, in which the serum levels were higher in people exhibiting periodontitis than in control subjects, showing a positive correlation with bleeding on probing.

Moreover, the releasing of the tumor necrosis factor-alpha both by the liver and the periodontal tissues in response to LPS, endotoxins of gram negative periodontal pathogens, would contribute to the insulin resistance.

Data of a study in humans have suggested that the reduction in the serum concentration of LPS may contribute to the control of the metabolic diseases.

A study investigated the role of oral bacterias in the obesity epidemic.

The bacterial population in the saliva of overweight women and normal weight women were measured. The percentage of Selenomonas noxia was capable of identifying 98.4% of the overweight women, suggesting the possibility that the bacterial species act as biological indicators for the development of weight gain and participate in the etiology of obesity.

PERIODONTITIS AND HYPERLIPIDEMIA:

The alterations in immune cell phenotype due to serum lipids and elevation in serum pro-inflammatory cytokines such as TNF-α and IL-1β through periodontitis as a chronic gram (-) infection verified substantial evidences supporting the bidirectional relationship

Lipid metabolism can be altered by chronic and acute periodontal infections which are involved in the plasma concentrations of unregulated cytokines and hormones. The main features of this catabolic state are lipid oxidation and elevated free fatty acids, triglycerides and low density lipoprotein (LDL) cholesterol.

Studies in humans and animals have shown a number of cytokines such as tumor necrosis factor alpha (TNF-α) and interleukin-1 beta (IL-1β) are produced in response to systemic Gram negative LPS exposure.

It is believed that these cytokines exert effects on lipid metabolism by influencing production of other cytokines,

altering hemodynamic/aminoacid utilization of various tissues involved in lipid metabolism, or modifying the hypothalamic-pituitary-adrenal axis increasing plasma concentrations of adrenocorticotropic hormone, cortisol, adrenaline, noradrenaline and glucagon.

These elevations in serum lipids are thought to arise from enhanced hepatic lipogenesis, increased adipose tissue lipolysis/blood flow, increased synthesis or reduced clearance of triglyceride, and reduced clearance of LDL due to reductions in lipoprotein lipase activity.Thus, any condition producing elevations in serum TNF-α and IL-1β which are increased in periodontitis has potential to cause hyperlipidemia.

Lipids may interact directly with the macrophage cell membrane, interfering with membrane-bound receptors and enzyme systems, altering macrophage gene expression for pro-inflammatory cytokines such as TNF-α and IL-1β and essential polypeptide growth factors such as platelet-derived growth factor (PDGF), transforming growth factor beta 1 (TGF-β1) and basic fibroblast growth factor (bFGF).

Additionally, serum lipids, whether induced by diabetes, or diet increase polymorphonuclear leukocyte (PMN) production of pro-inflammatory cytokines and inhibit macrophage production of essential polypeptide growth factors impairing the wound healing process.

Fatty acids may be incorporated into the plasma membrane after dietary lipid administration, so that the composition of lipids in this cellular structure will reflect the composition of dietary lipids.Because of this incorporation, the phospholipid profiles associated with plasma membrane of lymphocytes, monocytes/macrophages or polymorphonuclear cells may be altered by dietary lipids.

Diets including polyunsaturated fatty acids, such as eicosapentaenoic or docosahexaenoic acids, suppress the mitogenic response of lymphocytes to a greater extent than diets rich in saturated fatty acids.

Fatty acids may regulate cytokine production and in fact cytokine modulation by fatty acids seems to be responsible for the reduction of lymphocyte proliferation in both animals and humans.

Cytokines such as IL-1 and TNF are important mediators of inflammation and dietary fatty acids have been demonstrated to be substances capable of reducing the pro-inflammatory response induced by IL-1 and TNF.

It has been reported that unsaturated fatty acids increase phagocytosis which is an important mechanism in many cells for the elimination of microorganisms or foreign particles.

Mechanisms involved in fatty acid modulation are membrane fluidity, production of lipid peroxides, eicosanoid synthesis and influence on gene regulation. As a result of changes in the phospholipids fatty acid composition due to dietary lipid manipulation, the fluidity of the cell membrane may change.

Hyperlipidemia, arising from a high-fat diet or metabolic disorders such as type 2 diabetes, has a dysregulatory effect on immune system cells and on wound healing and as a result, it increases the susceptibility to periodontitis and other infections.

This condition needs a particular threshold level of circulating lipids for every individual, above which can lead to this dysregulatory effect within the gingival mucosa and elsewhere.

It has been reported that consumption of a typical high-fat American breakfast (fried eggs, bacon, potatoes) or a defined saturated-fatrich meal (i.e. ice cream) leads to functional abnormalities in PMNs.

A protective role for PMNs in the early response to periodontal infection is supported by compelling experiments in nature, wherein subjects with impairments of PMN function have more acute and severe periodontitis.

So, PMNs primed by endotoxin or other activating agents, including dietary lipids may play a major role in the pathogenesis of periodontitis. Hyperlipidemia is known to cause a hyperactivity of white blood cells.

Hyperactivity of white cells, e.g., increased production of oxygen radicals, have been shown to be frequently associated with progressive periodontitis in adults.In animals feeding a cholesterol-rich diet have caused to periodontitis.

In an animal model, Maglakelidze et al reported significant changes in extracellular matrix and gingival mucous cells as well as in microcirculatory bed components in hypercholesterolemia.

Hypercholesterolemia damages endotheliocytes, subendothelial zone and basal membrane permeability. The contact of lymphocytes and plasmocytes with the vascular wall confirms the trigger role of the vascular factor in damaging of periodontal complex.

There are several studies which report significant association between plasma lipid levels and the severity of the periodontal disease.

While some authors mentioned that there were significant correlations between periodontal status and cholesterol levels, others indicate that there were significant associations between triglyceride level and periodontal disease.

The studies which trying the effect of periodontal therapy on serum lipids and lipoprotein associated inflammatory mediators also suggested that the treatment of periodontal disease have beneficial effects on lipid metabolism.

In one study conducted in systemically healthy subjects with periodontitis, Pussinen et al stated that periodontitis is associated with macrophage activation via increased serum LPS concentration.

Additionally, there was a significant increase in the ratio of HDL/LDL after periodontal treatment in this study.

In another study, Pussinen et al reported that there were statistically significant decreases in CRP and serum amyloid A levels after periodontal treatment in systemically healthy subjects with periodontitis. That study also suggested that periodontitis diminishes the anti-atherogenic potency of HDL and increase the risk for coronary heart disease.

Lösche et al evaluated 32 patients with moderate to severe periodontitis before and 3 months after local periodontal treatment and they reported that treatment of periodontitis caused a significant reduction in the serum activity of lipoprotein-associated phospholipase A2 which is believed to be an independent cardiovascular risk factor.

In a similar study, 65 subjects presenting with severe (probing pocket depth greater than 6 mm and marginal alveolar bone loss greater than 30%), generalized (at least 50% of teeth affected) periodontitis were assessed and the 3 groups consisted of untreated control; standard periodontal therapy; and an intensive periodontal treatment including standard periodontal treatment with adjunctive local delivery of minocycline.

In that study both standard periodontal therapy and intensive periodontal therapy resulted in significant reductions in serum CRP compared with the untreated control and the intensive periodontal therapy group also showed a decrease in total and LDL cholesterol after 2 months following the periodontal treatment.

Higher serum levels of total cholesterol, LDL-C and triglycerides have been found in subjects with periodontal disease and hyperlipidemic patients have a significantly higher percentage of sites with probing depth greater than 3.5 mm than subjects with normal metabolic status.

The interrelationship between periodontitis and hyperlipidemia provides an example for systemic disease predisposing to oral infection, and once the oral infection is established, it exacerbates systemic disease.

PERIODONTITIS AND CARDIOVASCULAR DISEASE:

Systemic and local chronic inflammatory states, such as periodontitis and MetS, are characterized by an elevated presence of acute-phase proteins such as C- reactive protiens and fibrinogen, which represent a decisive contribution to the insurgence of atherosclerosis and CVD. Viceversa, the reduction of periodontal inflammation through plaque control, systemic antibiotics, scaling, and root planning seems to decrease CRP levels in patients suffering from MetS, reducing the risk of CVD (López NJ 2012).

Over the past 2 decades, inflammation has emerged as an integrative CVD factor. Inflammation can operate in ‘‘all stages of this disease from initiation through progression and, ultimately, the thrombotic complications of atherosclerosis.

Higher quantiles of CRP, measured by a high-sensitivity assay (hsCRP), predict future acute myocardial infarction and unstable angina pectoris and the onset of systemic arterial hypertension, diabetes mellitus, and stroke, independent of blood lipid levels.

CRP itself, beyond serving as a biomarker, have a role in endothelial cell dysfunction.

The erythrocyte sedimentation rate, chemokines, and cytokines including IL-6, IL-8, IL-10, IL-18, TNF-a, and monocyte chemoattractant protein–1 also are frequently abnormal in patients with acute coronary syndromes and in many other conditions.

Periodontal pathogens draw lymphocytes in an attempt to stem infection through phagocytosis and killing, causing

augmented production of ROS, which ends in a situation of oxidative stress. The presence of ROS promotes chemotaxis and recruits inflammatory mediators from the liver, causing periodontal destruction and favoring the making of endothelial atheromas.

Periodontal pathogens are also able to invade the endothelium and atheromas; in fact, oral infection, being a source of bacteria, is associated with CVD.

There are several theories that attempt to explain the correlation between periodontitis and CVD ((López NJ 2012).

One theory is the **bacteriological theory**, according to which oral pathogens, such as P. gingivalis, invade the systemic circulation and by means of the virulence factors, such as fimbriae, are able to invade the atheromatous plaques.

These bacteria can activate endothelial cells through TLR4 and induce apoptosis in these cells, disrupting the mechanisms of cell adhesion.

The **inflammatory theory** holds that in the course of periodontitis, gingival cells produce inflammatory mediators such as TNF-α, IL-6, PGE-2, and MMPs that locally promote tissue destruction and, once in the circulation, stimulate endothelial cells to produce other mediators such as monocyte chemotactic protein (MCP-1), macrophage colony stimulating factor (MCSF), intercellular adhesion molecule (I-CAM), vascular cell adhesion molecule (V-CAM), P-selectin, and E-selectin. These cytokines accelerate the formation of atheroma.

The third theory is the **autoimmune theory**, according to which antibodies against bacterial antigens may also react against endothelial protein, causing their destruction and therefore the arterial lesion.

It is of note that during the development of periodontitis, in the attempt to remove causal agents, hyperinflammation is

triggered, attracting numerous neutrophilic granulocytes, which, through the production of digestive enzymes during phagocytosis and killing, favor the production of ROS and the consequent constant release of inflammatory mediators with direct bacterial action damage on periodontal tissue.

In addition, it seems that in people suffering from periodontitis, pathogen bacteria, endotoxins, and inflammatory mediators cause leucocytosis and increased lipidic metabolism, with an increase of cholesterol and hepatic triglycerides favoring the risk of CVD. Furthermore, a systemic increase of oxidative stress caused by periodontal disease seems to promote LDL oxidation. LDLs are cholesterol carriers with proinflammatory and pro-atherogenic activity.

Periodontal treatment by scaling and root planning, and dental care instruction seem to reduce the circulating oxLDL level and, consequentially, the risk of the onset of CVD.

Systemic and local chronic inflammatory states, such as periodontitis and MetS, are characterized by an elevated presence of acute-phase proteins such as CRP and fibrinogen, which represent a decisive contribution to the insurgence of atherosclerosis and CVD.

Viceversa, the reduction of periodontal inflammation through plaque control, systemic antibiotics, scaling, and root planning seems to decrease CRP levels in patients suffering from MetS, reducing the risk of CVD.

The incidence of atherosclerotic CVD events increases in patients with chronic inflammatory diseases, in addition to periodontitis, including rheumatoid arthritis, psoriasis, systemic lupus erythematosus, some types of infections, mainly infections of the respiratory tract and urinary tract.

Arterial inflammation, along with arterial stiffness and remodeling, may be a factor in systemic arterial hypertension, particularly in obese patients.

Evidence supporting the role of inflammation in atherosclerotic events gained support with the findings of Justification for the Use of Statins in Primary Prevention: An Intervention Trial Evaluating Rosuvastatin (JUPITER), in which treatment with rosuvastatin significantly reduced the incidence of cardiovascular events in subjects with lower levels of LDL cholesterol but with mild chronic inflammation indicated by levels of hsCRP >2 mg/L.

The precise role of inflammation as a direct, causative factor in chronic atherogenesis and in the acute complications of atherosclerosis remains an area of intense current investigation.

Multiple studies, however, support two biologically possible mechanisms:

(1) Moderate to severe periodontitis increases the level of systemic inflammation, a characteristic of all chronic inflammatory diseases, and periodontitis has been associated with increased systemic inflammation as measured by hsCRP and other biomarkers. Treatment of moderate to severe periodontitis sufficient to reduce clinical signs of the disease also decreases the level of systemic inflammatory mediators.

(2) In untreated periodontitis, 108 to 1012 gram-negative bacteria may be found in periodontal pockets surrounding each diseased tooth and in approximation to ulcerated epithelium, and bacterial species found predominantly in the periodontal pockets also have been found in atheroma. (Haraszthy et el J Periodontol 2000)

An indirect relationship between periodontitis and atherosclerotic CVD is the many shared risk factors that commonly occur in the two diseases. Thus, many factors, especially cigarette smoking,5-10 are confounders in determining their relative importance in this relationship.

There is evidence that periodontal disease is related to CVD in young (aged £55 years) non-smokers.91 In addition to

tobacco use, the following risk factors are common to periodontitis and CVD:

(1) Diabetes mellitus: there are no reported interventional studies designed to ascertain whether periodontal disease prevention or treatment reduces CVD prevalence or mortality in patients with either type 1 or type 2 diabetes mellitus.

(2) Obesity: systemic inflammation, defined by increased circulating TNF-a, is associated with obesity and periodontitis and has been(Genco RJ et al 2005) proposed as a mechanism for the connection between these conditions.

(3) Lipids: a case-controlled study showed that periodontitis is associated with elevated plasma triglycerides and total cholesterol.

A large epidemiologic study in the United States determined that total serum cholesterol and plasma levels of CRP and fibrinogen are elevated in patients with periodontitis (Wu T et al 2000)

(4) Hypertension: an epidemiologic study in Sweden of >4,000 subjects showed an increased prevalence of hypertension in patients with periodontitis. Smaller studies in the United States found that, after adjusting for confounders, hypertension was more prevalent in patients with severe alveolar bone loss.(Holmlund A 2006), and significantly more hypertension occurs in patients with periodontitis compared with populations with little or no periodontal disease (Engstrom S 2007).

Systemic inflammation, a feature of hypertension, as evidenced by increased hsCRP plasma levels in patients with prehypertension and patients with established hypertension, may link these two conditions (Sesso HD et al 2003).

DIABETES AND PERIODONTAL DISEASE:

Diabetes, a pathology that is extremely widespread, involves an adulterated homeostasis in the glucose metabolism. Two types of diabetes exist: type 1 diabetes and type 2 diabetes (T2D). Either typology of diabetes, if not controlled, is a risk factor for periodontitis.

The first type affects young people and sets in from childhood. The pathological mechanism is that β cells of Langerhans are unable to produce insulin. Consequently, glucose tends to accumulate in the tissues and the blood.

The pathology develops in middle age.T2D is the most common type and consists in an adulterated insulin cellular response. The onset of T2D is associated with the recruitment of proinflammatory cytokines that are involved in the onset of the disease and related complications such as dyslipidemia and atherosclerosis, contributing to the onset of microvascular and macrovascular complications.

Patients with periodontitis show a higher risk of ketoacidosis, retinopathy, and neuropathy than do diabetic patients without periodontal disease. In addition, diabetic patients with neurological complications have severe gingivitis compared with diabetic individuals without this complication.

Many studies demonstrate a biological relation between diabetes and periodontitis, as tested relations exist between glycated hemoglobin, a diabetic marker, and periodontal parameters, and between plasmatic lipid peroxide, an index of oxidative stress, and periodontal markers.

Prolonged hyperglycemia associated with diabetes causes the formation of advanced glycation end-products (AGE). AGEs are physiologically produced by the organism, but in conditions of hyperglycemia or augmented oxidative stress their presence is largely augmented.

AGEs result from reversible glycation reactions, that is, the addition of sugars on the polypeptide chain of proteins, lipids, or nucleic acids.

Whether an enzyme attends or not in the glycation reactions, we can have an enzymatic or nonenzymatic glycation. Furthermore, more resistant proteins such as interstitial or vassal collagen can undergo a nonenzymatic glycation.

Several cells, such as endothelial, muscular, and immune cells, possess specific AGE receptors, called RAGE. In fact, a confirmation of AGE activity against periodontal tissue is proved by an elevated presence of RAGE in the periodontal compartment.

AGEs have deleterious effects for the organism and, being resistant to proteolytic digestion, are difficult to eliminate and tend to accumulate, expressing their harmful effect. AGE-degradation products are chiefly expelled through urine.

AGEs are substances able to promote cytokine production by macrophages such as TNF-α and IL-6, and to stimulate hepatic secretion of acute-phase proteins such as CRP, fibrinogen, plasminogen activator/inhibitor, and serum amyloid A, also correlated with oral infection and cardiovascular diseases, especially in patients suffering from periodontal diseases.

AGEs also promote monocyte migration and increase endothelial permeability, fibroblasts, and muscular cell activity. In addition,AGEs can bind collagen, which if modified alters basement membrane structure.

This gives to an inhibition of oxygen diffusion and tissue oxygenation, diminished waste removal, altered immune mediators, and migration that causes an adulterate inflammatory response, which results in inadequate tissue recovery.

AGEs also lead to the rapid expansion of energy in the respiratory polymorphonuclear neutrophils (PMN), and this causes increased damage to periodontal tissues and some changes in bone metabolism, especially on repair, also reducing the production of the extracellular matrix.

The course of the periodontal illness is due to basic neutrophilic activity that results in an exaggerated immune response and an uncontrolled ROS production.

These cause local and peripheral oxidative damage, both directly, through oxidative injury, and indirectly, by means of redox-sensitive gene transcription factors.

Nuclear factor kappa B and activating protein 1 are activated,triggering an inflammatory mediator cascade and quick cellular aging.

Diabetic patients with severe periodontitis have demonstrated a reduced chemotaxis of PMN compared with healthy subjects, or patients with less aggressive periodontitis, and an altered control of apoptosis, which is followed by an accumulation of PMNs in the periodontal tissues and therefore of MMPs and ROS.

The lack of glycemic control has also been associated with alterations in the oral mucosa barrier. The presence of diabetes seems to increase inflammation in the periodontium, so much so that in the gingival crevicular fluid there are increased levels of PGE2 and IL1-β compared with parodontopatic normoglycemic patients. Moreover, the presence of diabetes mellitus prolongs the inflammatory response to P. gingivalis, causing an increase in the production of TNF-α.

In synthesis, diabetes appears correlated to the onset of periodontal diseases, both through changes in the host immune response and through anomalies in the collagen metabolism. Recently, different molecules have been investigated for the treatment of diabetes.

Decursin (De), an active component of Angelica gigas, known to exert anticancer and neuroprotective effects, was recently studied for its antiobesity and antidiabetic potential. De treatment resulted in the inhibition of adipocyte differentiation and expression of fatty acid synthase.

Administration of De along with a high-fat diet (HFD) significantly reduced the secretion of HFD induced adipocytokines such as leptin, resistin, and IL-6 (Hwang JT et al 2012).

Periodontal inflammation can later give rise to a systemic inflammatory state. A recent study suggested a concrete relationship between severe periodontitis and systemic oxidative stress with a reduction in antioxidant systemic defenses. Moreover, it seems that after a periodontal treatment, a transitory inflammatory acute response occurs with a concomitant increase of systemic oxidative markers.

In periodontal diabetic individuals suffering from T2D, there is an augmented rate of oxidative systemic markers and a diminished plasma small-molecule antioxidant capacity. These patients also show reduced β-cell activity. Therefore, periodontitis enlarges oxidative stress– mediated dysfunction in β-cells of Langerhans.

Even in periodontitis, the mediated response of the host, in the presence of bacterial infections, results in an increased release of systemic inflammatory mediators.

The toll-like receptors (TLR), the receptors for the Ig superfamily (TLR4), and RAGE are implicated in the intensification of the systemic immune response during chronic diseases, such as diabetes and periodontal disease. Fibroblasts, macrophages, and epithelial cells present in the periodontium possess both RAGE and TLR4. It seems that hyperglycemia can promote the expression of these receptors in the periodontal district and increase the response to their ligands, favoring the accumulation of these ligands.

Several studies have shown how chemical and mechanical periodontal treatment may improve glycemic and lipidic control in time. It seems that periodontal therapy leads to a reduction in the glycated hemoglobin (HbA1c) plasma rate and to a better lipidic profile.

HYPERTENSION AND PERIODONTITIS:

Hypertensives suffering from MetS show increased oxidative stress and compromised antioxidant activity in plasma and cells. In addition, obesity and overweight are strictly related to hypertension. In fact, weight loss determines a diminished blood pressure independent from sodic diet (Chaves FJ et al 2007).

Hyperglycemia and hypertension are strictly related. Hyperglycemia provokes an increased stimulation of a sympathetic nervous system that causes vasoconstriction and increased sodium reabsorption with consequent water attraction and insurgence of hypertension, which damages the endothelium integrity of vessels (Scott CL 2003).

Augmented endothelial permeability allows the passage of lipoproteins and platelet-derived growth factors (PDGF), which give rise to the proliferation of muscular smooth cells in the intima, which occludes vessel lumen and causes embolia, hypoxia, and consequent cellular death (Arthur H et al 2007).

In a sample of 31,543 participants of the Health Professionals' Follow-Up Study, based on a prospective cohort of 40- to 75-year-old men at baseline, with no prior hypertension history and complete baseline information on oral health, an incidence of 10,828 cases of hypertension over 20 years of follow-up was identified, with no significant association between incident hypertension and periodontal disease. In a study population of 182 adults, a multivariate analysis showed no association between severe periodontitis and hypertension history (OR = 0.99; 95% CI: 0.40-2.48).

Severe periodontitis was associated with high blood pressure, with an OR of 2.93 (95% CI: 1.25-6.84) after adjusting for age, gender, smoking, and binge drinking.

This association was stronger when restricted to those with hypertension or taking antihypertensive medications, suggesting that periodontitis may contribute to poor blood pressure control among older adults (Rivas-Tumanyan S et al 2012).

Regarding the biological mechanism of this relationship, a recent study evaluated endothelial function in patients with periodontitis.

Circulating levels of CRP and IL-6 were significantly higher in the periodontitis subjects with hypertension, than in the control group. Periodontal therapy seems to reduce serum concentrations of CRP and IL-6 (Higashi Y et al 2008).

mediators related to endothelial and cardio-circulatory dysfunctions.

A very recent work reported a real relationship between periodontitis and MetS, especially in women, while abdominal obesity was the largest contributory factor in both gender.

CHAPTER-7

OXIDATIVE STRESS: A COMMON LINK BETWEEN METABOLIC SYNDROME AND PERIODONTAL DISEASE

Oxidative stress is defined as a persistent imbalance between the production of highly reactive molecular species (e.g., reactive oxygen species [ROS], reactive nitrogen species [RNS]) and anti-oxidant defenses (Halliwell, 1991).

There is an increase in ROS in the pre-diabetic stage, likely due to obesity related elevations of FFA, and several studies have shown that reversal of the imbalance between ROS and anti-oxidants improves insulin resistance in mice and humans (Ceriello and Motz, 2004; Wright et al., 2006).

Periodontitis is a generally chronic disorder characterized by the breakdown of the tooth-supporting tissues and the impaired host inflammatory immune response. This condition is due fundamentally to an ecological imbalance between the normal microbial biofilm on teeth and the host tissues (Newman, 1974). There is increasing evidence linking periodontitis to systemic diseases (Kuo et al., 2008), such as diabetes (Herring and Shah, 2006),rheumatoid arthritis (Pischon et al., 2008b), and, especially, CVD (Ford et al., 2007; Paquette et al., 2007; Fardi and Papadimitriou, 2008)—hence the search for factors that may explain such relationships.

A potential factor which could increase insulin resistance is the production of oxidative stress enhancing ROS in affected periodontal tissues (Battino et al., 1999; Chapple and Matthews, 2007).

Insulin resistance plays a key role in the pathophysiology of MetS. Several inflammatory mediators are involved in the pathogenesis of insulin resistance, with TNF-α having

apparently the strongest effect (Tilg and Moschen,2008). The most important tissues involved in the pathogenesis of this disorder are muscle and adipose tissue.

When caloric intake exceeds energy expenditure, the resultant substrate-induced increase in citric acid cycle activity generates an excess of ROS (Maddux et al., 2001). Oxidative stress alters the intracellular signaling pathway, inducing insulin resistance (Evans et al., 2003).

Recently, a study with a murine model (Matsuzawa-Nagata et al., 2008) has shown that the pathways for ROS production and oxidative stress are up-regulated in both the liver and adipose tissue of mice fed a high-fat diet before the onset of insulin resistance.

Moreover, the increased ROS production was previous to the TNF-α and FFA elevation in the plasma and liver. In agreement with this hypothesis, insulin resistance is associated with reduced intracellular anti-oxidant defense in humans (Bruce et al., 2003), and anti-oxidants improve insulin sensitivity (Paolisso and Giugliano, 1996; Ceriello, 2000).

There is a spectrum of potential molecular and cellular damage derived from ROS production. Lipoprotein modification takes place in the absence (glycation) and presence (glycoxidation) of oxygen (Baynes and Thorpe, 2000), and these modifications can alter their structure and function (Jenkins et al., 2004). These modified lipoproteins are formed through a non-enzymatic process in which sugars bind to free amino groups of the lipoprotein(Njoroge and Monnier, 1989; Basta et al., 2004).

Lipid peroxidation is the formation of lipid peroxides via an enzymatic and/or a non-enzymatic mechanism. ROS resulting from hyperglycemia are thought to contribute to the initiation of lipid peroxidation (Cosentino et al., 1997). Once formed, lipid peroxides undergo a series of complex reactions, ultimately binding chemically to proteins. Thus, lipoxidation is the covalent binding of products of lipid

peroxidation reactions to proteins (Esterbauer et al., 1991, 1992; Spiteller, 1998; Jenkins et al., 2004).

Several studies have demonstrated a relationship between MetS and oxidative stress in humans. Thus, systemic oxidative stress is significantly higher in persons with MetS compared with non-obese normolipidemic individuals.

Some HDL-C subfractions possess significantly lower specific anti-oxidative activity in affected persons than their counterparts in control individuals, and this attenuated anti-oxidative activity of HDL-C subfractions correlates with systemic oxidative stress and insulin resistance (Hansel et al., 2004). In agreement with these results, persons suffering from MetS have poor anti-oxidant status and significantly increased oxidative stress (serum lipid peroxide level), compared with those without MetS (Sharma et al., 2005).

Moreover, obese adults with MetS have significantly higher plasma concentrations of oxidized-LDL-C, compared with obese adults without this condition (Van Guilder et al., 2006). By contrast, Sjogren et al. (2005) found no significant differences for plasma oxidized-LDL-C and urinary 8-iso-prostaglandin F2α (8-iso-PGF2α) between healthy and MetS men.

Advanced glycation end-products (AGE) are important markers for oxidative stress, and their endogenous secretory receptor (esRAGE) in plasma, as a soluble decoy receptor for

AGE, is significantly and inversely correlated with components of the MetS, including body mass index, blood pressure, triglyceride, glycated hemoglobin (HbA1c), and an insulin resistance index (Koyama et al., 2005).

As previously mentioned, oxidative stress is one of the main factors studied to explain the pathophysiological mechanisms of inflammatory conditions, such as MetS and periodontitis.

A recent and exhaustive review (Chapple and Matthews, 2007) has described the complex role of oxidative stress in relation to periodontal breakdown.

It seems that peripheral blood neutrophil hyperactivity in chronic and aggressive periodontitis exists as a constitutional element (Matthews et al., 2007a,b), rather than being entirely the result of peripheral priming by cytokines or plaque bacterial LPS.

In addition, there may be possible baseline hyperactivity, with low-level extracellular ROS release in the absence of any exogenous stimulus in persons with periodontitis (Gustafsson and Asman, 1996; Gustafsson et al., 1997; Fredriksson et al., 1998; Matthews et al., 2007b).

There is increasing evidence for compromised anti-oxidant capacity in periodontal tissues and fluids, independent of smoking, and increased AGE levels in persons with type 2 diabetes and in smokers, which are risk factors for periodontitis.

Such oxidation products can increase neutrophil adhesion, chemotaxis, and priming in hyper-reactive neutrophils, and might augment the damaging effects of the resultant oxidative stress (Brock et al., 2004; Palmer et al., 2005; Panjamurthy et al.,2005).

In addition to this, the up-regulation of pro-inflammatory transcription factors, such as NF-κB and activating protein-1, in inflamed periodontal tissues contributes to reduced glutathione depletion and ROS generation (Chapple, 1997; Janssen- Heininger et al., 2000).

It is important to emphasize the influence of periodontitis on serum and/or plasma oxidative markers in humans. Several studies have demonstrated an increase in products of oxidative damage in peripheral blood from persons with periodontitis compared with control individuals (Battino et al., 2001; Montebugnoli et al., 2004; Baltacioglu et al., 2008).

Moreover, it is evidence of a decreased anti-oxidant capacity in persons with periodontitis, evaluated by different assays (Chapple et al., 2002, 2007; Battino et al., 2003; Brock et al., 2004; Panjamurthy et al., 2005; Baltacioglu et al., 2006; Akalin et al., 2007; Konopka et al., 2007;Zilinskas et al., 2007).

Therefore, it might be argued that this increased pro-oxidative state and decreased anti-oxidant capacity in persons with periodontitis could facilitate the onset of a decrease in insulin sensitivity, which could be aggravated by a high fat diet in these persons.

This is in agreement with the previously mentioned report which demonstrated that an increase in ROS production precedes insulin resistance (Matsuzawa-Nagata et al., 2008).

Conversely, the presence of MetS or any of its components in a previously periodontally healthy person could facilitate a prooxidant state which would diminish anti-oxidant capacity of the periodontal tissues, and the response of these tissues to bacterial challenge could be impaired.

The presence of a high RAGE expression in periodontal tissues (Katz et al., 2005) is an important finding supporting the sensitivity of these tissues to products derived from oxidative damage.

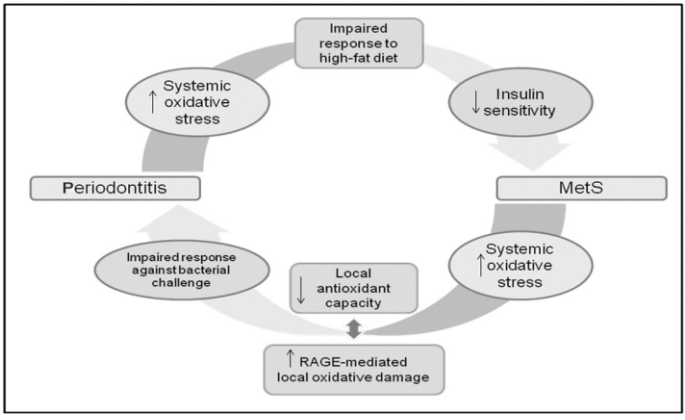
Hypothetic role of oxidative stress as a link between periodontitis and metabolic syndrome (MetS) promote apoptosis in osteoblasts (Alikhani et al., 2007a) and fibroblasts (Alikhani et al., 2007b), and this might have an influence on alveolar bone homeostasis and the progression of periodontitis.

Leptin and adiponectin appear as potential candidates to influence in a positive or negative manner, respectively, over the pro-oxidative state in periodontitis and MetS. Leptin has been demonstrated to have a predominantly pro-

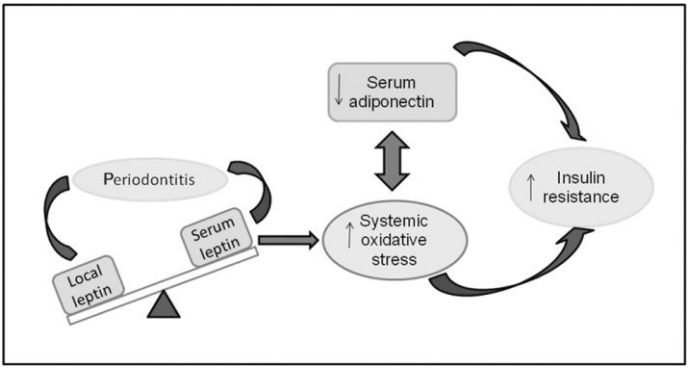
oxidative effect (Bouloumie et al., 1999; Maingrette and Renier, 2003; Suzuki et al., 2003; Beltowski et al., 2004).

The increased serum leptin levels existing in persons with periodontitis, possibly in an attempt to modulate the immune response, could be one of the factors that induces oxidative stress and accelerates the onset of insulin resistance.

This increased oxidative stress could facilitate a relative hypoadiponectinemia (Hattori et al., 2005; Soares et al., 2005; Katsuki et al., 2006), like that presenting in persons with periodontitis, which could also decrease the protection against oxidative damage, since this adipocytokine has been demonstrated to have a protective effect against oxidative stress (Nakanishi et al., 2005; Barazzoni et al., 2007.



Hypothetic role of oxidative stress as a link between periodontitis and metabolic syndrome (MetS). (P. Bullon et al, 2009)



Proposed roles of leptin and adiponectin as putative mediators in the oxidative imbalance enhancing periodontitis and insulin resistance. (P. Bullon et al, 2009)

CHAPTER: 8

LABORATORY INVESTIGATIONS OF METABOLIC SYNDROME

In the case of the WHO, abnormal values for blood pressure, urinary albumin excretion, and triacylglycerol and HDL-cholesterol concentrations will determine whether an insulin-resistant person has or does not have metabolic syndrome.

In the case of the IDF definition, even if a person displayed all of these abnormalities and had type 2 diabetes in addition, he or she would not have the metabolic syndrome if the Wiast circumference was not large enough.

The ATPIII version of the metabolic syndrome is the most democratic; there is no hierarchical relation between the 5 components, and any combination of 3 will do.

The lack on the part of the ATP III of assigning any priority to the 5 components of the metabolic may be a reflection of the panel's view that the cluster of abnormalities "probably has more than one cause".

It is difficult to disagree with the conclusion that the related abnormalities that make up all 3 versions of metabolic have more than one cause. For example, it is obvious there are many potential reasons for elevated blood pressures.

Glucose intolerance:

The prevalence of some degree of abnormal glucose tolerance or type 2 diabetes (or both)—one of the criteria in all 3 definitions of the metabolic syndrome—is the abnormality most closely related to insulin resistance.

Himsworth and Kerr challenged the conventional wisdom that "all cases of human diabetes could be explained by deficiency of insulin,"proposed that "a state of diabetes

might result from inefficient action of insulin as well as from a lack of insulin," and stated, "the diminished ability of the tissues to utilize glucose is referable either to a deficiency of insulin or to insensitivity to insulin, although it is possible that both factors may operate simultaneously."

It is now appreciated that insulin resistance is a common characteristic of patients with type 2 diabetes and that insulin resistance (or hyperinsulinemia as a surrogate estimate of insulin resistance) is a powerful and independent predictor of type 2 diabetes (Reaven GM et al 1993).

Finally, the greater the degree of insulin resistance, the higher the plasma glucose response to oral glucose in persons with normal oral glucose tolerance.

Thus, an enormous amount of evidence documents a very close relation between insulin resistance and abnormal elevations in plasma glucose concentrations.

Finally, it should be emphasized that nondiabetic persons with relatively minor degrees of glucose intolerance also have higher blood pressures and the dyslipidemic changes—high triacylglycerol and low HDL-cholesterol concentrations—that make up the remaining metabolic criteria of all 3 definitions of the metabolic syndrome.

Dyslipidemia:

There is a highly significant relation between insulin resistance, compensatory hyperinsulinemia, and hypertriglyceridemia.

It is now apparent that the link between insulin resistance or hyperinsulinemia and dyslipidemia is a much broader one, which is not limited to an increase in plasma triacylglycerol concentrations.

Thus, although the various definitions of metabolic syndrome have selected the combination of high plasma triacylglycerol and low HDL-cholesterol concentrations as

a diagnostic criterion, it is clear that these changes are also associated with a decrease in LDL particle size (small, dense LDL) and the postprandial accumulation of triacylglycerol-rich remnant lipoproteins.

Not only are all of these changes significantly associated with insulin resistance or hyperinsulinemia, but each one has also been shown to increase the risk of CVD.

Plasma triacylglycerol concentrations:

Implicit in these findings is the view that the major cause of elevated plasma triacylglycerol concentrations in nondiabetic persons is an increase in hepatic VLDL-triacylglycerol secretion rate, secondary to insulin resistance and the resultant hyperinsulinemia.

These data provide a quantitative estimate of the close relation between insulin resistance, compensatory hyperinsulinemia, hepatic VLDL triacylglycerol secretion, and plasma triacylglycerol concentrations in apparently healthy persons.

Relation between insulin resistance and plasma triacylglycerol concentrations

	Relation
Triacylglycerol 69–546 mg/dL2	IMGU 3 insulin concentration (r 0.74) 3 VLDL-triacylglycerol secretion rate (r 0.74) 3 triacylglycerol concentration (r 0.88)
33–174 mg/dL3	IMGU 3 insulin concentration (r 0.81)

	3 VLDL-triacylglycerol secretion rate (r 0.68) 3 triacylglycerol concentration (r 0.87)

IMGU, insulin-mediated glucose uptake, VLDL: Very low density lipoproteins

Postprandial lipemia:

The higher is the fasting triacylglycerol concentration, the greater will be the postprandial accumulation of triacylglycerol rich lipoproteins (ie, VLDL, chylomicron remnants, and VLDL remnants) in nondiabetic persons (Nestel PJ 1964)

Both the relation between fasting triacylglycerol concentration and postprandial lipemia and the daylong increases in triacylglycerol-rich

lipoproteins in nondiabetic persons are significantly correlated with the magnitudebof the insulin resistance and compensatory hyperinsulinemia.

Although the postprandial elevation of triacylglycerol-rich lipoproteins is related to the fasting triacylglycerol concentration, postprandial lipemia is also enhanced when insulin-resistant or hyperinsulinemic persons are matched by degree of fasting hypertriglyceridemia with persons from an insulin-sensitive population.

HDL cholesterol:

Increases in plasma VLDL-triacylglycerol concentration are usually associated with low HDL-cholesterol concentrations, and it appears that insulin resistance and compensatory hyperinsulinemia are independently associated with both of these changes.

Low HDL-cholesterol concentrations in insulin resistant or hyperinsulinemic persons are partly due to the transfer, which is catalyzed by cholesteryl ester transfer protein, of cholesterol from HDL to VLDL; the higher the VLDL pool size, the greater the transfer rate from HDL to VLDL and the lower the resulting HDL-cholesterol concentration.

The fractional catabolic rate of apoprotein A-I is increased in patients with primary hypertriglyceridemia, hypertension, and type 2 diabetes.

In type 2 diabetes, it has been shown that the greater the degree of hyperinsulinemia, the lower the HDL cholesterol concentration.

Evidence also exists that, in nondiabetic persons, the higher the fractional catabolic rate of apoprotein A-I, the lower the HDL-cholesterol concentration, and that these changes are associated with increases in plasma insulin concentrations LDL particle diameter.

Analysis of LDL particle size distribution has identified multiple distinct LDL subclasses, and it appears that LDL particles in most persons can be characterized by a predominance of larger LDL (diameter:255 Å; pattern A) or smaller LDL (diameter:255 Å; pattern B). Persons with pattern BLDL have higher plasma triacylglycerol and lower HDL-cholesterol concentrations than do persons with pattern A LDL.

Atherogenic lipoproteins and insulin resistance:

The evidence discussed above provides strong support for the conclusion that the lipoprotein abnormalities that are part of all 3 definitions of the metabolic syndrome are more likely to occur together and are significantly associated with insulin resistance and compensatory hyperinsulinemia.

However, not all persons with these abnormalities are insulin resistant. A high fasting plasma triacylglycerol concentration and hyperchylomicronemia can occur in

persons who have a primary defect in the catabolism of triacylglycerol-rich lipoproteins (ie, fat-induced lipemia).

Furthermore, not all insulin-resistant persons will develop the atherogenic lipoprotein profile associated with the defect in insulin action.

On the other hand, insulin resistance or hyperinsulinemia is the only physiologic abnormality that can lead to the clustering of abnormalities that includes the atherogenic lipoprotein profile discussed above, as well as increases in plasma glucose concentration and blood pressure.

Blood pressure:

The relation between insulin resistance, elevated blood pressure, and CVD is more complicated than that of any of the other components that make up the various definition of metabolic syndrome.

There is substantial evidence for the following 3 findings

Linking insulin resistance and hyperinsulinemia to essential hypertension.

First, patients with essential hypertension, as a group, are insulin resistant and hyperinsulinemic. Second, normotensive first-degree relatives of patients with essential hypertension are more insulin resistant and hyperinsulinemic than are matched control subjects without a family history of hypertension.

Third, hyperinsulinemia, as a surrogate estimate of insulin resistance, has been shown in population based studies to predict the eventual development of essential hypertension.

In contrast, probably no more than 50% of patients with essential hypertension are insulin resistant.

However, it is patients with essential hypertension who are insulin resistant or hyperinsulinemic who have the other components of the various definitions of metabolic syndrome and are therefore at greatest risk of CVD. For example, patients with essential hypertension and

electrocardiographic evidence of myocardial ischemia are insulin resistant, somewhat glucose intolerant, and hyperinsulinemic and have high triacylglycerol and low HDL-cholesterol concentrations compared with a normotensive control group or patients with essential hypertension whose electrocardiograms are entirely normal.

Direct evidence of the link between the dyslipidemia present in insulin-resistant or hyperinsulinemic patients with essential hypertension and CVD comes from the results of the Copenhagen Male Study, in which 2906 participants were divided into 3 groups according to their fasting plasma triacylglycerol and HDL-cholesterol concentrations.

Men whose plasma triacylglycerol and HDL-cholesterol concentrations were in the upper or lower third, respectively, of the whole population, were assigned to the high-triacylglycerol–low-HDL-cholesterol group.

At the other extreme, a low triacyl glycerol– high-HDL-cholesterol group was composed of those persons whose plasma triacylglycerol and HDL cholesterol concentrations were in the lower and upper thirds, respectively, of the study population for these 2 lipid measurements.

The intermediate group consisted of those participants whose lipid values did not qualify them for either of the 2 extreme groups. The results of this prospective study indicated that CVD risk was not increased in patients with hypertension in the absence of high triacylglycerol and low HDL-cholesterol concentrations, and the group at greatest risk was made up of those persons with high blood pressure and high triacylglycerol and low HDL-cholesterol concentrations.

In summary, insulin-resistant or hyperinsulinemic persons are more likely to develop essential hypertension, hypertension is a well-recognized CVD risk factor, and patients with essential hypertension and high triacylglycerol

and low HDL-cholesterolconcentrations are at greatest risk of CVD.

Insulin resistance and procoagulant and proinflammatory factors:

Although measures of procoagulant or proinflammatory factors have not been elevated to the status of diagnostic criteria, definitions of the metabolic, all comment on their relation with the cluster of abnormalities that make up the definition.

The association between insulin resistance and hyperinsulinemia, elevated concentrations of plasminogen activator inhibitor-1, and CVD has been known for some time. Concentrations of plasminogen activator inhibitor-1 in a group of apparently healthy persons was significantly correlated with degree of insulin resistance (as quantified by steady-state plasma glucose concentrations during the insulin suppression test), and fasting plasma insulin, triacylglycerol, and HDL cholesterol concentrations.

Thus, variations in concentrations of plasminogen activator inhibitor-1 cluster with insulin resistance or compensatory hyperinsulinemia, and the dyslipidemia characteristic of the defect in insulin action.

The proinflammatory factor currently attracting the most attention as indicating increased CVD risk is C-reactive protein, but there is a much longer history of a relation between an increase in white cell count and heart disease.

Indeed, data from the Women's Health Initiative Observational Study suggest that a high white cell count was comparable in magnitude to increases in concentrations of C-reactive protein as a predictor of CVD risk.

Evidence of a relation between white cell counts and insulin resistance or compensatory hyperinsulinemia was published several years ago (67); the evidence indicated that the higher the white cell count, the more insulin resistant person.

The relations described in this section provide evidence that the additional CVD risk factors considered to be present in patients diagnosed as having metabolic syndrome are significantly related to both insulin resistance and hyperinsulinemia, as well as to the other components of the metabolic syndrome.

Excess Adiposity, Insulin Resistance and Metabolic Syndrome:

Specifically, dyslipidemia (high triacylglycerol and low HDL-cholesterol concentrations), hyperglycemia, and hypertension are independent factors that directly increase the risk of CVD, whereas the relation between excess adiposity and CVD risk is different. For example, substantial numbers of overweight or obese persons do not have the abnormalities outlined above (Abbasi F et al 2002).

The components of the metabolic syndrome occur more commonly in overweight or obese persons, but this relation is not due to obesity, but rather to the fact that excess adiposity increases the likelihood that a person will be insulin resistant.

However, prospective studies exist that can serve as the basis for an operational definition. With the use of the magnitude of the insulin response to oral glucose as a surrogate maker of insulin resistance, 25% of an apparently healthy population with the highest insulin concentrations is at a significantly greater risk of CVD (Zavaron.I et al 1999).

According to the results of 2 prospective studies in which the insulin suppression test was used to quantify IGMU at baseline, the third of the population that was the most insulin resistant (ie, those with the highest steady-state plasma glucose concentrations) was at significantly greater risk of CVD than was the population third that was the most insulin sensitive (ie, those with the lowest steady-state plasma glucose concentrations).

Thus, for the purposes of this discussion, the third of the population with the highest steady-state plasma glucose concentrations will be operationally defined as insulin-resistant, and the third with the lowest steady-state plasma glucose concentrations will be defined as insulin-sensitive.

Visceral Obesity:

Evidence has shown that measurements of BMI and WC are highly correlated, that they are associated with a specific measure of IMGU to an identical degree, and that not all overweight or obese persons are insulin resistant.

This is because discrepant opinion of the importance of abdominal obesity in the genesis of insulin resistance and its consequences is the failure to take into consideration the importance of visceral obesity.

Relation between adiposity, insulin resistance, and risk of cardiovascular disease:

Rates of IMGU vary 600% in apparently healthy persons, and, because the distribution of these values is continuous (Yeni-Komshian et al 2000), there is no objective way to classify a person as insulin-resistant.

However, prospective studies exist that can serve as the basis for an operational definition. With the use of the magnitude of the insulin response to oral glucose as a surrogate maker of insulin resistance, 25% of an apparently healthy population with the highest insulin concentrations is at a significantly greater risk of CVD (Zavaron I et al 1999).

LABORATORY VALUES OF PATIENT WITH PERIODONTITIS AND METABOLIC SYNDROME:

Measured test	Value	Range
Fasting blood sugar	246mg/dl(H)	65-110mg/dl
HbA1c	11.3%(H)	4-6%(non-diabetic) Less than 7 for diabetic
Lipid profile Total serum cholesterol High Density Lipoprotien Cholesterol/HDL ratio Triglycerides	 223mg/dl 29mg/dl(L) 7.7(H) 141mg/dl	 150-200mg/dl More than 40mg/dl for men 3.8 50-150mg/dl
Blood pressure	140/90mm Hg	130/85mm Hg
Body Mass Index	27.68kg/m^2	27.65kg/m^2
Waistline	94cm(H)	90cm

CHAPTER-9

MANAGEMENT OF METABOLIC SYNDROME AND PERIODONTITIS

The treatment of metabolic syndrome patients with periodontitis can be divided into two categories

1) Medical management.
2) Periodontal management.

MetS is a state of chronic low grade inflammation with the profound systemic effects.

Clinical identification and management of patients with the MetS are important to begin efforts to adequately implement the treatments to reduce their risk of subsequent diseases.

Effective preventive approaches include lifestyle changes, primarily weight loss, diet, and exercise, and the treatment comprises the appropriate use of pharmacological agents to reduce the specific risk factors.

The clinical management of MetS is difficult because there is no recognized method to prevent or improve the whole syndrome, the background of which is essentially insulin resistance (G. M. Reaven 1988).

Thus, most physicians treat each component of MetS separately, laying a particular emphasis on those components that are easily amenable to the drug treatment.

Multidisciplinary approach to the MetS[8]

A: assessment

Calculate Framingham risk score: high risk (10-year risk ≥20%), moderately high risk (10-year risk 10% to 20%), or lower to moderate risk (10-year risk ≤10%). Make diagnosis of MetS using the diagnostic criteria.

A: aspirin

High risk: aspirin definitely beneficial.

High-intermediate risk (10–20%): aspirin likely to be beneficial.

Low-intermediate risk (6–10%): "individual clinical judgment", depending on sex and risk of bleeding.

Low risk (<6%): Risk of haemorrhage outweighs the benefits.

B: BP control

Initiate treatment: categorical hypertension (BP ≥ 140/≥90mmHg).

Patients with established diabetes (≥130/≥80mmHg).

ACEIs/ARBs first line agent may reduce incident diabetes mellitus.

Beta-blockers and thiazides may have an adverse effect on impaired glucose tolerance but outweighed by the benefits of reaching BP goal and lowering the risk of CVD events.

C: cholesterol

First target: LDL

Second target: non-HDL

Third target: HDL

Fourth target: CRP

Statin to achieve LDL-C <100mg/dL in high-risk, <130mg/dL in intermediate-risk, and <160mg/dL in low risk patients.

Statin intensification, consider niacin and/or fibrates once statin maximized. Consider fibrates, especially for those with combined hypertriglyceridemia/low HDL-C.

Consider further reduction in LDL-C with statin therapy to mitigate a risk of low HDL-C, consider niacin.

Statin therapy for those with high sensitivity CRP (hsCRP) ≥3mg/dL.

D: Diabetes prevention/diet

Intensive lifestyle modification is the most important therapy.

Weight reduction of 5–10% of preintervention weight over a period of four to six months.

Sodium intake of <65–100mmol/day with a goal of 90–120mmol of potassium per day.

Mediterranean diet: high consumption of fruits, vegetables, legumes, and grains, moderate alcohol intake, a moderate-to-low consumption of dairy products and meats/meat products, and a high monounsaturated- to-saturated fat ratio.

DASH diet: rich in fruits, vegetables, and low-fat dairy products, and low in saturated and total fat intake.

Consider low glycemic index food, complex unrefined carbohydrates, viscous soluble fibres, protein intake of 10–35% of total calorie intake and 25% to 35% of calories as total fat.

Metformin is second line in delaying the onset of T2DM.

Thiazolidinediones (Pioglitazones) and alpha-glucosidase inhibitors (Acarbose) have shown benefit in smaller studies and are therefore third line.

E: exercise

Daily moderate intensity activity of minimum 30 minutes for most days of the week. Recommend use of pedometer with goal >10,000 steps/day.

Formulated Treatment Plan For Metabolic Syndrome and Periodontal Disease Patients [51]:

Full mouth disinfection of the patient is an important perspective to prevent the severity of both metabolic syndrome and periodontitis.

Phase 1 Therapy (Etiotropic Phase):

1: Referral to medical physician for management of diabetes, hypertension and hypercholesterolemia. Hypertensive patients on calcium channel blockers which can cause gingival enlargement are substitutedwith other drugs after consultation of physician.

2: Thorough scaling and root planning , full mouth disinfection under local anaesthesia.

3: Patient adviced chlorohexidine mouthwash 0.12% 1:1 dilution twice daily for fifteen days.

3: Patient advised unifloss for tight contacts and interdental brush for open contacts.

5: Patient education and motivation

6: Diet councelling.

7: Advise on stress management.

Phase 2 Therapy (Surgical Phase):

1: Endodontic treatment if required carried out first.

2: Extraction of teeth with poor prognosis and grade III mobility.

3: If diabetes, hypertension are controlled then open root surface debridement (flap surgery) and alveolar bone grafting if osseous defects are present.

Phase 3 Therapy (Restorative Phase):

1: Patient advised fixed or removable dentures in edentulous spaces.

2: Restoration for carious teeth.

Phase 4 Therapy (Maintainance Phase):

1: Revaluation of fasting blood sugar, glycated heamoglobin, hypertension and lipid profile in three months time following non surgical therapy.

2: Regular monitoring of periodontal condition and supportive therapy.

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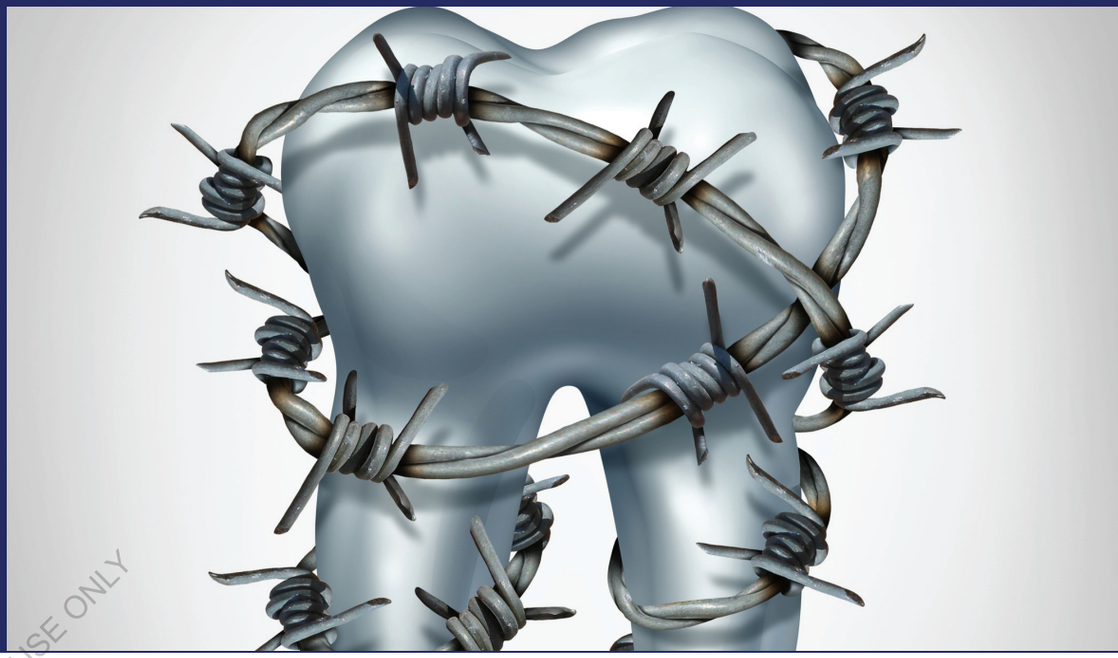
As part of the temporomandibular joint structure, the mandibular condyle is considered to play a key role in the stability of long-term treatment results after orthodontic and orthognathic treatments. Mandibular condyle plays pivotal role in the development of oro-facial complex, since it provides endochondral bone growth to function as a regional adaptive growth site and is known to adapt to different functional factors. Therefore, it has received special attention in orthodontics. On the contrary, impaired growth of the condyle contributes to the development of mandibular asymmetries and retrognathia, which are corrected in the orthodontic therapy in juveniles to improve functional relationship of the jaws. While cartilage of the mandibular condyle is often referred to as secondary, its main type is called primary cartilage, considered as a remnant of the cartilaginous skeleton, bulk of which forms bony skeleton.
This book aims to provide a broad perspective regarding the development, regulating factors, growth relativity hypothesis for condylar growth and current condylar growth concepts as well as clinical relevance in contemporary orthodontics.



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I am Dr Shivani Vaishy,doing MDS in Orthodontics from BVP Pune. I am passionate about my work, because I love what I do. This passion led me to challenge myself daily and learn new skills that helped me to do better work.

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Introduction

An understanding of the biological principles related to the development, growth and adaptation of the structures composing the craniofacial complex is essential for attaining competency within the field of orthodontics. Growth of the craniofacial skeleton largely influences occlusal relationships, jaw relationships, and orofacial functions.[1] In the growth of the craniofacial skeleton, cartilaginous tissues, including those of the sphenooccipital synchondrosis in the cranial base, the nasal septal cartilage in the nasomaxillary complex and the condylar cartilage in the mandible, plays important role as major growth sites for the respective anatomical components.[2,3] As part of the temporomandibular joint structure, the mandibular condyle is considered to play a key role in the stability of long-term treatment results after orthodontic and orthognathic treatments.

Mandibular condyle plays pivotal role in the development of oro-facial complex, since it provides endochondral bone growth to function as a regional adaptive growth site and is known to adapt to different functional factors. Therefore, it has received special attention in orthodontics. On the contrary, impaired growth of the condyle contributes to the development of mandibular asymmetries and retrognathia, which are corrected in the orthodontic therapy in juveniles to improve functional relationship of the jaws. While cartilage of the mandibular condyle is often referred to as secondary, its main type is called primary cartilage, considered as a remnant of the cartilaginous skeleton, bulk of which forms bony skeleton.[4]

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During mandibular growth, the condyle undergoes endochondral ossification and the condylar cartilage acts as a template for bone growth.[5]

The condylar process grows in a wide range of directions from anterosuperior to posterior, resulting in highly diverse mandibular growth and morphology. Condylar growth direction is closely related to mandibular displacement (transposition) direction and vertical jaw deviations (i.e., high or low angle).[6] Only a single cartilage, the mandibular condylar cartilage exists in the mandible throughout life and plays role in articulating function and growth. Therefore, the condylar cartilage is an “all-in-one type tissue”.[7]

This book aims to provide a broad perspective regarding the development, regulating factors, growth relativity hypothesis for condylar growth and current condylar growth concepts as well as clinical relevance in contemporary orthodontics.

ANATOMY AND HISTOLOGY OF CONDYLAR CARTILAGE

ANATOMY

The area where the mandible articulates with the temporal bone of the cranium, is called the TMJ, is one of the most complex joints in the body as shown in Figure-1.

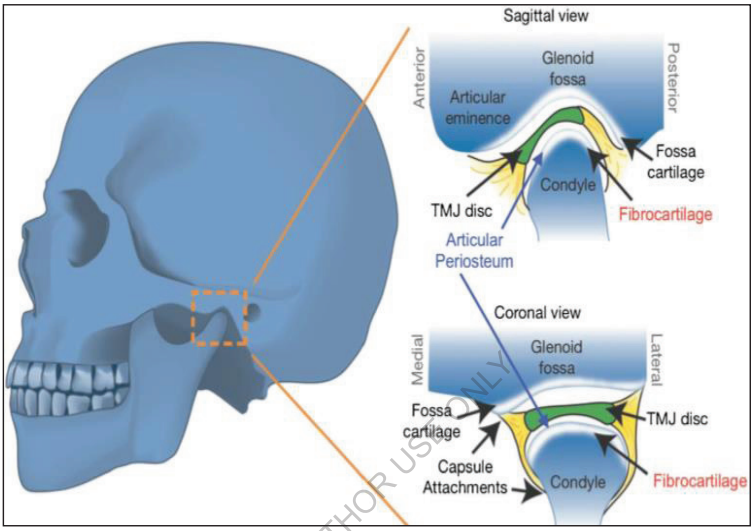

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Fig 1. The TMJ is shown in the sagittal and coronal (frontal) view. (Taken from Stocum D, Roberts W. Part I: Development and Physiology of the Temporomandibular Joint. Current Osteoporosis Reports. 2018;16(4):360-368.)

TMJ is divided into

1. Cranial component
2. Mandibular component

The condyle is the portion of the mandible that articulates at the base of the cranium with the squamous portion of the temporal bone around which movement occurs. From the anterior view, it has medial and lateral projections, called poles as shown in Figure-2. The medial pole is generally more prominent than the lateral pole. From above, a line drawn through the centers of the poles of the condyle will usually extend medially and posteriorly toward the anterior border of foramen magnum as shown in Figure-3.

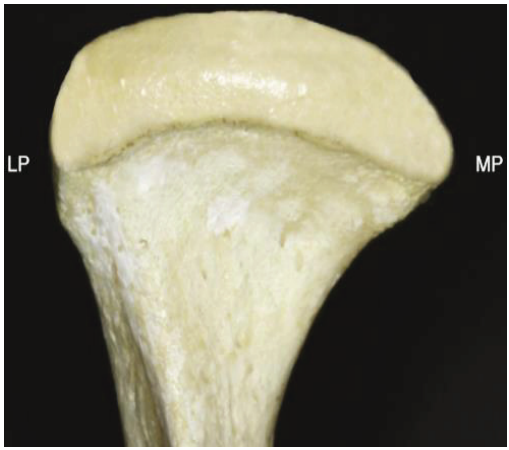

Fig 2. Condyle (Anterior view).The medial pole(MP) is more prominent than the lateral pole(LP). (Taken from Okeson. J. Management of temporomandibular disorders and occlusion. 7th ed. St Louis, Missouri Elsevier Mosby;2013:p.3-10.)

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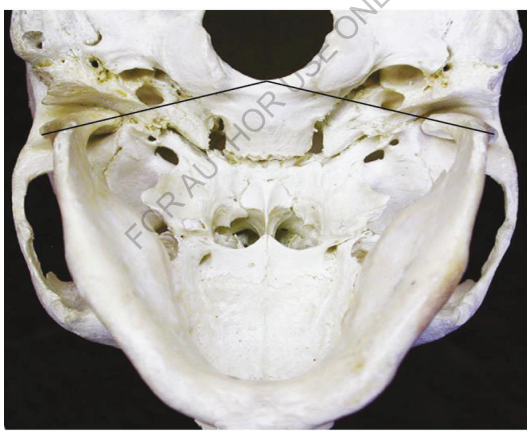

Fig 3. Inferior view of surface of the cranium and mandible. (Taken from Okeson. J. Management of temporomandibular disorders and occlusion. 7th ed. St Louis, Missouri Elsevier Mosby;2013:p.3-10.)

The total mediolateral length of the condyle is between 18 and 23 mm and the anteroposterior width is between 8 and 10 mm. The actual articulating surface of the condyle extends both anteriorly and posteriorly to the most superior aspect of condyle as shown in Figure-4 and 5. The posterior articulating surface is greater than the anterior surface. The articulating surface of the condyle is quite convex anteroposteriorly and only slightly convex mediolaterally.[8]

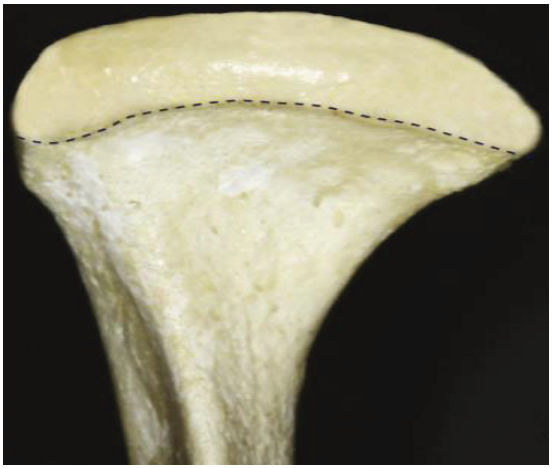

Fig 4. Condyle. (Anterior view). A dotted line marks the border of articular surface. (Taken from Okeson. J. Management of temporomandibular disorders and occlusion. 7th ed. St Louis, Missouri Elsevier Mosby;2013:p.3-10.)

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Fig 5. Condyle (Posterior view). A dotted line marks the border of articular surface. (Taken from Okeson. J. Management of temporomandibular disorders and occlusion. 7th ed. St Louis, Missouri Elsevier Mosby;2013:p.3-10.)

HISTOLOGY

The mandibular condyle is covered by a zonal cartilage layer from the articular surface to the underlying bone, which serves to absorb shock and contributes to bone remodelling. Mature condylar cartilage of the mandible consists of four zones:

(1) Articular surface of fibrous tissue facing the disc expressing collagen I

(2) Proliferative cells in the prechondroblastic zone expressing collagen I

(3) Chondroblastic zone expressing collagen II, the proteoglycans aggrecan, decorin, chondroitin sulfate PG, and keratin sulfate PG.

(4) Hypertrophic zone adjacent to bone expressing collagen X as shown in Figure-6.

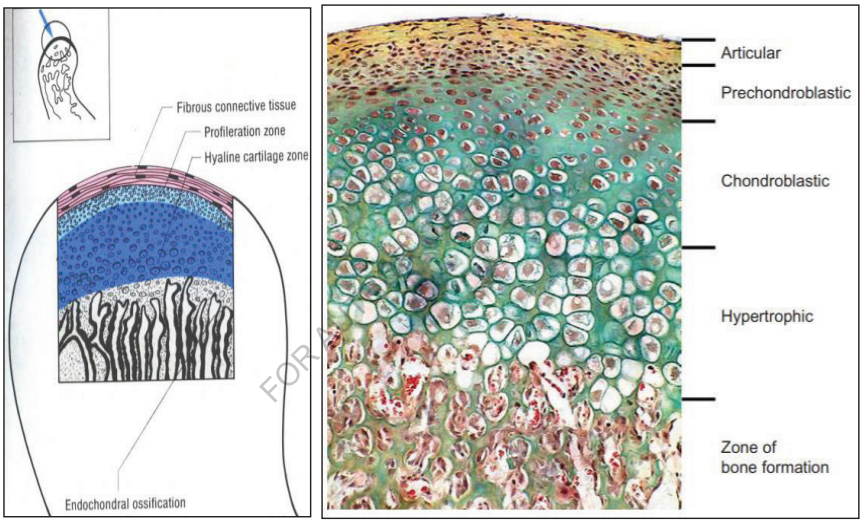

Fig 6. A histologic section of a healthy mandibular condyle showing the four zones: articular zone, proliferative zone, fibrocartilaginous zone, and the calcified cartilage zone. (Taken from Hinton R. Genes that regulate morphogenesis and growth of the temporomandibular joint: A review. Dev Dynam 2014;243(7):864-874.)

The most superficial layer is called the articular zone. It is found adjacent to the joint cavity and forms the outermost functional surface. This layer is made of dense fibrous connective tissue. Collagen fibers are oriented parallel to the cartilage surface but angled together to form a sheet-like structure.[9] The fibers are tightly packed and able to withstand the forces of movement. The articular fibrous zone is comprised of

fibroblast-like cells which have a flat shape and endoplasmic reticulum surrounded by dense cytoplasm.[10]

The second zone is called the proliferative zone and is mainly cellular. It is in this area that undifferentiated mesenchymal tissue is found. This tissue is responsible for the proliferation of articular cartilage in response to the functional demands placed on the articular surfaces during loading. Essentially, it serves as a separating barrier between the fibrocartilaginous fibrous zone and the hyaline-like mature and hypertrophic zones. Below the cartilage is the mandibular bone, with cancellous bone covered by a layer of compact cortical plate.[11] The proliferative zone indeed plays an important role as a cell reservoir, which has mesenchymal cells distributed heterogeneously as chondrocyte precursors for the underlying zones. Thus, it is likely that these mesenchymal cells partly contribute to the changes in the thickness and shape of mandibular condylar cartilage in adaptation.

In third zone is the collagen fibrils are arranged in bundles in a crossing pattern, although some of the collagen is seen in a radial orientation. The fibrocartilage appears in a random orientation, providing a three dimensional network that offers resistance against compressive and lateral forces.

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The fourth and deepest zone is made up of chondrocytes and chondroblasts distributed throughout the articular cartilage. In this zone the chondrocytes become hypertrophic, die, and have their cytoplasm evacuated, forming bone cells from within the medullary cavity. The surface of the extracellular matrix scaffolding provides an active site for remodelling activity during endosteal bone growth, as it does elsewhere in the body.[12]

These various zones do not have linear columns of daughter cells. This is a notable histologic difference between primary and secondary types of growth cartilage. The nonlinear arrangement of the daughter cells in the condylar cartilage thus does not reflect the direction in which the condyle is growing. It also means that the cap of condylar cartilage has multidirectional proliferative capacity. This is one of the most significant developmental features of the condyle.

DEVELOPMENT OF SECONDARY CARTILAGE

The primary and secondary cartilages have different embryonic origins. The primary cartilage is different from most of the articular cartilages which are also primary, while the secondary cartilages appear later during the embryonic development, independent of the appearance of chondro-skeleton. Apart from constituting the mandibular condyle, secondary cartilage also occurs in the sutures of maxilla, mandibular symphysis and angular as well as coronoid processes. The two types of cartilages show differences in histological organization and in the pattern of cell proliferation.[12] By contrast, the secondary cartilage only secondarily follows these overall stimuli after additional modulation by local growth factors.[13] By approximately 10-12 weeks gestation, secondary cartilage appears.

As the cartilage comprising the mandibular condyle arises "secondarily" within a skeletogenic membrane and apart from the primary embryonic cartilaginous anlagen, it is referred to as a secondary cartilage as shown in Figure-7.

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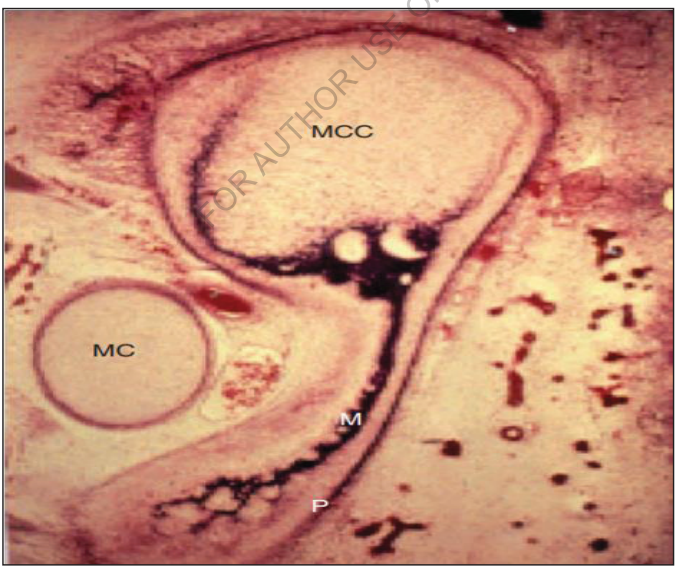

Fig 7. Frontal histologic section of a human foetus (approximately 8 weeks gestation). The bone comprising the body and ramus of the mandible (M) originates in membrane lateral to Meckel's cartilage (MC). The periosteal membrane enveloping the mandible gives rise secondarily to the mandibular condylar cartilage (MCC). (Taken from Graber LW,Vanarsdall RL & Vig KWL. Orthodontics: Current Principles and Techniques. 5th ed. Elsevier Health Sciences;2011:p.229-233.)

There are some important reasons to define condylar cartilage as secondary cartilage:

(1) Being late in ontogenetic development, the new cartilage develops within a mesenchymal blastema. Primary cartilages are covered by a thin perichondrium. Secondary cartilage is covered by a fully developed mesenchymal tissue layer. The mesenchymal covering of the condyle is responsible for a fundamental characteristic of the condylar cartilage. There are mesenchymal cells first and these cells differentiate into cartilage only as a secondary event.[12]

(2) The term 'secondary cartilage' may also apply to the characteristic response of the condyle during growth. Primary epiphyseal cartilage reacts during development, primarily to systemic growth stimuli such as hormones. In contrast, condylar cartilage only secondarily follows these overall stimuli after additional modulation by local growth factors.[13]

(3) In pre-natal development, most other synovial joints have already been formed before the temporomandibular joint.[14] The delayed occurrence of condylar cartilage was confirmed by immunolocalization of types II and X collagen in the fetal mouse mandible, where the immunoreactions were not positive until day 15 of pregnancy. The new articulation between the temporal bone and the mandible is therefore indicated as secondary, in contrast to primary joints formed earlier.

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(4) Subsequent to all other true primary cartilages that form within the mesenchymal blastema of what will be the future mandible, new cartilage formation begins as a secondary event in 4 regions: the condylar process, the coronoid process, the symphysis, and the gonial area. The latter three will have disappeared around birth. Condylar secondary cartilage, remains for the rest of our lives. Probably due to articular functioning, cartilage is induced and maintained within the membranous components of the condylar process of the mandible.

Secondary cartilage is a unique type of skeletal tissue that has the characteristics of both intramembranous bone and certain histologic and functional features of hyaline growth cartilage. Secondary cartilage is formed in areas of precocious stresses and strains within intramembranous bones, as well as in areas of rapid development and growth of bone.[15] The secondary cartilage composing both the condylar and the temporal portion of the TMJ can be divided into two general layers: an articular tissue layer and a subarticular growth layer. Each of these layers is present in the neonate and remains in the condyle through maturity.[16] However, in the adults, the remnant condylar cartilage serves more ‘articular’ function than ‘growth’ function.[17]

The condylar cartilage appears at 12 weeks of development and rapidly forms a cone-shaped or carrot-shaped mass that occupies most of the developing ramus. This mass of cartilage is converted quickly to bone by endochondral ossification, so that at 20 weeks of development only a thin layer of cartilage remains in the condylar head as shown in Figure-8.

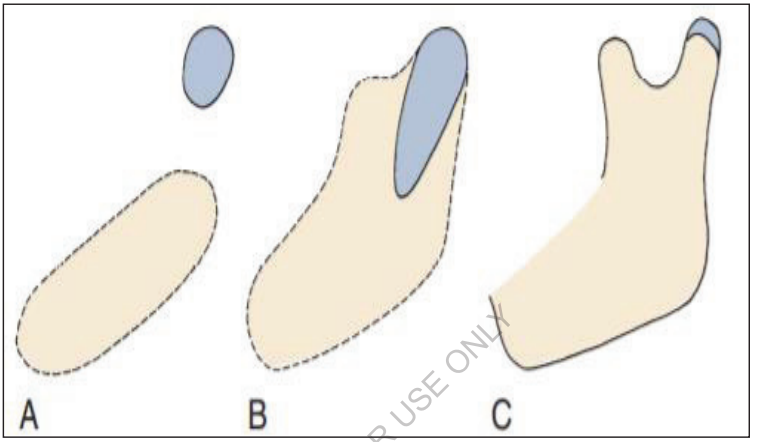

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Fig 8. The condylar cartilage (blue) develops initially as a separate area of condensation from that of the body of the mandible and only later is incorporated within. (A) Separate areas of mesenchymal condensation at 8 weeks. (B) Fusion of the cartilage with the mandibular body at 4 months. (C) Situation at birth (Taken from Proffit WR, Fields Jr HW. Later stages of development. In: Proffit WR. Contemporary Orthodontics. 5th ed. St Louis, MO: Mosby;2000:p.87-104.)

This remnant of cartilage persists until the end of the second decade of life, providing a mechanism for growth of the mandible, in the same way as the epiphyseal cartilage does in the limbs.[18]

PRENATAL CONDYLAR GROWTH

The embryonic development of the temporomandibular joint differs considerably from that of other synovial joints, reflecting its complicated evolutionary history. Most synovial joints complete the development of their initial cavity by the 7th week post conception, but the temporomandibular joint does not start to appear until this time. Whereas limb joints develop directly into their adult form by cavity formation within the single blastema from which both adjoining endochondral bones develop as shown in Figure-9.

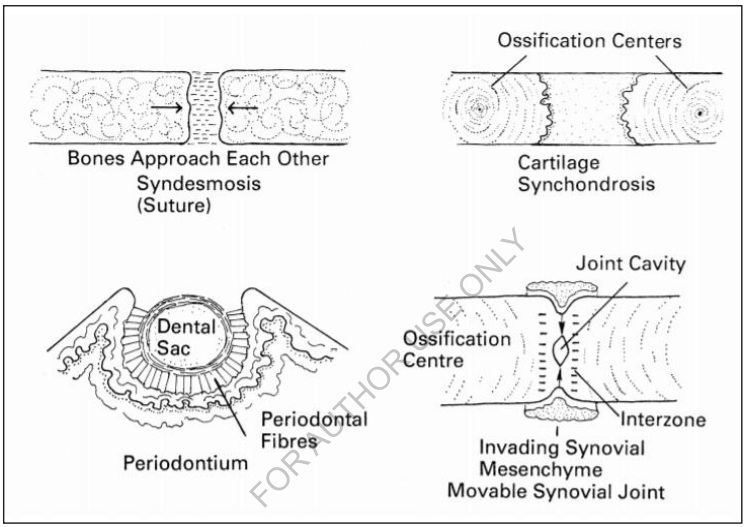

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Fig 9. Embryonic origins of various types of joints. (Taken from Sperber G. Craniofacial development. Hamilton, Ont.: B.C. Decker; 2001:p.126-142.)

The temporomandibular joint develops from initially widely separated temporal and condylar blastemata that grow towards each other.

The dorsal half of the arch gives rise to the maxillary process and the ventral half to the mandibular process. Within the mandibular process, Meckel's cartilage develops from the 8th to 16th weeks as shown in Figure-10.

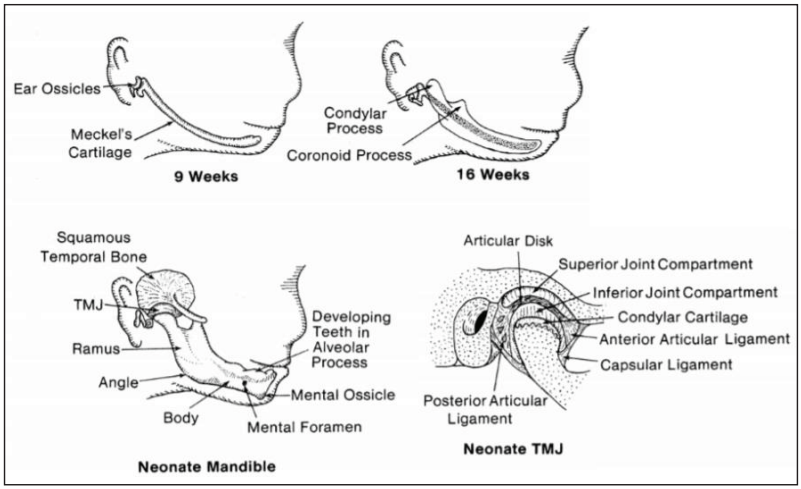

Fig 10. Development of the mandible and the temporomandibular joint. (Taken from Sperber G. Craniofacial development. Hamilton, Ont.: B.C. Decker; 2001:p.126-142.)

The temporal blastema arises from the otic capsule, a component of the basicranium that forms the petrous temporal bone. The term 'secondary cartilage' may also apply to the characteristic response of the condyle during growth.

The mandibular condyle in the fetal and newborn period is an articular cartilage, as well as an active skeletal growth center for the mandible, in the same way as the growth plates are the skeletal growth center for the long bones of the extremities. Most synovial joints complete the development of their initial cavity by the 7th week post conception, but the temporomandibular joint does not start to appear until this time. The embryonic origin of the TMJ involves neural crest mesenchyme migrating ventrally to form the first (mandibular) pharyngeal arch.[19]

The human TMJ develops in three stages between the 7th and 20th week

a) The glenoid fossa of the temporal bone
b) The condylar process of the mandibular ramus
c) The articular disc

The first phase (7th–8th week) is the approximation of the condylar process to the developing concavity of the glenoid fossa at the base of the temporal bone.

The second phase (9th–11th week) encompasses the coordinated development of the condyle and fossa, the articular disc, joint capsule, and joint cavities.

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Endochondral ossification of the condylar process begins in the 17th week and after the 20th week the secondary cartilage is almost entirely ossified. The articular disc and joint capsule develop between the articular fossa and the condylar process. The disc forms in a biconcave shape and separates the joint cavity into two spaces, an upper space between the disc and the glenoid fossa, and a lower space between the disc and the condyle.

By the 20th week, the articular disc has differentiated into periosteal articular surface with underlying fibrocartilage.

This more complex process is consistent with the TMJ being a secondary joint with a periosteal articular surface that has regenerative potential.[20] Neural crest mesenchyme migrates during the fourth week of embryonic development to form the first branchial (mandibular) arches surrounding the prospective stomodeal region. During this time, a blastema forming the condylar secondary cartilage (CSC) develops beneath the periosteum from the ramal surface of the developing mandibular body and the development of the mandibular condyle is shown in Figure-11 [a,b]. The secondary cartilage blastema that forms the ramus and condyle arises at around 6 weeks in utero, from the medial surface of the intramembranous bone of the primordial mandibular body as shown in Figure-11a. The blastema originates in the subperiosteal space from osteogenic perivascular cells, so the secondary cartilage is covered with periosteum (blue outline) throughout its development. At about 20 weeks, the carrot-shaped condyle is formed (arrow in Figure-11b) via secondary cartilage that is mineralized to form the endochondral bone that composes a substantial portion of the subcondylar ramus (Figure-11c). The periosteal articular surface of the mandibular condyle is composed of the fibrous and cambium layers of the periosteum with an underlying cushion of fibrocartilage.[21] The buds for the deciduous molars are formed at the same time as the condyle (Figure-11b).

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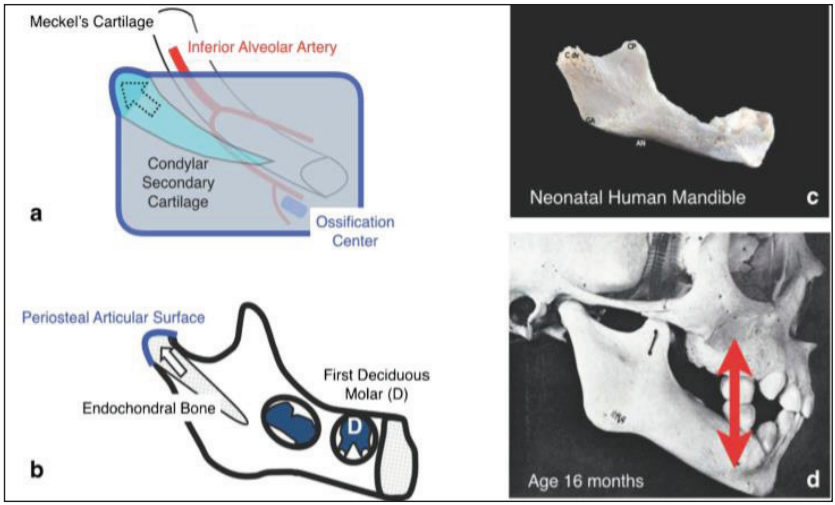

Fig 11. Biomechanics of mandibular development is illustrated for the right side: **a)** At 6–8 weeks in utero, bone formation begins at the ossification center and grows into a plate of bone (gray) surrounded by a periosteum (blue line). The condylar secondary cartilage emerges as a subperiosteal blastema from the lingual surface. **b)** From 8–20 weeks, the condyle grows in a superior and inferior direction. The condyle has a periosteal articular surface (blue line) with an underlying fibrocartilage layer that forms endochondral bone. The first deciduous molar (d) is forming at the same time. **c)** Neonatal human mandible shows the following skeletal landmarks: osseous portion of the condylar process (Cdr), gonial angle (GA), antegonial notch (AN), and corinoid process (CP). **d)** At ~16 months of age, the first deciduous molars (Ds) occlude bilaterally, resulting in heavy loads (red double-headed arrow) being equally distributed to the mandible and the cranium. (Taken from Stocum D, Roberts W. Part I: Development and Physiology of the Temporomandibular Joint. Current Osteoporosis Reports 2018;16(4):360-368.)

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In contrast to other synovial joints, fibrous cartilage (rather than hyaline cartilage) forms on the articular facets of the temporal mandibular fossa and mandibular condyle. In the later site, the underlying secondary cartilage acts as a growth center.

POSTNATAL CONDYLAR GROWTH

Growth of the mandible was thought to occur principally by growth at condyle. Grow th of the condyle during the postnatal period is accompanied by a significant thickness, increase in the fibrous zone and an obvious thickness decrease in the hypertrophic zone, with an overall decrease in the cartilage thickness.[22] The traditional concept of mandibular growth views the condyle as a primary growth centre, which under the control of intrinsic factors not only governs the over-all growth of the mandible but also displaces the mandible downward and forward, thereby regulating the anteroposterior relationship of the mandible to the maxilla.

Superior and posterior growth of condyle presses against the glenoid fossa providing an anterior thrust to displace the lower jaw forward (similar to growth of maxilla). The concept of posterior growth and anterior displacement leads to primary displace ment. Charles (1925) concluded that the mandible growth is solely controlled by the growth that takes place at the top of the condyle.[23]

According to Moss (1969), who has expressed that the origin, growth and maintenance of the skeleton depend almost exclusively upon the functional matrix, to those tissues, organs, and functioning spaces related to any given skeletal element. Applying the hypothesis to the mandible, Moss failed to credit the condyle with any inherent growth and maintains that mandibular growth occurs as a secondary or adaptive response to the functional behaviour of the oral cavity and related orofacial musculature.[24]

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The characteristics of cartilage make it a most appropriate tissue for performing two very important functions in the body.

1) The capacity of cartilage to produce a strong but flexible provisional supportive frame-work at a relatively high rate of growth fulfils a crucial function during embryonal and postnatal growth.

2) The chemical and physical properties of the matrix components give cartilage RESILIENCE, a property which is well suited to cushion compressive forces in loaded articular joints.

Mandibular condylar cartilage fulfils both functions, though for the greater part, diachronously. These functions influence the development and determine the ultimate shape and composition of the mandibular condyle. The relative intensity of expressions of the two functions during development was shown in Figure-12.

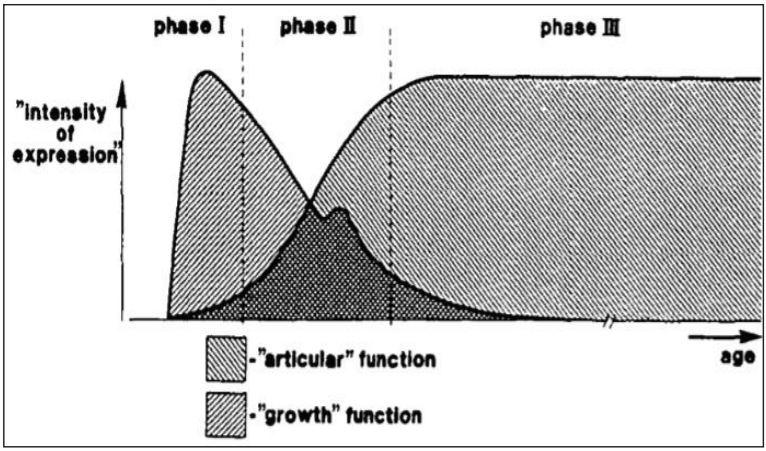

Fig 12. Graphic representation of the function of mandibular condylar cartilage during development. (Taken from Copray JC, Dibbets JM, Kantomaa T. The role of condylar cartilage in the development of the temporomandibular joint. Angle Orthod 1988;58(4):369-380.)

Each of these three phases reflects the changing functions of the mandibular condyle during development.

PHASE I- During phase I, the embryonal and the early postnatal stages, the mandibular condylar cartilage functions mainly as a growth cartilage. Although some intrauterine mandibular movements with functional activity in the TMJ have been observed, the articular function of the condylar cartilage still seems subordinate.

PHASE II- In phase II, the functional activity increases, causing the mandibular condylar cartilage to function more as an articular cartilage. Increase of the articular functioning is accompanied by a decrease of the growth activity, despite the hormonally induced growth spurt occurring during this stage. It starts before birth and runs until about 20 years of age, with growth activity continuing until approximately age 25.

PHASE III- In phase III, the orofacial muscular structure and activity reach their relatively stable adult stage and gradually the condylar cartilage functions almost entirely as an articular cartilage. The growth activity diminishes further and some maintenance turn over activity might be considered as the last remnant of the “growth” function.[17]

The secondary cartilage of the condyle is not the genetic pacemaker for the growth of the mandible. Its real contribution is to provide regional adaptive growth (i.e., growth

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that is secondarily responsive to a variety of circumstantial conditions) thus giving yet another meaning for the term "secondary." The condylar cartilage is thus phylogenetically and ontogenetically unique and differs in histologic organization from most other growth cartilages involved in endochondral bone formation.

Thus, the condyle is not a "primary" center of growth, but rather

(1) Secondary in evolution;

(2) Secondary in embryonic origin;

(3) and secondary in adaptive responses to changing developmental conditions (regional adaptive growth) .

The post-natal growth of the mandible in terms of the changes taking place in different regions.

The Condylar neck

The lingual and buccal sides of the neck characteristically have resorptive surfaces as shown in Figure-13.

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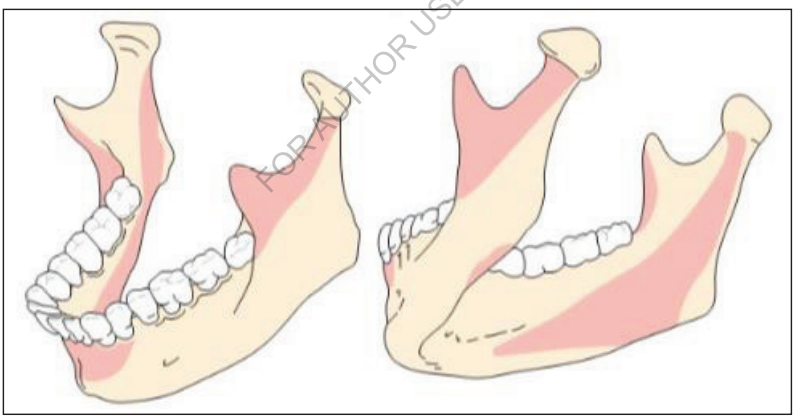

Fig 13. Mandibular remodelling-Resorptive surfaces are dark shaded and depository surfaces are unshaded. (Taken From Moyers R. Growth of the craniofacial skeleton. In: Handbook of Orthodontics. 4th ed. Chicago: Year Book Medical Publishers;1988.)

This is because the condyle is quite broad and the neck is narrow. The endosteal surface of the neck actually faces the growth direction; the periosteal side points away from the course of growth. This is another example of the V principle, with the V-shaped cone of the condylar neck growing toward its wide end as shown in Figure-14.[2]

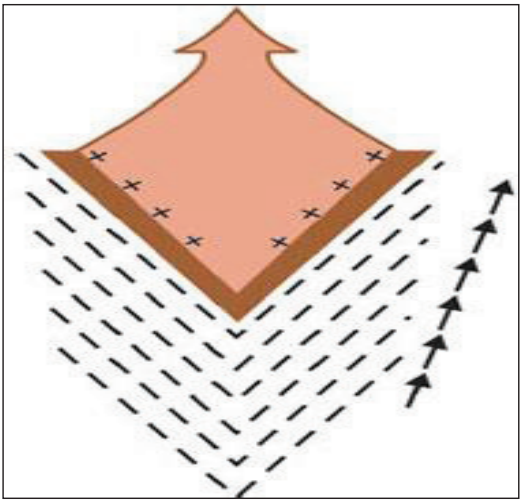

Fig 14. V principle- Bone deposition occurs on the inner side of the V; resorption takes place on the outside surface. The V thereby moves from position A to B and at the same time, increases in overall dimensions. The direction of movement is toward the wide end of the V. (Taken from Enlow D, Hans M. Essentials of facial growth. Philadelphia, London, Toronto: W.B. Saunders;1975.)

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As growth progresses, bone from one level in the condyle-upper ramus region, gets incorporated into the next level lower down.

In sequence: Condylar head parts incorporated into new upper Condylar neck.

- Upper parts of the neck undergo remodelling conversion into the new lower parts.
- The lower portions receive direct remodelling changes into the ramus proper.

The successive growth movements involve the principle of 'area relocation', which

represents the basic factor that underlies these remodelling processes. With each successive addition of new bone at the free end of the condyle, all the levels down the line in the neck and ramus necessarily receive relocation in their relative positions. Each local level, as it becomes repositioned, undergoes adjustments in shape and dimensions to convert it into the next level in sequence.[25] As condylar and ramus development proceeds, the mandible as a whole, is becoming displaced antero-inferiorly as shown in Figure-15.

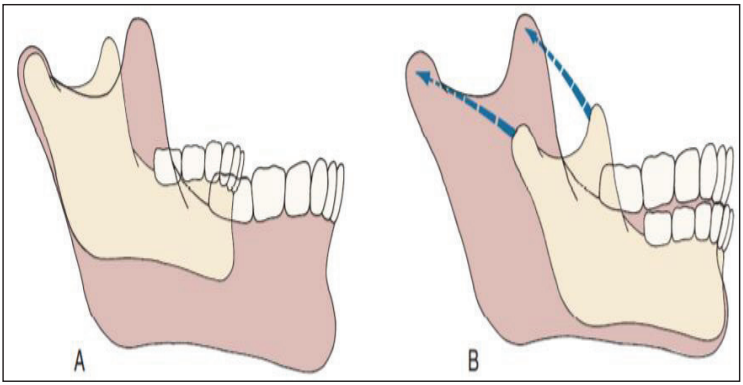

Fig 15. The condyle enlarges directly toward its articular contact in the glenoid fossa of the cranial floor. As this takes place, the whole mandible is moved forward and downward by the same amount that it remodels upward and backward (Taken from Proffit WR, Fields Jr HW. Later stages of development. In: Proffit WR. Contemporary Orthodontics. 5th ed. St Louis, MO: Mosby;2000:p.87-104.)

What is the physical force that produces the forward and downward primary displacement of the mandible?

For many years it was presumed that growth of the condylar cartilage, because it is known that cartilage is a special pressure-adapted type of tissue, creates a "thrust" of the mandible against its articular-bearing surface in the glenoid fossa. The proliferation of the cartilage toward its contact thereby was presumed to push the whole mandible away from it.

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The Condylar head

The condylar head is much broader than the neck beneath it, because the neck is sequentially derived from the head by remodeling , a marked reduction in width takes place as shown in Figure-16.

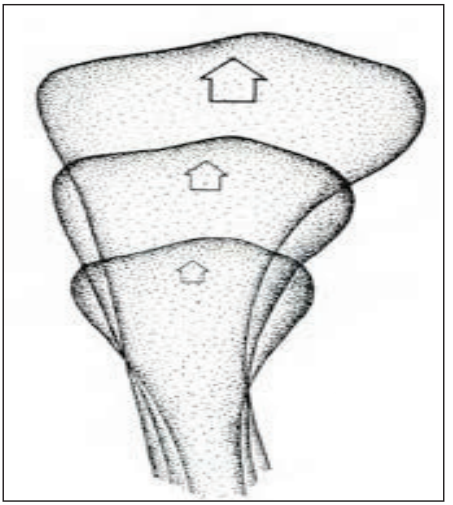

Fig 16. The diameter of the narrow condylar neck is progressively reduced from the wider dimensions of the posterior moving condyle. (Taken from Enlow, DH & Harris DB. A study of the postnatal growth of the human mandible. Am J Orthod Dentofac Orthop 1964;50(1): 25-50.)

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Reduction is brought about by surface resorption of bone on periosteal side of the cortical plate together with continued, proportionate deposition of bone on the endosteal surface.

The entire cortex drifts in an endosteal direction as

(1) The head moves progressively away from the existing neck, and

(2) The neck becomes lengthened by this process of endosteal growth behind the mov ing head.

The buccal and lingual cortical plates move in an inward, medullary direction toward each other as the transverse dimensions of the neck become reduced. The growth and remodelling process in the condylar neck follow the V principle. New bone is added to the inner side of the V shaped neck while bone is removed from the outer (periosteal) surface at the same time as shown in Figure-17.[26]

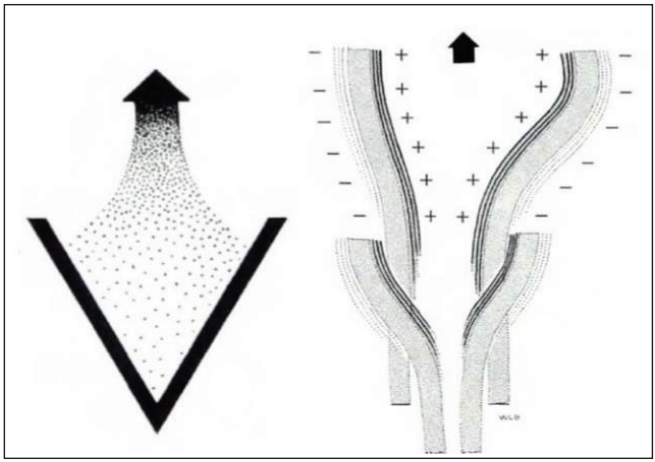

Fig 17. Inward growth of the buccal and lingual cortices is accomplished by a combination process of periosteal resorption (-) and endosteal deposition (+) . This is an example of the V principle. (Taken from Enlow, DH & Harris DB. A study of the postnatal growth of the human mandible. Am J Orthod Dentofac Orthop 1964;50(1): 25-50.)

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The V mechanism of remodelling provides three simultaneous growth functions

1. It moves the entire structure in a progressive course toward its free (wide) end, cau sing a continuous change in position of the condyle and neck to keep pace with the moving condylar growth cartilage.

2. Second, it produces an overall enlargement of the whole V shaped region proportionate to the increasing size of the mandible as a whole.

3. Third, it results in a sequential reduction of the tapering wide part of the head and neck into more narrow areas as the latter becomes relocated into the former. This reduction is produced by cortical growth in an endosteal manner. The growth principle dealing with surfaces facing toward and away from the direction of growth applies.[27]

In summary, the condyle rather than acting as a "master growth center," actually performs in a much more functional role. It provides a pressure-tolerant articular contact and it makes possible a multidimensional growth capacity in response to ever-changing developmental conditions and variations.

BIOMECHANICAL AND BIOCHEMICAL DEVELOPMENT OF THE CONDYLAR BONE

Bone constantly strives for optimal architecture. Mandibular condyle, which is subjected to various mechanical loads forcing it to be highly adaptive, has a unique structure and a relatively high remodelling rate and maintains an optimal architecture withstanding forces with the least material possible. Mandibular condyle adjusts its architecture to these specific, mostly compressive loading in supero-inferior direction with the articular surface supported for the most part by vertically oriented trabeculae.[28]

Biomechanical consequences of developmental changes

(i) The role of the mineralized component in the apparent bone mechanical properties

Bone density influences bone stiffness at the apparent level, yield stress, and ultimate stress. Bone trabeculae decrease in number and increase in thickness during prenatal development, resulting in an increase in bone density. Additionally, anisotropy matters as bone is stiffest in the direction in which its elements are aligned.[29] Bone stiffness is correlated positively to its mineralization degree too. Within physiologic limits, mineral content and ultimate strength are correlated positively. Osteoporotic bones show low bone density and high mineral content as apposition of new, lowly mineralized, tissue is limited. The higher mineralization in the cores of condylar trabeculae and the concomitant remodelling-related low mineralization at the bone surfaces result in a heterogeneous mineral distribution.

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(ii) The role of collagen in the apparent mechanical properties of bone

The amount of collagen is positively correlated to toughness, to tensile strength when tested parallel to the main collagen fibre orientation, to compressive and bending strength when tested perpendicular to the main collagen fibre orientation, and to post-yield properties of bone.[30] The more the collagen fibres are aligned, the larger are potential bone microfractures in the collagen fibres main direction. Changes in collagen content, fibre orientation, and the number of HP, LP, and Pen cross links correlate with bone stiffness measurements, but experimentally altered numbers of HP, LP, and Pen cross links do not change apparent bone stiffness.[31]

(iii) The role of the mineralized bone component in the micromechanical properties of bone

Micromechanical properties of bone can be studied at the level of single bone trabeculae using highly accurate and non-destructive methods such as, atomic force microscopy and nanoindentation. The correlation between local mineralization degree and local bone tissue stiffness is positive but highly variable with coefficients of determination ranging from 0.07 to 0.94.[32] In addition, local mineralization degree might affect fracture risk and mechanical properties at the apparent level.[33]

(iv) The role of collagen in the micromechanical properties of bone

Collagen fibre orientation has a marked local influence on the micromechanical properties of bone in compression. The collagen cross links probably play a negligible, if any, role in bone micromechanical properties.[32]

(v) Biomechanical consequences of developmental changes of mandibular condyle

Bone of the aging condyle is characterized by a decrease in mineralization heterogeneity. A sharp rise of the mean mineralization degree of bone, might occur during aging has adverse effects on the mechanical properties.[34] The apparent stiffness of condylar bone is raised by the increase in the degree of mineralization, the decrease in the degree of anisotropy, and the transition from the rod-like to the plate-like trabecular shape. The latter shape changes and the reduction of the number of HP, LP, and Pen may enhance the post-yield and ultimate stress characteristics of condylar bone as shown in Figure-18.

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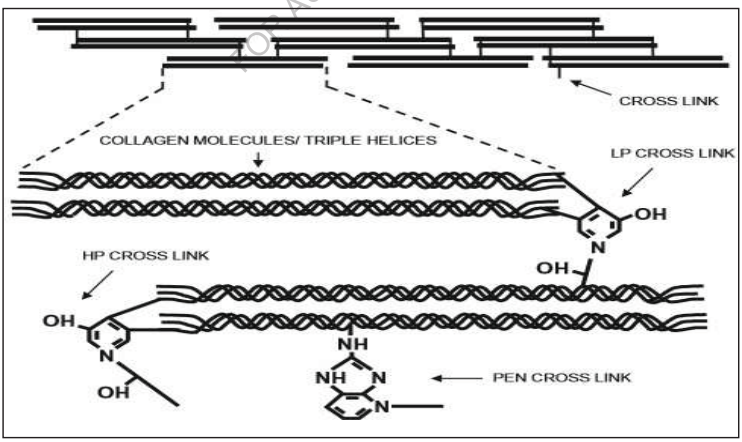

Fig 18. Schematic figure of collagen fibres, molecules, and the most important cross links between these molecules. HP, hydroxylysylpyridinoline; LP, lysylpyridinoline; Pen, pentosidine. (Taken from Willems N, Langenbach G, Everts V, Zentner A. The microstructural and biomechanical development of the condylar bone: a review. Eur J Orthod 2013;36(4):479-485.)

Biochemical composition of the mandibular condylar cartilage

Articular cartilage contains chondrocytes and a large amount of surrounding matrix macromolecules such as proteoglycans, glycosaminoglycans (GAGs) and type II, IX, and XI collagens. These molecules contribute to the flexibility of cartilage and protection of the joint components from mechanical threats originating from compression, shearing and stretching loads. The load-bearing functions of cartilage are mainly provided by the viscoelastic property of collagen fiber network and the osmotic pressure due to the presence of proteoglycans. The mandibular condylar cartilage consists largely of fibrocartilage, with thick multi-layers composed of several collagen fiber zones as shown in Figure-19.[35]

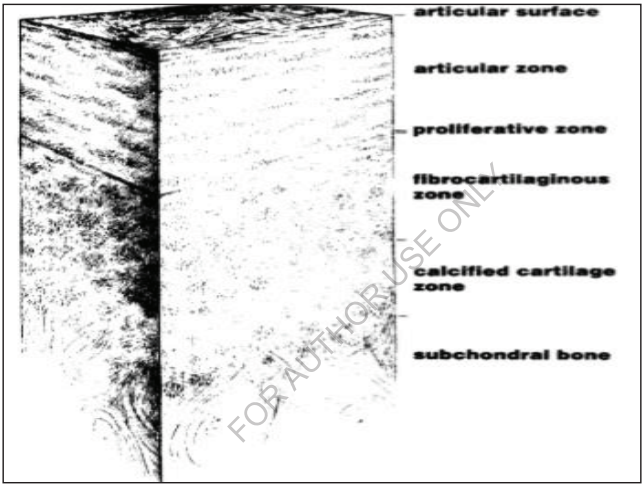

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Fig 19. Diagram of the spatial arrangement of collagen fibrils in the articular cartilage of the mandibular condyle.(Taken from De Bont LGM, Boering G, Havinga P & Liem RSB. Spatial arrangement of collagen fibrils in the articular cartilage of the mandibular condyle: A light microscopic and scanning electron microscopic study. J Oral Maxillofac Surg, 1984;42(5):306-313.)

The collagen fibers are considered to provide mainly tensile strength to the cartilage. Shear strength has been suggested to originate from cross-links between the collagen fibers.[36] In the mandibular condylar cartilage, collagen fibers run mainly in the antero-posterior direction, which is suggested to be an optimized orientation to resist antero-posterior shear forces.[37]

FACTORS REGULATING MANDIBULAR CONDYLAR GROWTH

Petrovic and Stutzmann (1975) hypothesized that "There must be a negative feedback-signal originating from the proximal part of the chondroblastic zone and exerting a restraining effect on the prechondroblastic multiplication rate."[38] Condylar growth must be regulated by a host of orchestrated influences of various growth factors and other regulatory factors that are endogenously expressed in the condyles.

Several factors have been verified to have great impact on growth and development of mandibular condyle. They are:

i) Sox9 and type II collagen

The transcription factor Sox9 [Sex-determining Region on the Y Chromosome (SRY)-related High-Mobility Group (HMG) Box 9] plays a key role in chondrocyte differentiation.[39] Sox9 regulates chondrogenesis in two ways. Firstly, it is essential in the progress that mesenchymal cells differentiate into chondrocytes. Secondly, Sox9 regulates condylar cartilage formation by modulating the expression of Col2a1 (Core binding factor alpha 1)-encoding type II collagen, the most abundant structural collagen component of cartilage, together with other elements of cartilage-specific extracellular matrix (collagens IX, XI, the large proteoglycan aggrecan, etc). Rabie and Hagg (2002) found that during natural growth of rats condyles, Sox9 was expressed in mesenchymal cells and chondrocytes, indicating its similar effects on regulating mesenchymal cells differentiation and cartilage formation.[5]

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When the mandible is positioned forward, there is an up-regulation of the expression of Sox9 as well as type II collagen in the condyle and the glenoid fossa, resulting in an increased amount of cartilage formation and subsequent new bone deposition.[40,41]

ii) Parathyroid hormone-related protein

It was hypothesized that Sox9 was a target for PTHrP signaling. PTHrP was observed to up-regulate Sox9, the factor regulating the differentiation of mesenchymal cells into chondroblasts. Therefore, it was suggested that PTHrP may induce the differentiation of mesenchymal cells through the Sox9 pathway.

It was found that forward positioning of mandible triggered the expression of PTHrP, which led to an increased number of differentiated chondroblasts and retardation of chondrocyte hypertrophy, followed by increased cartilage volume. Therefore, through functional appliance therapy, the condyle is endowed with more potential to construct the cartilage frame for future endochondral bone deposition.[42]

iii) Indian hedgehog

Indian hedgehog (Ihh) plays a key role in proliferation, hypertrophy and apoptosis of chondrocytes.

Mandibular advancement stimulated the expression of Ihh in condylar cartilage resulting in an increased number of proliferating mesenchymal cells and a shortened turnover time. Ihh may mediate the conversion process of the mechanical signals caused by mandibular advancement into cellular replication in condylar cartilage.[43]

iv) Fibroblast growth factor and its receptors

The fibroblast growth factor receptors (FGFRs) are known to have a significant impact on the growth and development of cartilaginous tissues.[44] In mandibular condyle, chondroblasts and hypertrophic chondrocytes showed the most pronounced immunoreactivity for receptors of FGF-2, including FGFR1 and FGFR3.

Designed to create a lateral functional shift of the mandible, intraoral appliances bring about a transverse rotation of the mandible with the condyle on the shifting side remaining in place or moving slightly posteriorly (non-protruded) while the opposite site distracted anteriorly (protruded) from the glenoid fossa. There were significant differences in gene expression for FGF-2, FGFR1, FGFR2 and FGFR3 between the protruded and non-protruded condylar cartilage.

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v) Type X collagen

Type X collagen, secreted by hypertrophic chondrocytes, is recognized as an indicator for endochondral ossification and bone replacement of the cartilage matrix.[45] Therefore, it was considered as a unique element of the hypertrophic cartilage matrix and a critical marker for endochondral bone formation.

When the mandible is positioned forward by functional appliances, intensive expression of type X collagen is found to distribute throughout the hypertrophic zone when compared with the controls, indicating the onset of condylar endochondral bone formation stimulated by the functional appliances therapy.

vi) Vascular endothelial growth factor

Vascular Endothelial Growth Factor (VEGF) is known to be a potent regulator of neovascularization.[46]

VEGF also plays an important role in regulating endochondral ossification in condyles by controlling neovascularization.

Besides hypoxia, Upon forward mandibular positioning by bite-jumping appliance, there was a significant up-regulation of VEGF, followed by accelerated vascularization and subsequently increased new bone formation in both the condyle and glenoid fossa.[47,48] It was found that the temporal expression of VEGF was correlated with the pattern of new bone formation in condyle and glenoid fossa during stepwise mandibular advancement. In comparison with one-step advancement, the initial advancement in the stepwise group, demonstrated significantly less expression of VEGF. However, rf VEGF expression appeared to increase significantly, in the stepwise group when compared with the single advancement group and the natural growth group. This result suggested that the mechanical stimuli provided by stepwise mandibular advancement may trigger a sequence of cellular events resulting in increased vascularization and bone deposition in condyle. [49,50]

Vii) Core binding factor alpha 1/ Runt-related transcription factor 2

Core binding factor alpha 1 (Cbfa1), also known as Runt related transcription factor 2 (Runx2), serve as a key regulator of condylar cartilage development, osteoblast differentiation and bone matrix deposition.[51] Rabie et al. (2004) found that during the natural development of mandibular condyle, the peaking of Cbfa1 level coincides with chondrocyte hypertrophy and matrix mineralization.[52] Mandibular advancement triggers Cbfa1/Runx2 expression in condylar cartilage, resulting in increased osteoblasts invasion and stimulated chondrocyte terminal maturation.[53]

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viii) Osteoprotegerin / Receptor activator of NF-kappaB ligand

Receptor activator of NF-kappaB ligand (RANKL) which belongs to the tumor necrosis factor superfamily together with osteoprotegerin (OPG). The ratio of OPG/RANKL plays a major role in the regulation of osteoclastogenesis: an increased ratio leads to a reduced number of newly formed osteoclasts and vice versa.[54] A decrease of chondrocytes secreted OPG/RANKL ratio and decrease of OPG level was observed, suggesting its critical role in the osteoclastogenesis of mandibular condyle. However, functional appliances effects on endochondral ossification in mandibular condyle, achieved by coordination between osteoblasts and osteoclasts still needs to be obtained with the introduction of OPG and RANKL.

ix) Insulin-like Growth Factors

The insulin-like growth factors (IGFs or somatomedins) are a family of low molecular weight peptides (mass about 7.5 kDa). Two main isoforms of IGF (IGF1 and IGF-2) are respectively composed of 70 and 67 amino acid residues.

Several roles to IGF-1 have been attributed in the growth of the mandibular condyle:

a) It facilitates in vitro proliferation of the cartilaginous cells in condyles.
b) It enhances synthesis of PG and maintains an expression for the synthesis of type II collagen in the absence of serum.
c) It stimulates the replication of osteoblasts and synthesis of the bone matrix.
d) It blocks cytokine-stimulated cartilage degradation in a manner comparable to that of TGF-b-1.
e) It participates in the control of cartilage homeostasis in the orofacial area.
f) IGFs regulate cartilage growth and differentiation.
g) IGFs are involved in the growth and development of teeth, mandibles, maxilla and tongue in the oro-facial area.[4]

x) Matrix-mettalo-proteinases

MMPs being a family of proteolytic enzymes, regulating cell differentiation and tissue remodeling, they are secreted by most types of cells, with their expression transcriptionally regulated by the growth factors and cytokines.[55] Consequently, they allow

(1) Cell migration

(2) Cell attachment

(3) Proliferation

(4) Differentiation

(5) Alteration in the ECM micro-environment

(6) Induction in the altered cellular behavior, and

(7) Morphogenesis.

The administration of growth factors along with the use of mandibular advancement appliance has increased genetic expression of MMP-1 and MMP-13 supported by histomorphometric evidence indicating growth of condylar cartilage.[56]

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INCREMENTAL GROWTH CHARTS FOR CONDYLAR GROWTH

Dimensional changes

For the three planes of space in both the maxilla and mandible, there is a definite sequence in which growth is "completed". Growth in width is completed first, then growth in length, and finally growth in height. Growth in length and height of both jaws continues through the period of puberty.

Sexual dimorphism in condylar growth was clearly indicated. Male condyles grew at slightly faster rates during childhood and at substantially faster rates during adolescence, for other craniofacial measures.[57,58] Baumrind and co-workers (1992) reported relatively constant rates of condylar growth for a sample of treated and untreated children between 8.5 and 15.5 years of age, although sex differences in growth patterns were identified.[59]

During later childhood and adolescence, the condyle shows substantially greater amounts of superior than posterior growth. For every 1mm of posterior growth, there is 8 to 9 mm of superior growth. [60] It has been estimated that the condyles of females and males grew 2-2.5 and 2.5 to 3.0 mm/yr respectively, during childhood and adolescence, with the greatest rates occurring during the earlier childhood years and during the adolescent spurt as shown in Figure-20[a,b].

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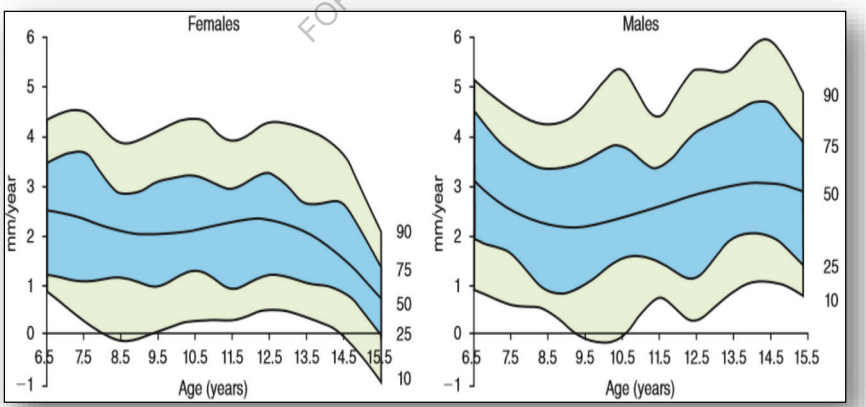

Fig 20. (a) Total condylar growth. Incremental chart for females. **(b)** Total condylar growth. Incremental chart for males.(Taken from Buschang PH, Santos-Pinto A & Demirjian A. Incremental growth charts for condylar growth between 6 and 16 years of age. Eur J Orthod 1999;21(2):167-173.)

Dimorphism in the timing of the adolescent spurt (12.2 years and 14.3 years for females and males, respectively) coincides with estimated ages of peak adolescent velocity reported for other craniofacial and somatic measures.[61,62] This suggested that some children exhibit negative growth velocities, especially around the prepubertal minimal growth period and towards the end of adolescence. This may be due to structural bony changes in the mandibular condyle associated with craniomandibular disorders, such as osteoarthosis, osteoarthritis, and polyarthritis. Such structural bony changes in approximately 5 per cent of a sample followed between childhood and adulthood.[63]

The data provides a means for monitoring treatment outcomes, making it possible to more accurately evaluate the response of condylar growth to treatment and also help orthodontists to identify children who require further investigation or therapy, Since the majority of patients with Class II and Class III skeletal malocclusions had abnormal mandibular growth and the condyles are the foci of treating mandibular growth problems.[64] They provide standards against which individual patient's past growth can be assessed.

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Conclusion

- The condyles follow the general or somatic pattern of growth with childhood deceleration, acceleration during adolescence to peak velocity, and rapid deceleration after the peak.
- There is sexual dimorphism in condylar growth. Females have less intense rates of condylar growth, especially during adolescence, than males and they attain peak adolescent velocity approximately 2 years earlier than boys.
- There is substantial individual variation in condylar growth. Some individuals had little or negative growth, while others showed more than 5 mm of growth per year.
- The data provides an objective means of evaluating patient's growth potential and treatment outcome.

ROLE OF ANGIOGENESIS IN CONDYLAR GROWTH

Introduction

Angiogenesis is the crucial step in mandibular condylar growth for it regulates the transformation from cartilage to bone.

According to Rabie *et al.* (2003) several factors play important roles during the condylar process. Sox 9 regulates the synthesis of type II collagen, type IX collagen, type XI collagen and aggrecan and it is the target of PTHrp signalling.[40]

On this basis, a feedback model is suggested for:

(i) Progressive growth of avascular epiphyseal cartilage which leads to a state of increased hypoxia that up-regulates VEGF expression.
(ii) Its control by the diffusion of soluble VEGF isoform(s) from the hypoxic center towards the periphery to induce epiphyseal vessel outgrowth and thereby reduce the hypoxic stress. Subsequently, VEGF induces an invasion of vessels into the cartilage to initiate secondary ossification. Thus, growth initiation and growth control has an auto-signaling mechanism as depicted in Figure-21.[65]

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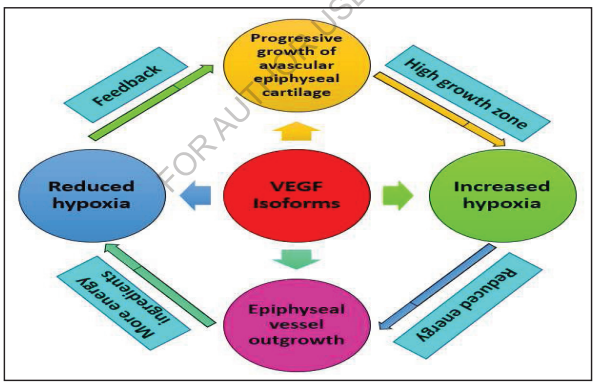

Fig 21. Feedback model of VEGF isoforms to initiate and control hypoxic condition during angiogenesis.(Taken from Patil AS, Sable RB, Kothari RM. Occurrence, biochemical profile of vascular endothelial growth factor (VEGF) isoforms and their functions in endochondral ossification. J Cell Physiol 2012;227:1298-1308.)

The role of angiogenesis in condylar growth

Condylar cartilage has a dual structure, a thick fibro-articular area for appositional growth and a deeper hyaline-cartilaginous area for interstitial growth. This is important in bearing the compressive stress transmitted to the condyle during mandibular movement and growth. Vascular invasion is prerequisite for bone formation.

Osteogenesis, which is the formation of the new bone and angiogenesis, which is the invasion of new blood vessels, are closely related processes.[66] Blumer *et al.* (2005) investigated that Growth of cartilage canals into the secondary ossification centre was improved by VEGF. The canals contained chondroclasts which opened the lacunae of hypertrophic chondrocytes. The following process was the invasion of mesenchymal cells into the empty lacunae and formation of an osteoid layer. The accelerated cartilage resorption was possibly due to new blood vessel invasion, which leads to the recruitment of chondroblasts into the area of bone formation.[67] These two processes may act together to enhance bone formation as shown in Figure-22.

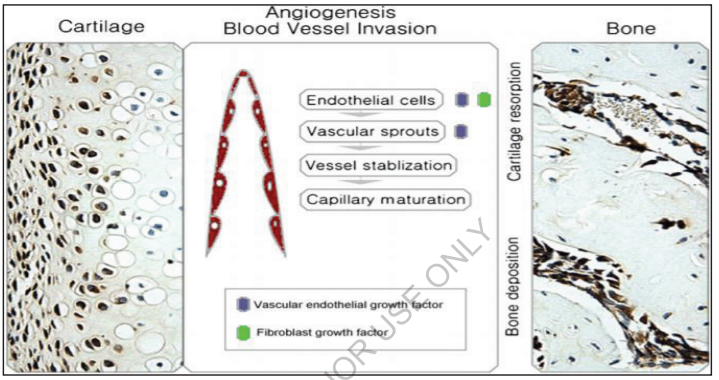

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Fig 22. Illustration of the process of condylar growth-blood vessel invasion transformed condylar cartilage into bone. Left: cartilage layers, VEGF Immunostaining, the brown spots show the distribution of VEGF. Middle: endothelial cells migrate towards the stimulus such as VEGF and FGF, proliferating to form vascular sprouts and eventually form a lumen. Right: Formed new bones. VEGF Immunostaining. Brown spots show the distribution of VEGF.(Taken from Li Q, Rabie A. A new approach to control condylar growth by regulating angiogenesis. Arch Oral Biol 2007;52(11):1009-1017.)

Mandibular protrusion leads to an increase in the number of mesenchymal cells in the mandibular condyle and glenoid fossa. The more mesenchymal cells will bring more bone formation. Thus, VEGF-dependent new blood vessel recruitment is essential for coupling cartilage resorption and mineralized bone formation during the process of endochondral ossification in bone development.[68] Blood vessel invasion of cartilage, which is normally avascular, is the first crucial step in this process.

From cartilage to bone, angiogenesis leads the way.

Angiogenesis regulators

a) Vascular endothelial growth factor

VEGF can enhance neovascularization and create the new blood supply required for bone formation. It can also help with the differentiation of osteoprogenitor cells.[69] These substances can guide the differentiation of mesenchymal cells by making them enter the osteogenic pathway and further engage in osteogenesis.

b) Fibroblast growth factor

FGF is important in the initial vascularization of the healing process in bone graft.[70] The FGF receptors (FGFRs) represent a family of four tyrosine kinase receptors (FGFR 1–4) that bind FGFs with variable affinity. FGF 1,2,4,8,9 and particularly 18, which is produced by the perichondrium, bind and activate FGFR3 with high affinity.

Angiogenesis inhibitors

Angiogenesis inhibitors can be mainly divided into four groups: endogenous naturally occurring inhibitors, exogenous angiogenic inhibitors, VEGF ligands antibodies and VEGF receptor inhibitors.

1) Endogenous naturally occurring inhibitors

Three naturally occurring inhibitors are angiostatin, endostatin and thrombospondin.

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a) Angiostatin

Angiostatin can act as an anti-angiogenesis factor in several aspects. Firstly, angiostatin can inhibit endothelial cell proliferation. Secondly, angiostatin can induce endothelial cell apoptosis. Thirdly, angiostatin can inhibit endothelial cell migration and invasion. On the contrary, it had little effect on VEGF expression or it can increase its expression because of hypoxia in the tumour tissue.

b) Endostatin

Endostatin is a 20 kDa C-terminal cleavage product of collagen XVIII that belongs to the multiplexin family and is characterized by multiple triple-helix domains and interruptions.

c) Thrombospondin

Thrombospondin (TSP), a 450 kDa matricellular protein, was the first anti-angiogenic factor discovered in 1990s. TSP prevented VEGF-induced angiogenesis and induced endothelial cell apoptosis.

2) Exogenous angiogenic inhibitors

TNP-470 (or AGM-1470) is a synthetic derivative of fumagillin that inhibits methionine aminopeptidase-2, a cytoplasmatic enzyme of endothelial cells, cell proliferation and cell migration, thus blocking capillarogenesis and angiogenesis. It was one of the first antiangiogenic agents to enter clinical trials (entering human testing in 1992).

Thalidomide was originally marketed about 40 years ago as a sedative, and its widespread use by pregnant women led to the discovery of its teratogenic effects. It is apoptogenic for neovasculature and inhibits angiogenesis.

a) VEGF antibodies and VEGF receptor inhibitors

VEGF antibodies such as Avastin Bevacizumab (Avastin), anti-VEGF antibody 2C3,VEGF-Trap and VEGF receptor inhibitors such as SU5416 had shown to contain toxicities.

Promising strategies to regulate condylar growth

a) Nanotechnology

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Nanobiotechnology is a recently coined term describing the convergence of the two existing but distant worlds of engineering and molecular biology.[71] Nanovector liposomes had been used successfully for the therapy of breast cancer.

b) Artificial cells, cell encapsulation and stem

Encapsulated hepatocytes was used as a model for cell and gene therapy. Cells in capsules produce proteins that can provoke inflammatory responses in immune cells and that this even occurs with isografts. Another possibility is that inflammatory cell response results from using standard method for cell encapsulation, which leads to a few cells protruding on the surface of artificial cells. Stem cells was recognized as another possible therapeutic approach because they can differentiate into different types of cells.

c) Gene therapy

Gene therapy is a technique used to deliver small DNA or RNA sequence to cells or tissues to correct a genetic defect or treat a disease. rAAV is a group of nonpathogenic, replication-defective small DNA viruses. Rabie's research group (2007) has proved that compared with rAAV1, rAAV5, rAAV6 and rAAV8, rAAV2 has the highest infection efficiency for the transduction of primary cultured chondrocytes.[72]

ROLE OF FUNCTIONAL APPLIANCE THERAPY IN CONDYLAR GROWTH

Biomechanical force produced by mandibular forward positioning provokes cellular and molecular responses in the temporomandibular joint (TMJ) of growing animals, leading to condylar and glenoid fossa growth.[73] Forward mandibular positioning precipitates a series of changes in the level of expression of these factors that leads to condylar growth in growing rats, particularly the level of expression of type II collagen, the major collagenous framework of cartilage as well as the level of expression of type X collagen, the major component of the hypertrophic cartilage matrix.[40]

Retrognathic mandible and increased lower facial height are common features in patients with Class II malocclusion.[64] Functional appliance therapy in growing patients should thus aim to increase mandibular prognathism without a detrimental effect on facial height.

The cellular and molecular events participating in bone formation in the condyle gave the data for the changes in condylar growth in response to functional appliance therapy. If the effect of functional appliance therapy on condylar growth is acceleration, then the expression of factors regulating key processes in condylar growth should be accelerated when compared with their expression during natural growth. If the effect of functional appliance therapy was actual growth, then the cartilage matrix and the amount of bone formed during mandibular advancement should be more than the amount of bone formed during the same period of natural growth. A true enhancement of growth in response to functional appliance therapy i.e. an actual increase in growth that should not have occurred, relies on maintaining the increase in bone formation in the posttreatment period until the end of the pubertal growth period.

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Histologic changes in the condylar cartilage after anterior translation of the mandible

After 1 week of treatment with a hyperpropulsor, the cell proliferation zone in the rat cartilage is thickened without producing noticeable changes in the cartilage zone.

Not until the appliance has been worn for 4 weeks can the cell proliferation zone and the cartilage zone be seen as significantly wider as shown in Figure-23.

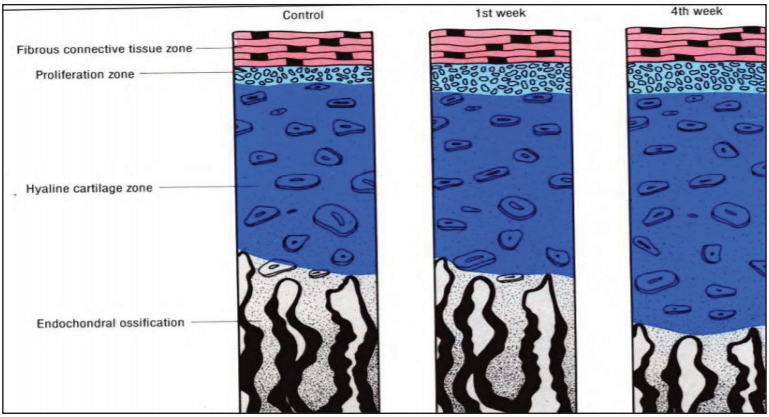

Fig 23. Histologic changes in the condylar cartilage after anterior translation of the mandible.(Taken from Rakosi T, Jonas I, Graber T. Color atlas of dental medicine - orthodontic diagnosis. Shenyang: Liaoning ke xue ji shu chu ban she;2000.)

Histologic changes in the condylar cartilage after posterior translation of the mandible

After 1 week of treatment with a chin cap, the cell proliferation zone in the rat cartilage is narrowed.

After wearing the chin cap for 4 weeks the height of the cartilage zone has also decreased. This change therefore appears to be secondary, as a result of the reduced number of undifferentiated cells in the proliferation zone, which later become differentiated to chondroblasts as shown in Figure-24.[38]

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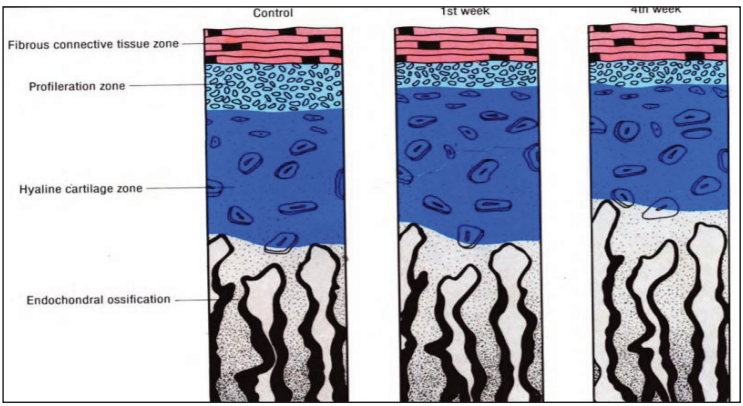

Fig 24. Histologic changes in the condylar cartilage after anterior translation of the mandible.(Taken from Rakosi T, Jonas I, Graber T. Color atlas of dental medicine - orthodontic diagnosis. Shenyang: Liaoning ke xue ji shu chu ban she;2000.)

There are consistent reports that treatment with fixed functional (Herbst) appliances increases the extent of mandibular prognathism compared with no treatment.[74,75]

In experimental studies, the condyle's response to forward repositioning of the mandible is enhanced growth and significantly more so with stepwise advancement than with maximum jumping of the mandible. In particular, stepwise mandibular advancement tends to lead to more prognathism than does maximum jumping.[76] An early study showed that treatment with the Herbst appliance enhanced sagittal but not vertical condylar growth.[77] Treatment with a headgear-Herbst appliance for 12 months of stepwise advancement has been shown to achieve more mandibular prognathism and less lower face lengthening than in untreated controls.[74] In contrast, in a study of a headgear-activator with maximum jumping of the mandible, neither growth of the lower face nor mandibular prognathism was affected.[78]

Studies of patients treated with the Twin-block appliance for 7 months[19] and the Herbst appliance for 12 months[14] found no differences in mandibular prognathism when stepwise advancement of the mandible was compared with maximum jumping.[76]

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Pancherz *et al.* (1998) reported that, after 7.5 months of treatment, an effect on mandibular prognathism was observed, but it vanished completely 7.5 months after the Herbst appliance was removed.[79] That temporary result might be because of insufficient retention and insufficient treatment time to allow newly formed bone to mature.[80,81]

According to Mills and McCulloch (2000), whose use of the Twin-block appliance resulted in an average increase in mandibular length during active treatment. In the posttreatment period, there was a slight reduction in the mandibular growth rate, but most of the increase in mandibular length achieved during treatment was still evident 3 years later.[82]

Therefore, Forward mandibular positioning accelerates and enhances chondrocyte differentiation and cartilage matrix formation in the mandibular condyle by accelerating and enhancing the expression of Sox 9 and type II collagen and osteogenesis in the mandibular condyles and also mandibular advancement led to a significant increase in the amount of bone formed in the posterior part of the condyle. Various modes of advancing the mandible during functional appliance therapy affect condylar growth differently, specifically stepwise mandibular advancement vs maximum mandibular jumping.

GROWTH RELATIVITY HYPOTHESIS FOR CONDYLAR GROWTH

Understanding mechanisms of action for orthopedic appliances is critical for orthodontists who hope to treat and retain the achieved corrections in patients with initial Class II mandibular retrognathism. That knowledge can help orthodontists produce clinically significant bone formation and avoid compression at the condyle-glenoid fossa region.

Growth relativity hypothesis

Hypothesis presented for the mechanism of condylar-fossa growth modification with propulsive mandibular appliances, such as the Herbst & Twin-block.

Growth relativity refers to growth that is relative to the displaced condyles from actively relocating glenoid fossae.

How condylar modifications occur ?

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Over the years several theories have emerged attempting to shed light on condylar growth. These are-

a) Genetic theory

One of the earliest theories, the genetic theory, suggests the condyle is under strong genetic control that causes the entire mandible to grow downward and forward.[83] Although this may be related more to development of prenatal than postnatal condylar growth, this theory does indirectly question the effectiveness of orthopedic appliances in condylar growth as proposed by Brodie (1946).[84]

b) Lateral pterygoid hyperactivity hypothesis

The masticatory muscles, particularly the lateral pterygoid has aroused considerable orthodontic interest. Petrovic *et al.* (1975) raised the possibility that the lateral pterygoid activity increased the proliferation of condylar tissue.[85]

McNamara (1973), using protrusive bite planes and temporary acute electromyographic (EMG) electrode placements found that activity in the superior head of the lateral pterygoid muscle could be directly or indirectly correlated with gradual skeletal adaptations.[86] More recently, after an extensive review of the literature, Johnston (1996) concluded that the lateral pterygoid muscle hyperactivity hypothesis is incorrect.[87] Rees (1954) reported that other muscles and tendons including those of

the deep masseter and temporalis, also attach to the articular disk region.[88] Attachments of lateral pterygoid muscle to the condylar head or articular disk may expected to cause condylar growth but an anatomic research has not found evidence that significant attachments actually exist as shown in Figure-25 [A,B].

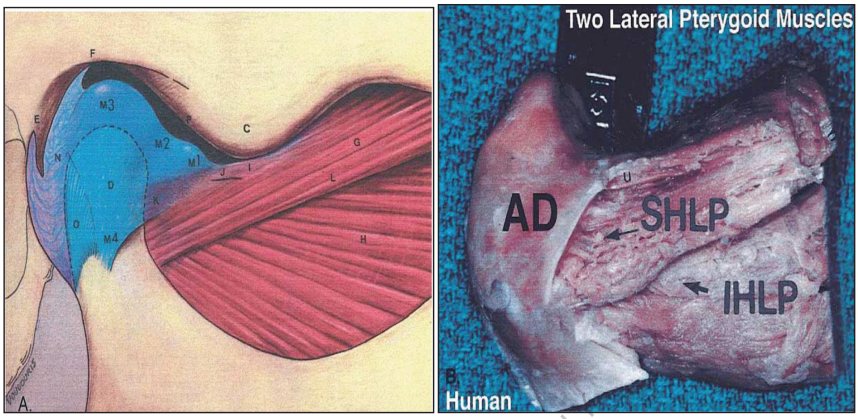

Fig 25. (A) Three-dimensional illustration of unadvanced human TMJ shows minimal attachment (J) of superior head of the lateral pterygoid muscle to articular disk (M1, blue) and retrodiskal tissue complex (N). **(B)** Clean, representative TMJ dissection from human adult cadaver specimen to expose the pterygoid muscles. Fascia and tendon of a small upper proportion (u) of SHLP fibers are firmly attached to stabilize the articular disk from the posteriorly attaching retrodiskal tissues that continue to be extended at the start of closing (not shown). It is important to note the majority of both the SHLP and inferior head of the LPM (IHLP) fibers attach lower to the neck of the condyle (arrows) and not the articular disk or condylar head. (Taken from Voudouris JC, Kuftinec MM. Improved clinical use of Twin-block and Herbst as a result of radiating viscoelastic tissue forces on the condyle and fossa in treatment and long-term retention: growth relativity. Am J Orthod Dentofac Orthop 2000;117:247-66.)

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More recently, permanently induced implanted longitudinal muscle monitoring techniques have found that the condylar growth is actually related to decreased postural and functional lateral pterygoid muscle activity.[89] This notion was also supported in human studies by Auf der Maur (1980),[90] Pancherz and Anehus Pancherz (1980),[91] and Ingervall and Bitsanis (1986),[92] who reported decreased muscle activity.

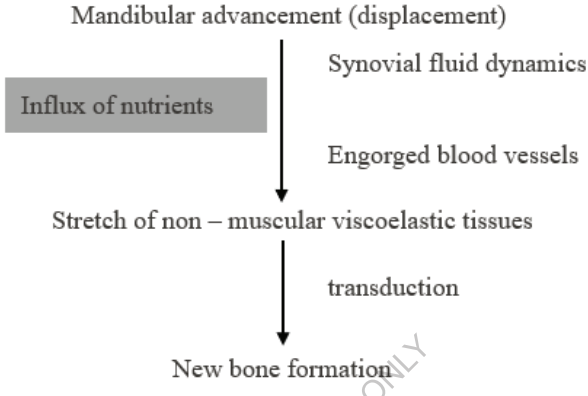
c) Functional matrix theory

what specifically affects the growth at the condylar head ?

A third hypothesis, the functional matrix theory, postulates the principal control of bone growth is not the bone itself, but rather the growth of soft tissues directly associated with it,[93-96] but there has been no explanation as to exactly how condylar growth would be stimulated. Thus, this theory's validity has been questioned.[87,97]

Extension of wolff's law

Growth relativity states that- "with orthopaedically displaced condyle, the bone architecture is influenced by the neuromusculature and the contiguous, nonmuscular, viscoelastic tissues anchored to the glenoid fossa and the altered dynamics of the fluids enveloping bone".



Flowchart-1

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Viscoelastic changes : During orthopedic mandibular advancement, there is an influx of nutrients and other biodynamic factors into the region through the engorged blood vessels of the stretched retrodiskal tissues as, that feed on the fibrocartilage of the condyle. The expulsion of these factors occurs during reseating of the displaced condyles in the fossa during relapse. The result is a metabolic pump-like action of the retrodiskal tissues.[98]

Three growth stimuli

The 3 trigger switches for glenoid fossa growth can similarly initiate short-term condylar growth modifications. These are (Displacement + Viscoelasticity + Referred Force)

a) Displacement- significant glenoid fossa bone formation occurs during treatment that includes mandibular displacement.
b) Several direct viscoelastic connections- glenoid fossa modification is a result of the stretch forces of the retrodiskal tissues, capsule and altered flow of viscous synovium.
c) and transduction of forces or referral of forces- observations that glenoid fossa bone formation takes place a distance from the soft tissue attachment.

Light bulb analogy of the condylar growth and retention

To describe condyle-glenoid fossa growth modification, an analogy is made to a light bulb on a dimmer switch. The condyle illuminates in treatment, dims down in the retention period, to near base levels over the long-term.

When the condylar growth is continuously advanced, it lights up like a light bulb.

When the condyle is released from the anterior displacement, the reactivated muscle activity dims the light bulb and returns it close to normal growth activity. Its growth potential diminishes with age, whereas the glenoid fossa remodeling "lighting" potential lasts long into adulthood. The upper open coil in the box shows the potential of the anterior digastric muscle and other peri-mandibular connective tissues to reactivate and return the condyle back into the fossa once the advancement is released. The lower coil represents the shortened inferior LPM as shown in Figure-26.[99]

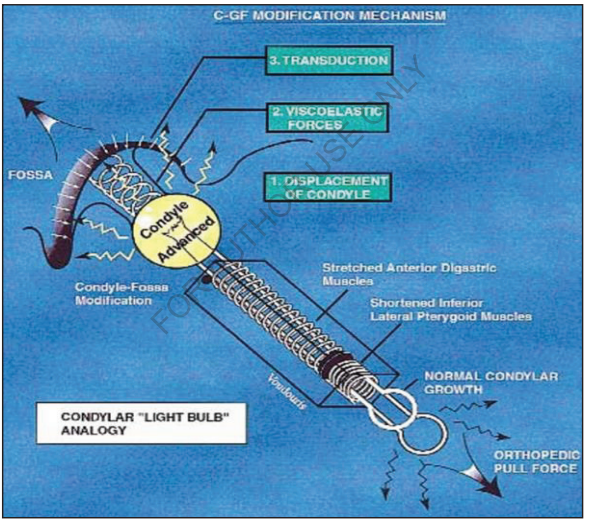

Fig 26. Light bulb analogy of condylar growth and retention. When the growing condyle is continuously advanced, it lights up like a light bulb on a dimmer switch.When the condyle is released from the anterior displacement, the reactivated muscle activity dims the light bulb and returns it close to normal growth activity. In the boxed area, the upper open coil shows the potential of the anterior digastric muscle and other perimandibular connective tissues to reactivate and return the condyle back into the fossa once the advancement is released.The lower coil in the box represents the shortened inferior LPM.The open coil above the yellow condylar light bulb represents the effects of the stretched retrodiskal tissues. (Taken from Voudouris JC, Kuftinec MM. Improved clinical use of Twin-block and Herbst as a result of radiating viscoelastic tissue forces on the condyle and fossa in treatment and long-term retention: growth relativity. Am J Orthod Dentofac Orthop 2000;117:247-66.)

CONCLUSION

The MCC is a secondary cartilage that in subadult individuals serves both as a site of growth and as a place of articulation. As such, it displays some functional characteristics of both a growth plate as well as an articular cartilage, but it differs from both in fundamental aspects of its development and structure throughout ontogeny.[13]

Clinical relevance

Condylar growth and adaptation are important in various clinical conditions. Mandibular morphology reflects condylar growth direction. The direction of condylar growth was found to be related to both mandibular rotation and overbite.

Vertical condylar growth was shown to occur in association with forward mandibular rotation and an overdevelopment of posterior facial height. Vertical condylar growth should not necessarily be considered a contraindication to treatment of deep overbite. Backward rotation usually occurred when condylar growth was in a sagittal direction as shown in Figure-27.

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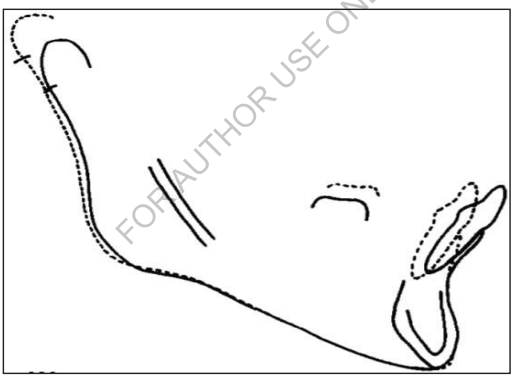

Fig 27. Facial growth with a more sagittal type of mandibular condylar growth (Taken from Levin RI. Treatment results with the Begg technique. Am J Orthod Dentofac Orthop 1977;72:239-260.)

Treatment of deep overbite differed for patients with vertical or sagittal condylar growth. In cases with sagittal condylar growth, the overbite was significantly smaller at the end of treatment and at the final examination. Therefore, it appears that deep overbite was treated more successfully when condylar growth was sagittal.

Patients with upward and forward growth of the mandibular condyle often have reduced anterior face height; if they develop a malocclusion; it is nearly always characterized by a deep bite.

In more extreme cases of upward and forward growth of the condyle a class II division 2 malocclusion in combination with a skeletal deep bite is common.

Patients with 'long face syndrome,' and a pronounced increase in lower face height in contrast have a more posteriorly directed growth pattern of the mandibular condyle as shown in Figure-28.[100]

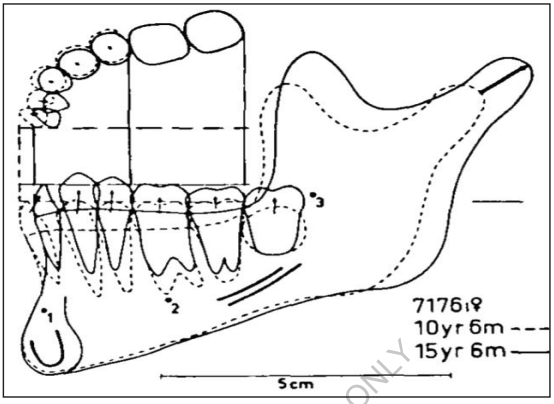

Fig 28. The condylar growth direction is mainly posterior. The direction of the eruption of the teeth is almost vertical.(Taken from Bjork A. Variations in the growth pattern of the human mandible: longitudinal cephalometric study by the implant method. J Dent Res 1963;400-411.)

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Growth rotations and vertical malocclusion

The changes related to facial growth illustrated with these two extreme growth patterns are due not only to differences in condylar growth direction, but are also the result of differences in anterior facial height (AFH) and posterior facial height (PFH) development. These differences in height development lead to rotational growth or positional changes of the mandible that greatly influence the position of the chin. The factors that determine the increase in AFH are the eruption of the maxillary and mandibular posterior teeth and the amount of sutural lowering of the maxilla. PFH on the other hand is determined by the lowering of the temporomandibular fossae and condylar growth.[101]

When vertical condylar growth exceeds dentoalveolar growth, i.e. eruption of the teeth in the jaws, forward rotation of the mandible occurs. In contrast, if dentoalveolar growth is greater than vertical condylar growth, the resulting change in mandibular position is backward or posterior rotation of the mandible. The two extreme mandibular growth patterns also show differences with respect to the amount of effective vertical condylar growth.

Patients with an anterior condylar growth pattern usually have a greater amount of vertical growth than patients with posteriorly directed growth, a factor that further accentuates the differences. Patients with posterior condylar growth often have similar amounts of AFH and PFH increase, where the mandible translates during growth without rotation.

Hemimandibular hyperplasia causes an enlargement of the condyle, the ramus and the body of the mandible including the alveolar process without an accompanying marked chin deviation. While articular cartilage and subchondral bone are separated in the healthy condyle, in hemimandibular hyperplasia, no distinction can be made histologically between these tissues.

Hemimandibular elongation is another abnormal growth condition that induces lengthening of the mandibular condyle, ramus, and body, and causes chin deviation. No histological abnormalities are detected within the condyle.

The use of functional appliances results in a small but statistically significant increase of mandibular length. Functional appliances constructed on the principles of 'jumping the bite', such as the Herbst appliance and the twin-block are more effective in modifying mandibular growth than passive appliances, such as the Andresen activator and its variants. This might be the combined result of remodelling of both the condyle and the fossa.[102] In short, mandibular condyle is highly adaptive and its growth direction and magnitude can be modified. Following a bilateral sagittal split osteotomy, mandibular body is moved into a new maxillomandibular relationship, during which meticulous attention is paid keeping the condyle–fossa relationship unchanged.[103]

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Variation in growth intensity is an additional factor that not only induces change in the developing occlusion, but also affects the length and outcome of orthodontic treatment. During periods of low condylar growth intensity such as the juvenile period or the prepubertal growth minimum, intensity may be as little as 1-2mm per year in the condyles. Orthodontic treatment during these periods presents the orthodontist with significant clinical problems. It is difficult during these periods in some patients to obtain sufficient skeletal change and treatment can become protracted. Fortunately, some young patients are more actively growing during the juvenile period and skeletal correction can be achieved over a more reasonable period of time.[100]

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This book is a compilation of the craniofacial muscles, their embryogenesis and morphogenesis. The detailed anatomy of the craniofacial muscles and their role in the growth and development of the craniofacial complex. The role of the masticatory muscles in different facial types also has been a debate for long i.e. genetics versus function and an elaborate discussion with evidence-based data has been included in this book. Muscles have shown to play a very active growth in the formation, shape and extent of growth of the bones of the craniofacial complex.

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Craniofacial Muscles

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Introduction

Unraveling the complex tissue interactions essential to generate structural and functional diversity present among craniofacial muscles is very challenging. There are 60 distinct skeletal muscles in craniofacial region the head that control food intake, facial expression and eye movement. The development of these muscles is closely coordinated with other craniofacial tissues. The head musculature is known to originate from the cranial paraxial mesoderm (CPM) located anterior to the somites., and lacks any overt signs of segmentation. The CPM cells move into the branchial arches which eventually give rise to the facial structures. The regulation of head muscle patterning and differentiation by signals from adjacent tissues has been extensively explored in recent past.[1] The organization of craniofacial muscles is highly conserved, yet they are the most diverse musculoskeletal structures present in vertebrates. Skeletal muscles throughout the body originate within paraxial mesoderm. In the head of amniote embryos, this tissue forms and remains as mesenchymal population, devoid of either epithelial compartments or overt segmentation. Following gastrulation, neural and surface ectodermal epithelia over lay the cephalic paraxial mesoderm and pharyngeal endoderm below it. Neural crest cells subsequently spread over its superficial surface. Identifiable compartments such as myotomes and sclerotomes are not evident, still the cell types generated within head paraxial me-soderm are identical to those present in trunk somite.

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At various axial levels, the differentiation of skeletal muscle require a consortium of transducting signals, whose regulatory influences establish spatially and temporally diverse myogenic populations.[2]

Various tissues adjacent to craniofacial myogenic mesoderm are unique to the head (neural crest–derived mesenchymal cells and pharyngeal endoderm) and segment-specific. Each of these adjacent tissues needs to be vetted for its role in head myoblast differentiation and morphogenesis. Having neighboring mesodermal cells being mesenchymal instead of epithelial creates opportunities for various different signaling and signal transduction strategies. Most craniofacial muscle primordial move from their sites of differentiation within the paraxial mesoderm into peripheral locations e.g., muscles that rotate or elevate the skull, move in conjunction with their connective tissue precursorsand most venture into novel surroundings. During various excursions, which may precede or follow overt differentiation of myocytes (cells expressing skeletal muscle specific markers), head muscles become surrounded by and infused with neural crest cells which form endo ,peri and epimysial compartments. The combination of crest and myogenic mesoderm cells coincides with the elongation and alignment of myocytes and immediately precedes both the segregation of individual muscles from common progenitor cells and the formation ofintramuscular vascular channels.

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Classification Of Craniofacial Muscles

The head muscles are generally classified according to their anatomical location within the head:

They can also be classified as four distinct populations [3]

i. extra-ocular

ii. branchial

iii. laryngoglossal,

iv. axial

Axial includes epaxial and hypaxial muscle groups that elevate, depress, and rotate the head. Terrestrial vertebrates have superficial muscles that are part of a constrictor colli system which circumscribe the caudal part of the head and extend underneath the jaw, and function to provide ventral muscle tone and help in swallowing. Mammals set of superficial facial muscles that allow fine movements of lips, eyelids, and cheek, nose and with specialized pharyngeal constrictors.

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A] Extra-Ocular Muscles (EOMs)

The function of EOMs is to move and maintain the rotational stability of the eye in birds. The basic pattern of the six EOMs is common among all vertebrate classes, with various evolutionary adaptations. In early gnathosomes, vertical orientation of the lateral rectus is seen instead of the horizontal alignment seen in most vertebrates. In caecilian amphibians, the size of the eyes is reduced and varioous EOMs have been modified as protractor and retractors of an external appendage called the tentacle. A functional EOM adaptation is seen in marlins,

sailfish, and swordfish. The dorsal rectus is sufficiently enlarged and modified asa tissue capable of warming the brain and eye 14°C above normal temperatures. [3] Amniote EOMs which are established during primary myogenesis are compartmentalized into global and superficial orbital domains[4]. The distal attachments of individual domain are different thus allowing the global domain to initiate eye movements, while the orbital acts via the connective tissue pulleys as an elastic loading system, maintaining the rotational stability as the eyes move along the horizontal and vertical planes.[3]

B] Branchial Muscles

Branchial muscles are those associated with maxilla, mandible, hyoid, and caudal branchial skeletal structures and their homologues. These muscles have evolved from an iterative set of serially homologous gill muscles, which along with gill skeletal elements constituted the branchiomeric apparatus.[5] However, recent evidence suggests that the first branchial arch mig have arisen with unique structural and molecular attributes and not evolved from gill-supporting ancestor [3] Axons innervating branchial muscles extend from motor neurons which become segregated in lateral regions of the brainstem, distinct from EOM and somatic motor nuclei.[6] As the terrestrial vertebrates evolved and there was loss of gill- supporting skeletal elements and the muscles within each arch underwent substantial modifications.

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The embryonic origins of suprahyoid muscles are diverse, including mylohyoid arch and digastricus, stylohyoid, plus occipital somites (geniohyoid). Muscles

associated with external ear movement and facial expression are unique to mammals. They are derived from late-differentiating second branchial arch myoblasts that segregate to periauricular, periorbital, and perioral regions. [3]

C] Tongue and Intrinsic Laryngeal Muscles

Glossal and laryngeal structures are relatively recent evolutionary adaptations of the craniofacial musculoskeleton.[7] However, the muscles associated with these structures have a more extended ancestry. Analyses of pax3/7 gene expression in lamprey embryos identify a population of hypobranchial myoblasts that originate from the lateral borders of rostral somites and migrate beneath pharyngeal structures.[8] Comparable myoblasts in fishes attach ventral gill elements to the coracoids bone of the pectoral girdle.[9] In amphibians and amniotes, migratory myoblasts arising from occipital somites form a condensed mesenchymal band, the hypoglossal cord that elongates and similarly brings myoblasts ventral to pharynx, where they form both intrinsic and most extrinsic tongue muscles and intrinsic laryngeal muscles.[10]

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Since these muscles arise at the boundary of trunk and head, there has been much conjecture about which category best suits these wandering myoblasts. Early hypotheses that tongue muscles are modified gill (branchial arch) muscles isdisappeared by the finding that their innervation (cranial nerve XII) is fromneurons located in somatic rather than branchial motor nuclei.[11] Also, some tongue muscles are spared in transgenic mice null for Tbx1, a transcription factor that is required for differentiation of all branchial muscles.[12] They are probably

best described as hybrids, originating from somites but completing their development within craniofacial microenvironments.

D] Axial Muscles

Muscles associated with postural stabilization and movements of the head are multisegmental and all arise from medio-dorsal and latero-ventral domains of occipital and cervical somites.[13] These muscles are organized as epaxial (dorsal tothe transverse process of each vertebra) and hypaxial (ventral to the transverse process) similar to other trunk muscles. Among the hypaxial are the infrahyoid muscles, which in mammals include the omo-, sterno-, and thryohyoid muscles. These function to lower the root of the tongue as well as larynx and, and are innervated by hypoglossal (XII) and cervical nerves.

Embryonic origins and organization of head mesoderm

e cascade of events will be explained according to following sequence1 Head Cavities and Pre-Otic "Somites"

2 Prechordal Mesoderm

3 Paraxial Mesoderm

4 Regionalization of the head mesoderm

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1] Head Cavities and Pre-Otic "Somites"

Balfour (1877) described a series of three segmentally arranged, epithelial-lined condensations rostral to the otic vesicle in shark embryos.[14,15] At early stages, these retain connections with the coelomic cavity. These become isolated during

expansion of pharyngeal pouches and visceral clefts. The dorsomedial layer surrounding each head cavity forms a myotome-like epithelium that becomes associated with an EOM-innervating cranial nerve. Gilbert (1957) identified mesenchymal condensations in early cat and human embryos that included primordia of extraocular muscles and within which small epithelial clusters formed [16]. Jacob and colleagues described small, paired premandibular cavities in chick embryos. [17]

2] Prechordal Mesoderm

Head mesoderm is formed at the beginning of gastrulation and is in position by mid gastrulation stages. In the median plane, it includes prechordal mesoderm located beneath the rostral neural plate, followed caudally by the notochord. Prechordal mesoderm is contiguous laterally with paraxial mesoderm which extends caudally to the first somite. [18]

Prechordal mesoderm is generated from progenitors located in the rostral margin of the elongating primitive streak (avian) and is often indistinguishable from the overlying neuroepithelial and underlying endodermal layers.[19] Hedgehog and nodal signals from these mesodermal cells are necessary for the regional specification of the rostral neural plate and also for the bilateralization of prosencephalic structures. [20,3]

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Transplantation and retroviral mapping studies show that these cells contribute to the formation of the dorsal, ventral, and medial rectus and ventral oblique muscles, all of which are innervated by the oculomotor (IIIrd) nerve. [21,22]

3] Paraxial Mesoderm

Paraxial mesoderm generated from the primitive node and streak beginning at the onset of gastrulation, and most of the head mesoderm is formed by the time the streak reaches its maximum length. The head paraxial mesoderm appears as a rapidly generated population without spatially separable progenitors. [23]

4] Regionalization of the head mesoderm

The exact molecular nature of the CPM and SpM , remains unclear. Recent gene expression analyses in avian models have begun to reveal the molecular milieu of head muscle progenitors in St. 8, St. 10, St. 16 and St. 20 and 24 chick embryos. [24,25,26,27] Pitx2, Tcf21 (capsulin), Msc (MyoR), Twist, Alx4, and Tbx1 genes are shown to be expressed in the head mesoderm; Alx4, Tbx1, Cyp26C1, and Twist are expressed in the CPM In St. 8 chick embryos, the SpM is found to express, Isl1, Nkx2.5, Fgf10, and Tbx20, a set of second heart field markers in agreement with the cardiogenic potential of these cells. [24] There is considerable overlap in the expression of head muscle markers e.g., Myf5, Tcf21 (capsulin), Msc (MyoR), Tbx1, Pitx2 and cardiac lineage markers (e.g., Islet1 and Nkx2.5) in the CPM and SpM.[24] Taken together, these studies have begun to delineate the molecular regionalization of the headmesoderm continuum in these fields along the medial– lateral/dorsal–ventral axes.

Most head paraxial mesoderm remains mesenchymal, and the population appears homogeneous from the optic vesicles to the hindbrain, where the first somite

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forms either close to or several rhombomere lengths caudal to the otic primordium. Fgf8, retinoic acid, and Wnt signaling integrated with periodic waves of Notch pathway related genes such as hairy1 and 2 and lunatic fringe ordinate the formation of somites.

In a series of SEM examinations in amphibians, reptiles, chicks and mammals; the superficial and deep surfaces of head mesoderm were found to be demarcated by a series of shallow transverse grooves, between which the mesenchymal cells showed a biased circular orientation named somitomeres, represent vestiges of an evolutionarily earlier condition in which head mesoderm was fully segmented.[28,29,30] However they arrest before epithelialization and thus lack any apparent separations.

Comparative analyses show that the position of specific somitomeres relative to other axial structures, specifically mid- and hindbrain segments, is not constant among embryos of the different vertebrate classes thus far examined.

An important early distinction among the progenitors for each of these lineages is their pattern of movement. Chondrogenic mesoderm cells are essentially stationary, changing location by differential expansion and growth of prechondrogenic and early cartilage cell populations, analogous to the processes underlying vertebra and rib formation.[31] Osteogenic precursors of intramembranous bone originate deep and medially within head paraxial mesoderm. These cells move dorsally around the brain, occupying sites where in the chick embryo the roofing part of the frontal and the parietal bones will form.In mice, the entire frontal is of neural crest origin.

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Early accounts of head muscle origins in a wide range of vertebrate embryos described the initial locations of many myogenic condensations within branchial arches, and concluded that myoblasts originate within this lateral mesoderm. [32] With the availability of progenitor cell–labeling methods, especially in avian and murine embryos it was discovered that all head myoblasts arise in paraxial mesoderm, often far removed from the locations at which overt condensation and terminal differentiation will occur. [22,33]

Progenitors of head skeletal muscles are organized either as individual muscle primordia, e.g., most EOMs, or as cohorts of myoblasts that will populate specific branchial arches and later segregate into several muscles. Branchial muscle primordial are located superficially within head paraxial mesoderm. As such they are initially in contact with overlying surface ectoderm and are more distant from the notochord and pharyngeal endoderm. EOM primordia tend to be closer to the midbrain and hindbrain than are branchial myoblasts. The precursors of the lateral rectus, especially, are located ventromedially, tucked between the trigeminal ganglion and the ventrolateral margin of rhombomere 2. [34]

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Molecular aspect of Axial Muscle Differentiation

The core myogenic network consists of the basic helix-loop-helix (bHLH) myogenic regulatory factors Myf5, Mrf4 (Myf6 – Mouse Genome Informatics), Myod (Myod1 – Mouse Genome Informatics) and myogenin, which determine muscle identity and/or promote muscle differentiation.[35] These factors have been

'redeployed' during evolution to build the new head muscles. However, their roles differ in EOM versus PA skeletal muscle founder cells. [36]

A] Myf5

Myf5 expression in the cervical and occipital somites is regulated by a unique promoter, and loss of gene function (e.g., six1/4, pax3, CREB, or shh) has been shown to differentially affect myogenic differentiation in this region.[37] These differences may be the result of the combinatorial Hox code along the body axis, changes in Notch signaling in the mesoderm underlying the developing hindbrain.

[38] Heterogeneity between the different head and trunk muscles is further exemplified by analyses of the myf5 regulatory sites. Distinct enhancers regulate myf5 expression both temporally and spatially within the developing embryo in a combinatorial and co-operative fashion. Myf5 expression within the craniofacial musculature is also differentially controlled. [39] Each of the several branchial arch muscle enhancers will drive myf5 expression, but loss of function studies suggest these regulatory sites operate as part of an integrated modular controlling network. [36]

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B] MyoD

The myoD enhancer controls the onset of myoD expression, and regulates myoD expression in differentiating myoblasts. [40] Even within the short core enhancer, myoD expression in the somites versus the limb and branchial arches is

differentially regulated, again indicating that the signaling networks regulating the onset of myogenesis are not mimicked throughout the embryo.

C] Pax3 and Pax7

In somitic muscle founders, Pax3 and Pax7, paired-homeodomain genes, act genetically upstream of Myod and they are likely to activate Myod expression by binding to its regulatory sequences. [41,42] Pax3 expression is absent in head muscle stem/progenitors. [43] Furthermore, in Pax3:Myf5:(Mrf4) mutant embryos (in which embryonic Mrf4 expression is perturbed in cis by disruption of the Myf5 locus) trunk muscles fail to form whereas most head muscles develop. Some head muscles or their precursors express several regulatory genes, including tbx1 , engrailed, and capsulin (epicardin,POD1) that are not typically part of the axial myogenic repertoire. Inactivation of Tbx1 in mice or zebra fish (van gogh) causes severe reduction of branchial arch muscles sparing only a small number of myoR and capsulin-expressing muscle cells in the mandibular prominence. [12] These survivors indicate the presence of heterogeneity among branchial arches either in the myogenic populations or the surrounding signaling environments MyoR, was originally identified as a myogenic repressor and it is possible that this upregulation is linked to the first arch myogenic defects in the tbx1 mutants. [36]

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D] Pitx2 and Tbx1

Pituitary homeobox 2 (Pitx2) is a bicoid-related homeodomain transcription factor expressed widely in the head of mouse embryos, including within the CM and the

pharyngeal ectoderm. It plays a key role in specifying EOMs, which are missing in Pitx2-null mice as well as is a key regulator of PA muscle development. [44] Pitx2 is expressed in trunk muscle progenitors has shown to act downstream of Pax3 in somitic myogenesis. [45] Pitx2 binds directly to the promoters of Myf5 and Myod., in EOMs.[45] The T-box gene Tbx1 is critical for PA muscle development but is not required for trunk myogenesis. This transcription factor specifies PA, but not EOM, muscle founder cells. [43] In Tbx1- null mouse mutants, first PA myogenesis is impaired, and the posterior arches themselves are absent, highlighting the additional role that Tbx1 has in ectoderm and endoderm in PA development. A monolateral ablation of skeletal muscles is observed in Tbx1-nullmutants, indiating that an all-or-nothing mechanism for the generation of muscle founder cells. [46]

Tbx1 and Pitx2 cross-regulate each other and activate the same target genes explaining that PA myogenesis is observed occasionally in Tbx1:Myf5 double mutant mice [43]

Pitx2 and Tbx1 expression is not restricted to the mesoderm but instead has a much broader expression pattern in cells adjacent to EOM and PA mesoderm. In humans, PITX2 mutations cause Rieger syndrome, which is associated with ocular as well as cardiac anomalies and dental hypoplasia. [47] Human TBX1 mutations contribute to the anomalies seen in DiGeorge syndrome, which is characterised by cardiovascular and craniofacial defects together with PA muscle weakness and skeletal muscle hypotonia. Therefore, these genes could act both

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cell autonomously, as well as non-cell autonomously, to affect muscle development.

E] Musculin and Tcf21

Msc (musculin; also known as MyoR) is expressed in head and body muscles, andTcf21 (also known as capsulin), are bHLH transcription factors which are considered to act as repressors. They play key roles in the PA, but are not expressed in the EOM founder cells. Mouse embryos with mutations in both thesegenes fail to develop a subset of first arch-derived jaw muscles (the masseter, pterygoid and temporalis muscles. [48] The link between these transcription factors and the MRFs has not been clearly established.

F] Others

Other regulatory genes common to subsets of both head and trunk muscles are the transcription factors, myoR, meox1, six1 and -4, barx2, the homeobox transcription factor pitx2, and the c-Met ligand HGF (hepatocyte growth factor).

[49] The order of expression of these genes is often dissimilar between head and trunk. Loss of function studies of these genes typically result in less severe disruption of head myogenesis compared with the trunk. Inactivation of the homeobox gene, six1, affects the diaphragm and abdominal wall muscles togetherwith a subset of limb and tongue muscles but leaves epaxial and other head muscles relatively unaffected. In the double Six1/Six4 knockouts, these defects are exacerbated. Moreover, the defects now extend to the head muscles, delaying

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extraocular but not branchial arch myogenesis. [37] Myogenic lesions following lossof pitx2 function in mice are found only in the extraocular muscles, which fail to condense. In this initial study, it was not evident whether the muscle dysgenesis resulted from an intrinsic defect in the developing myoblasts or was secondary to loss of pitx2 expression in the periocular mesenchyme. Our own studies have suggested that pitx2 regulates myogenic cell number cell autonomously, consistent with its ability to regulate cell proliferation in the satellite cell line, C2C12. This has been confirmed recently by the demonstration that gene- inactivation of pitx2 in the periocular cranial neural crest cell does not affect the early differentiation of eye muscles. Many genes essential to the formation of subsets of trunk muscles are either not expressed in head muscles or only in very limited circumstances. [36]

Mechanisms Of Craniofacial Myogenesis

The preceding sections have emphasized unique attributes of developing craniofacial muscles, both individually and as groups, and revealed significant disparities between head and trunk myogenic populations. Relatively little isknown of the mechanisms underlying this diversity. Extrapolating from analyses of trunk myogenesis, tissue interactions that control development of primary head myofibers will involve multiple surrounding tissues, including other members of the paraxial mesoderm community. These interactions will require a consortium of molecular signals to produce a combination of positive inductive and inhibitorysignals. [50]

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Cranial myogenic mesoderm is variably proximate to a number of tissues e.g., the neural tube, notochord, pharyngeal endoderm, surface ectoderm, and neural crest cells, each of which harbors cells simultaneously making localized commitments to different lineages. For example, within surface ectoderm overlying several head muscle precursors are sites at which neurogenic placodes for trigeminal, facial and glossopharyngeal sensory ganglia are established. The initial specification of these placodal fields are determined by combinatorial signaling involving members of the Wnt, Fgf, and Bmp families that are produced by underlying paraxial mesoderm: Bmps and Wnts are inhibitory for placodal specification while FGFs are inductive.[3] Additional region-specific signaling scenarios have been identified within the paraxial mesoderm underlying the otic placode. Here the mesoderm produces Fgf3, Fgf19, and Tbx1. Were as cranial mesoderm expresses Wnt and Bmp antagonists and surface ectoderm depress the ability of mesoderm cells to initiate (or elevate) expression of Myf5.[51] Normally, the neural crest population expands over the precursors of 1st branchial arch muscles, effectively separating myogenic cells from this overlying source of inhibition. Furthermore, crest cells express the Wnt antagonist Frzb, and the Bmp antagonists noggin and gremlin.

Wnt1 exhibits a dynamic expression pattern in the midbrain, and except for the dorsal midline is not expressed in the metencephalon. It can be envisaged that local areas of lesser Wnt release might correspond to specific myogenic foci within paraxial mesoderm.Wnt3a expression is confined to the caudal hindbrain

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(myelencephalon),while wnt5a transcripts are present in the rostral hindbrain(metencephalon); wnt7a is absent from the ventral midbrain

Shh is released by the notochord and ventral neural tube in the head, and also by bands of pharyngeal endoderm cells. Despite the key role of Shh in the maintenance of epaxial trunk muscles, cranial mesoderm explants failed to demonstrate any physiological role for Shh in the initial regulation of myogenic differentiation, to the onset of myogenesis. [52] This lack of Shh responsiveness may be augmented by the co-expression of Bmp7 from the floor of the diencephalon and midbrain and also the notochord. [53]

Finally, we must consider intra-mesodermal interactions, which in somites are essential to specify both the medial and lateral myotomal regions.

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Morphogenesis of Head Muscles

Muscle morphogenesis encompasses three integrated processes:

i. the relocation of muscle precursors from their site of origin to the location of their terminal differentiation,

ii. the assembly and alignment of primary myotubes

iii. the segregation of individual muscles with appropriate attachments to surrounding connective tissues. Migrating myoblasts emigrate from the lateral myotomes at specific, restricted sites (occipital, cervical, brachial, lumbosacral). These cells are pax3-dependent, and express the transcription factors lbx1, paraxis, and six1. [54,55] Lbx1 and the c- Met as well as CXCR4 receptors are essential for their emigrations. Migrators

from each of the several occipital somites contribute to all intrinsic and extrinsic tongue muscles; therefore, the spatial organization for individual muscles occurs either en route or upon the arrival of myoblasts at their final destination.

Neural crest cells en route to each arch overlie presumptive branchial muscle primordia, and both of these mesenchymal populations shift ventrally in concert and during this process, crest cells circumscribe but do not penetrate the condensed cord of muscle precursors. Shortly thereafter, motor axons contact and enter the myogenic cord. [56]

EOM primordia achieve their terminal locations by a combination of population expansion, extended, multidirectional movements, and changes in the relative position and orientation of the eye due to cranial flexure move en masse into neural crest– occupied periocular territories. [57] Reciprocal interactions between the eye and EOMs are necessary for both differentiation of the retina and formation of secondary motubes. [58,3]

From its origin lateral to the midbrain, the dorsal oblique primordium shifts rostrally right angle around the equatorial margin of the optic cup. These movements distance it from its initial neighbor, the lateral rectus precursor, and, remarkably, cause it to pass the ventral oblique primordium that is moving in the opposite direction. [3] These translocations bring each EOM primordium into periocular mesenchyme derived from neural crest cells. The crest-mesoderm interface is undetectable in normal embryos. [3]

Borue and Noden, (2004) have proposed a passive displacement model based on changes in the contour of the neural crest: mesoderm interface. [59] Following

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transplantation of trunk paraxial mesoderm into sites normally occupied by lateral rectus and some dorsal oblique progenitors, it was found that a discrete band of small muscles and individual myotubes distributed along the pathway traversed by the dorsal oblique muscle. This suggests that the dorsal oblique is not a moving island, but rather is at the tip of a finger-like projection of mesoderm that penetrates and interdigitates with comparable but oppositely oriented projections of neural crest cells. Normally, periocular crest cells would encircle and isolate the myogenic tip, perhaps similar to the process by which branchial crest cells circumscribe the myogenic core within each arch. However, this final step is blocked when ectopic trunk mesoderm cells are present, as has been previously described.

The separation of individual muscles and their formation of attachments with branchial skeletal and connective tissues is dependent upon positional cues provided by surrounding connective tissues. Manipulation of branchial arch crest populations, either by transplantation or genetic alteration; results in a patterned alteration in the organization of muscles that mimics the changes in skeletal organization. [60,61] Despite the regional differences in pre-tendon signals, there must be extensive overlap in the consortium of signals controlling muscle morphogenesis in the head and trunk, as transplanted mesoderms cells are fully able to respond to cues in either location.

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The morphogenesis of many head muscles is a prolonged process during which some muscle cells form attachments far from their original branchial confinements. Koentges and Lumsden (1996) showed that neural crest and

myogenic populations maintain their original close association even when they exit the arch in which they originated. [62] These establish attachments with skeletalelements in adjacent branchial arches and also with the mesodermal cartilages in laryngeal, neurocranial, and shoulder regions. This congruency between myogenic and crest-derived connective tissue precursors is not established until after crest cells have fully occupied the branchial arches and circumscribed each muscle plate. [22] Later remodeling of branchial muscle attachment sites occur independent of the neural crest. The mechanisms by which individual muscles detach and then reattach to separate skeletal structures are not known. The rule of congruence between myoblasts and neural crest cells also does not apply to the muscles associated with facial expression.

While it is presumed that periocular neural crest cells play a similar role in EOM morphogenesis, direct evidence is lacking. Gross disruptions of either eye development.

The term “cardio-craniofacial morphogenetic field” reflects the intimate developmental and cellular relationship between the head, face, and heart, which is manifested in numerous cardiac and craniofacial birth defects. [3]

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The Masseter Muscle

The masseter muscle is one of the muscles of mastication that has been investigated extensively in humans. This has been due to its close relation to the mandible and its ease of accessibility. It is composed of two portions, the deepand the superficial bellies

a) The superficial belly arises from the zygomatic process of the maxilla as well as the zygomatic arch and runs downwards in a diagonal direction to be inserted onto the lower lateral border of the ramus of the mandible and the gonial angle

b) The deep belly arises from the medial surface of the zygomatic arch and runs downwards and backwards to be inserted onto the upper half of the ramus of the mandible.

Masseter muscle fibre types

Several methods have been employed to classify muscle fibres (e.g. histochemicaltyp I, IIA and IIB fibres). However, with the evolution of science, new classifications have been implemented using mainly molecular genetic techniques. This scheme includes the transcriptome (gene expression) and proteomic (protein) expression properties of the myosin heavy chain (MyHC) proteins. The human masseter muscle has been reported to have various MyHC proteins encoded by various myosin heavy chain genes (MYH)

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Temporalis Muscle

The temporalis muscle is a very important muscle with respect to mastication, reducing temporomandibular dislocations, and as a landmark distally foridentifying the long buccal nerve. The Latin name is musculus temporalis. It is considered one of the four main muscles of mastication and is crucial to the elevation and retraction of the mandible. The temporalis originates from the temporal lines of the parietal bone of the skull, whose fibers converge and descend into a tendon that passes through the gap formed from the zygomatic archand the side of the skull. The fibers then insert onto the medial surface, the apex, anterior, and posterior borders of the coronoid process, and further down onto the anterior border of the ramus of the mandible. The muscle can be subdivided into the anterior (vertical) and posterior (horizontal) fibers, whose actions are to elevate and retract the mandible back into a resting position after movement. The temporalis can be further subdivided into a deep and superficial portion, such that the deep portion can be considered a separate muscle, the sphenomandibularis muscle. The overwhelming majority of the textbooks, atlases, and specialty dentaltexts described simply a “coronoid process attachment” and/or an “attachment to the anterior border of the ramus of the mandible.” A few further described the distal attachment “down as far as posterior to the third molar.” Although all these descriptions of the distal attachment of the temporalis tendon are partially correct, they are inconsistent with each other and incomplete with respect to the evidence found from the dissections of actual cadavers. The osseous nomenclature of its distal attachment is also unclear. The region described as “posterior to the third

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molar" is often referred to as the retromolar triangle or fossa. Cadavers reveal the distal attachment of the temporalis tendon bifurcating before attaching to the medial and lateral borders of the retromolar fossa, which is located posterior tothe last molar of the mandible. This description is more accurate with respect to the observations from the cadaver dissections. The temporalis tendon also attaches to the coronoid process and to the anterior border of the ramus of the mandible. The bifurcation of the distal attachment might impart a better balance between the broad origin attachment of the temporalis and the narrow insertion of the tendon because the increased number of attachmentmsites can better counterbalance the forces generated by the muscle.

Medial Pterygoid

The Medial pterygoid muscle in quadrangular in shape and has deep and superficial head. The deep head is attached above to the medial surface of the lateral plate of the pterigoid process and the associated surface of the pyramidal process of the palatine bone and descends obliquely downwards ,medial to the sphenomandibular ligament , to attach to mandible near the angle of mandible;The superficial head originates from the tuberosity of the maxilla and adjacent pyramidal process of the palatine bone and joins with the deep head to insert on the mandible The medial pterygoid elevates the mandible. Because it passes obliquely backwards to insert into the mandible, it also assists the lateral

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pterygoid muscle in protruding the lower jaw. The medial pterygoid is innervated by the nerve to medial pterygoid from mandibular nerve.

Lateral Pterygoid

The human lateral pterygoid muscle plays an important role in the control of jaw movements. It consists of an upper or superior head (SHLP) and a lower or inferior head (IHLP). The lateral pterygoid is a thick triangular muscle and likethe medial pterygoid the muscle has two heads has two heads. The upper head originates from the roof of the infratemporal fossa (inferior surface of them greater wing of the sphenoid and the infratemporal crest) lateral to the foramen ovale and foramen spinosum. The lower head is larger than the upper head and originates from the lateral surface of the lateral plateof the pterigoid process and the inferior pat insinuates itself between the cranial attachments of the two heads of medial pterygoid. The fibres from both the heads of the pterygoid muscle converge to insert into the pterygoid fovea of neck of mandible and into capsule that are attached internally to articular disc. Unlike medial pterygoid muscle whose fibres tend to be oriented vertically those of lateral pterygoid muscle are oriented almost horizontally. As a result when lateral pterygoid contracts it pulls the articular tubercle and therefore the major protuder of lower jaw. The lateral pterygoid is innervated by nerve to lateral pterygoid froms the mandibular nerve. When lateral and medial pterygoids contract on only one side,the chin moves to the opposite side when opposite movements of the two temporomandibular joints are coordinated a chewing movement results. Contrary to previous anatomical

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views that the SHLP inserts into the temporomandibular disk with the IHLP inserting into the condyle, the current view is that the IHLP inserts into the condylar neck and capsule, and the SHLP has a complex insertion into the condyle and the disk-capsule complex. The classical description of the normal function of the lateral pterygoid muscle is that the IHLP is active on jaw-opening, jaw protrusion, and contralateral jaw movements, and that the SHLP is active on jaw-closing, jaw retrusion, and ipsilateral jaw movements. Both heads are therefore said to have a reciprocal pattern of activity. One of the anatomic features of the LP that is unique to the jaw motor system is its muscle fiber architecture, which allows a major vector component of the total force output from the muscle to be generated in the horizontal plane; the LP is therefore ideally suited to generating horizontal jaw movements. Many investigators have studied LP anatomy; the muscle consists of an upper or superior head (SHLP) and a lower or inferior head (IHLP). While the IHLP inserts into the condylar neck and capsule, the SHLP has a complex insertion into the condyle and the disk-capsule complex. Within the SHLP and IHLP, there is a marked convergence of muscle fibers onto a small insertion site on the condylar fovea, capsule, and disc from a broad origin at the roof of the infratemporal fossa and lateral pterygoid plate. This marked change in fiber alignment from the uppermost to the lowermost muscle fibers, and from the medial to the lateral side of the muscle provides the opportunity for a range of force vectors capable of moving the condyle at the appropriate rate, and for the appropriate range and direction to effect the desired horizontal jaw movement.

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Introduction

As long ago as 1955, Schottstaedt et al. described the feasibility of complete muscle transposition to restore function or to compensate for paralysed muscles. They transposed the sternomastoid muscles to function as masseter muscles in humans and also used the sternomastoids to replace the orbicularis otis muscles when the 5 th and 7 th cranial nerves were damaged. Several years later, Hamacher (1969) and Dingman (1969) also performed a muscle transposition so that the sternomastoids functioned as masseters. Eschler (1969) described a technique for transposing the masseters in human infants with the Pierre Robin syndrome, which consisted of detaching the masseter insertion from the angle of the mandible and repositioning it onto the posterior border of the ascending ramus. Eschler (1969) claimed that within three weeks his patients were able to keep their airways patent without assistance. Experimentally, Washburn (1947) and Horowitz and Shapiro (1951) demonstrated in guinea pigs a significant reduction in the size of the coronoid process, after removing the temporalis muscle. Reduction or absence of the coronoid process and some change in the morphology of the remaining coronoid area was noted. Boyd et al. (1967), also using guinea pigs, demonstrated that removal of the temporalis origin only, while maintaining muscle attachment to the coronoid process, resulted in a reduction in size of the coronoid in only 2 of the 9 animals. They concluded that vascular compromise was a more important factor in skeletal remodeling than was the influence of muscle function. Yellich et al. (1981), experimented on rhesus

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monkeys, measuring the effects of lengthening, detachment, and reattachment of the masseter muscle. Changes in muscle position and length can affect the dento-facial growth configuration of infant primates. The physiological length of the masseter muscle when shortened by surgically shifting the insertion closer to its origin and by moving the coronoid process farther away from its origin, placing the insertions of the masseter and the temporalis in a more posterior position realigned the contractile units of the muscles, causing them to contract in a more anterosuperior direction during chewing. This cascade superior and anterior rotation of the mandible and the maxilla. Yellich et al. (1981) demonstrated muscle adaptation following the elongation of the masseter by inserting a bite-opening appliance; a 50 % return toward the pretreatment length occurred over a 48-week period. Return to the original length of a muscle appears to be a long process (at least a year). In this study, the masseter muscles showed a bilateral lack of electrical activity, but activity returned during the three to six-week postoperative period. The temporalis muscle, however, maintained electrical activity during the entire postoperative period. The lack muscle marker precluded measurement of thechanges in the length of the muscle, although the results of Yellich's experiments (1981) suggested that some muscle adaptation could be predicted. The dry-skull preparations demonstrated dramatically the skeletal changes that occurred. The muscle transposition definitely contributed to the gross skeletal changes, which supports the theory of functional matrices affecting bon growth and remodeling.

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Although mastication is a hallmark attribute of mammals, there is great diversity of all its components.RMasticatory muscle activation and coordination determine the direction of jaw movement, control occlusal force, and deform the skull in a variety of ways. The critical features to understand, then, are action line, force production, and relationship to the cranium. Action line and force production are not as straightforward in the complicated masticatory muscles as in limb muscles, which tend to be arranged more linearly. Similar difficulties with the irregularly shaped skull make the effect of muscles on the bones challenging to model.

One feature in common among mammals is the size and complexity of the muscles of mastication, which occupy much of the head. In terms of size, it is customary to examine the relative mass of individual jaw muscles as a percentage of the whole.1 This procedure illuminates the contrast between species whose masticatory apparatus is dominated by the temporalis muscle (typically generalised species and specialized carnivores with a hinge-like TMJ like cats) and those that emphasise the masseter and medial pterygoid (typically omnivores like primates or herbivores like rabbits, with anteroposterior mobility of the TMJ). However, standardizing each muscle mass to the total masticatory mass obscures whether there are differences in the relative size of the total masticatory mass relative to head size, which remains an unanswered question. Although the same basic terminology (e.g., ‘‘masseter’’ and ‘‘lateral pterygoid’’) is used for all mammals, it is important to realise that these names are based on bony attachment areasand not on function. The anteriorly directed, fascially subdivided superficial masseter muscle of rodents has little functional resemblance to its relatively

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vertical and unitary human counterpart. The jaw muscles have broadly distributed origins and insertions on the skull and mandible, but the main factor that contributes to functional complexity is the fact that most muscle fibers attach to internal aponeuroses rather than to the bones directly. Necessarily, fibers that attach to different surfaces of an aponeurosis must have different orientations, raising the possibility that differential contraction of fibers could change the direction ofmuscle pull, a possibility that has been confirmed in a variety of masticatory muscles.2–5 Thus, action line is not a constant, but varies dynamically throughout a masticatory cycle. Distortion of aponeuroses fromstretching or folding could alter fiber direction evenmore, but results from one muscle, the pig masseter, indicate that aponeurotic stretching is limited to no more than about 5% linear strain.

Muscle anatomy both causes and reflects jaw movement. Muscles (or parts of muscles) may be mostly rotatory (open/ close) or mostly translatory (anterior/posterior or medial/ lateral). The relative importance of upward, medial, and anterior components in the power stroke is associated with startlingly differentmuscleanatomy.Thus,wecan explainwhy the lateral pterygoid is small and unimportant in carnivorans such as cats and ferrets but huge in humans, and why the masseter of rodents is specialised and subdivided. There are some surprises. Parts of the medial pterygoid and/or masseter in several species open the jaw rather than closing it raising some interesting questions about neural circuitry.

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Masticatory muscles, through their direct action on bony attachments and their indirect action in loading the teeth and the jaw joints, constitute the major biomechanical challenge to the skull. Direct effects of a muscle attachment are sensitive to the particular muscles used and to the pattern of muscle coordination. For example, the temporalis and masseter twist the pig braincase in opposite directions, and because these muscles usually act in opposite-side ‘‘couples’’, the effect is exaggerated rather than cancelled. Indirect effects depend on global features such as total muscle force and the particular teeth in occlusion. With regard to total muscle force, the point is simply that the muscles collide the mandible with the upper jaw and thus engender reaction forces at points of contact, specifically the teeth and the TMJs. The former is occlusal force, and its major influence on the skull is to shear the maxilla upward and the mandible downward.13 The reaction force on the TMJs arises from lever mechanics and the fact that the resultant muscle force rarely if ever passes through the bite point. Depending on the particular species, however, it is clear that there are major differences in the geometry of the muscle resultant and hence the relative magnitude of the TMJ reaction load.

The choreographed interplay within and between the complicated masticatory muscles focuses attention on whether, and how, mastication would be changed if one muscle or even just one muscle compartment were incapacitated. This question might seem arcane, because most neuromuscular diseases attack indiscriminately and would not target single muscles. However, it is increasingly common these days for patients to have single muscles paralysed, not only for

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therapeutic, but also for cosmetic reasons.To some extent, the answer depends on which muscle and species. The loss of one masseter may be less of a problem for those taxa in which the inclined planes of the teeth guide the power stroke (such as rabbits) than for those that depend on muscle choreography (such as pigs). In order to maintain occlusal force, however, all species should increase the recruitment level of synergists. Muscle weights suggest that the unparalysed masseter in rabbits hypertrophies. The short-term pig experiment showed that the masseter's synergists for transverse movements, the ipsilateral pterygoids and the contralateral temporalis, were overactive, a prelude to hypertrophy. It is also likely that such changes in muscle usage would alter skull loading. Both the masseter and medial pterygoid create similar strain magnitudes on the pig mandibular condyle, but the orientation of strain is unique for each muscle. Therefore, if one masseter were incapacitated, total joint load would not only be reduced, but also re-oriented. If such conditions were long maintained, as for example with botulinum toxin, bony adaptations would be likely. The growing rabbits in the study by Matic developed smaller condyles on the paralysed side, presumably because of decreased loading. Our own preliminary data on adult rabbits suggest that bone strain in the condyle is indeed reduced by paralysis of the ipsilateral masseter, and that this unloading leads to massive bone loss in the condyle.

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Muscle action and skull biomechanics are inextricably intertwined. In the evolutionary sense, the muscles of mastication are co-adapted with dental morphology and jaw movements to produce species-specific chewing patterns. In

the physiological sense, masticatory muscles comprise the major loading on the skull, influencing its growth and controlling its strength.

Regarding the asymmetric adult patients, the right and left ramus and body length and mandibular angle were strikingly different, whereas there was no significant bilateral skeletal asymmetry in the non-asymmetry group. In our patients with asymmetry, mandibular morphology was characterized by the elongation of one half of the mandible (mandibular body and ramus) and an increase in the gonial angle, which is a characteristic of hemimandibular elongation. The longer mandibular side showed larger mandibular volume in proportion to the degree of chin deviation. It has been proposed that these types of asymmetries are related to asymmetric condylar hyperactivity, that influence not only the growth of the condyle itself, but also the ramus and body of the mandible. However, the mechanism of influence of the condyle cartilage on the length or mass of the mandible has not yet been proven.

The results showed that the medial pterygoid muscle had a significant right-left difference and intergroup difference. However, the masseter, lateral pterygoid,and temporalis did not show a right-left difference. It is interesting that the medial pterygoid volume in the mandibular elongation side decreased in the asymmetry group. As mandibular structures can be influenced by local environmental factors in the form of tension and pressure forces on the muscles adjacent to the bony structure, we tried to determine whether muscular factors can explain mandibular asymmetry.

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The study of adult symmetric subjects showed that people with a large masseter and a medial pterygoid muscle showed that they had a short anterior face and a small gonial angle. In addition to this, there was a correlation between mandibularbody length or ramal height and masticatory muscle size. An increase in the function of the masticatory muscle is associated with anterior growth rotation of the mandible and well-developed angular, coronoid, and condyle process. It had been reported that there is a correlation between a larger adult masseter and medial pterygoid volume and a small mandibular angle and a longer ramal height. There was also a correlation between the larger medial pterygoid volume and a longer body length. If this relation does exist in patients with facial asymmetry, it may be expected that their ramal or body length is relatively longer and that their gonial angle is smaller in the side that has larger masseter or medial pterygoid volume. However, in patients with asymmetry, larger masticatory muscle volume did not accompany longer skeletal measurements. In particular, the medial pterygoid volume decreased in proportion to the increase in the body or ramal length. These findings are contrary to previous reports on symmetrical adultsubject.

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Muscles And Mandible

The mandibular muscles ie masseter, temporalis, medial pterygoid, and lateral pterygoid have been discussed earlier. Mandibular muscle function and formcorrelate with the morphologic features of the craniomandibular apparatus to which the muscles are related. Many attempts have been made to investigate the

seemingly complex relationship between features of the mandibular muscles and the various facial patterns. [63]

Mandibles can grow in more vertical or horizontal directions. Several authors have attempted to describe the normal variation in the vertical and horizontal dimension of the human face. [63]

Relationship Between Craniofacial Morphology And TheMandibular Muscles

Bite-force and facial morphology

Bite force is a direct measure of muscle activity. Significantly smaller maximum molar bite forces have been found in dolichofacial subjects during maximum effort than in mesofacial and brachyfacial subjects. This implies a correlation between bite force and facial morphology, and these findings have been used to support the theory that the form of the face partly depends on the strength of the mandibular muscles. Ingervall and Helkimo(1978) found that adults with weak muscles have a greater variation in facial morphology than those with strong muscles, and it was believed that this argues for the primary importance of the mandibular muscles in forming the face. [64] Kiliaridis(1995) suggested that strong muscles produce faces with similar morphologic features, whereas weak muscles cannot influence the morphology to such an extent. Variation between people with weak muscles is therefore wide, and those with weak mandibular muscles can belong to either the mesofacial or the dolichofacial group. [63]

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Cross-sectional area of the mandibular muscles and facial morphology Various authors have described the relationship between the cross-sectional area of the mandibular muscles and facial morphology. [65,66] It has been observed that the masseter and medial pterygoid muscles have large cross-sections in subjects with short anterior face heights and small gonial angles. On the contrary, Van Spronsen et al (1991) reported no significant correlations between either anterior facial height or posterior facial height and any jaw elevator cross sectional areas with normal skull shapes, when studied with magnetic resonance imaging. [67]

An important determinant of the maximum force that can be produced by a muscle is apparently its cross-sectional area. Significant positive correlations have been reported between the cross-sectional areas of the masseter and medial pterygoid and the maximum molar bite force. Hannam and Wood found a statistically significant correlation between masseter and medial pterygoid cross- sectional areas and molar bite force but no correlation between cross-sectional areas and the muscle moment arms.

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Position, orientation and mechanical advantage of the mandibular muscles According to Takada et al (1984) short posterior face height with steep mandibular plane and large gonial angles is often associated with an anteriorly inclined superficial masseter relative to the occlusal plane and a superior positioning of its insertion on the mandible. This is consistent with the observations of Proctor and DeVincenzo (1970) that the superficial masseter was

angled considerably more anteriorly with a much more acute angle to the occlusal plane in a dolichofacial specimen when compared with a brachyfacial specimen.

[68] Van Spronsen et al,(1996) observed that the orientation of the mandibular muscles in mesofacial and dolichofacial subjects can be strikingly similar. [69] The issue of whether masseter angulation is constant relative to the occlusal plane is controversial. Proctor and DeVincenzo noted a constant angular relationship (about 69°) between the superficial masseters and the occlusal planes in two groups with contrasting vertical facial patterns, others have not been able to demonstrate such a constant relationship.

The efficiency with which a muscle generates a force at a particular point on the lever arm would seem to be related to its mechanical advantage, which has been defined as the ratio of the moment arm of the muscle to the moment arm of the load. [63] Throckmorton et al explained that the significantly smaller bite force of dolichofacial subjects might to a large extent be due to the reduced mechanical advantage of the mandibular muscles in these subjects. Although this has formed the basis for the contemporarily accepted concept of muscular mechanical advantage, it is not universally accepted. Sasaki et al (1989) for instance, found that the variation of maximum bite force could be accounted for largely by musclecrosssectional areas rather than simply by muscle lever arms. [70]

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Cause and effect relationship between muscle function and craniofacial morphology

There is often a relationship between form and function, but it is not known whether a genetically determined facial morphology dictates the strength of the mandibular muscles or whether a strong musculature influences the form of the face. [71] In animal studies, it has been shown that interference with the development of the jaw and facial muscles can lead to major changes in the shapes of jaw bones. It has also been shown that human subjects with strong bite forces tend to have brachyfacial patterns, in contrast to those with weak bite forces, who tend to have dolichofacial patterns. This difference in bite force has led to much speculation about the etiology of vertical facial patterns. According toProffit and Fields (1983) , it is possible that the lower bite force in dolichofacial people might allow greater eruption of the posterior teeth than might otherwise occur, and so are directly related to the excessive tooth eruption and backward rotation of the mandible often seen in such subjects. [72] Ingervall and Helkimo suggested that the interindividual form of the face is smaller in persons withstrong muscles than in those with weak muscles. This would support the hypothesis that the muscles do actually contribute to the final shape of the face. Further support for this theory presumably came from the findings of Ingervalland Bitsanis(1987), who showed that training the jaw muscles in dolichofacial children strengthened these muscles and induced a favorable anterior mandibular growth rotation. [73]

Whether the bite force differences play a role in determining the ultimate facial morphology or merely reflect the mechanical advantage obtained by the muscles in the different facial types has been a matter of some controversy. The model

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proposed by Throckmorton et al, which depicts the unfavorable mechanical position of the mandibular muscles in dolichofacial subjects, implies that the muscular function is influenced by skeletal form. The fact that the dolichofacial pattern can be recognized before an age at which decreased occlusal forces are present strongly suggests that the decreased forces are an effect of the condition, rather than a cause.

It has been suggested that subjects with increased vertical craniofacial dimensions have relatively obliquely oriented jaw muscles, with a consequent reduced potential to restrain the vertical component of craniofacial growth. [74] This situation is obviously different to that in brachyfacial subjects, with vertically oriented jaw muscles, which would be expected to restrain the vertical componentof growth and contribute to the forward rotation of the mandible; this is a characteristic of this group. The relationship between the growth patterns of the skull and characteristic jaw muscle function and orientation in subjects with increased vertical dimension has received considerable attention. [67,71] None of these studies, however, has provided an ultimate answer about whether jaw muscle function determines the outcome of craniofacial growth or vice versa.

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Masticatory Muscles And Maxilla

Various studies have shown an association between the functional capacity of the masticatory muscles and craniofacial morphology. A positive association betweencross-sectional areas or

thickness of masticatory muscles and craniofacial widths has been reported, i.e. subjects with thicker masticatory muscles have broader faces. The muscles found to be involved in this relationship were the temporal muscle, the masseter and the medial pterygoid muscles. [67,66] Since there is an association between masticatory muscle size and craniofacial width, a similar association might be expected toexist regarding dental arch width. The findings of the present study suggest that there is a significant association between masseter muscle thickness and maxillary arch width in female subjects. The multiple regression model that used masseter muscle thickness and age as independent variables could explain approximately one-quarter of the total variance in intermolar width. In male subjects, no significant association between maxillary arch width and masseter thickness was recorded. This finding could be related to the lack of relationship between masseter muscle thickness and measurements describing the width of the face in adult males. [65]

In patients suffering from myotonic dystrophy, a decreased width of the palatehas been reported. This might be due to muscle weakness but also to other factors (e.g. head posture) that affect equilibrium both sexes between 3 and 13 years of age, after which it remains stable in males, whereas it decreases slightly in females. Males have been found to have a significantly larger maxillary intermolar width than females in all age groups. The greater arch width found in medieval dentitions compared with those from a modern control sample is considered to be due mainly to differences in diet and masticatory function. Masumoto et al. (2001) reported that the lower molars of skulls with a long facial

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configuration were more lingually inclined than in skulls with an average or short facial configuration, this difference possibly being related to variations in the functional capacity of the masticatory muscles. This might reflect a compensatory mechanism of the dental arches to offset a smaller maxillary base. The masseter muscle has been found to be thinner on the crossbite side than on the normal side in patients with functional lateral crossbite. The functional capacity of the masticatory muscles should be considered as one of the factors influencing the width of the maxillary dental arch. [75] Increase in the muscle thickness leds to an increase in the dental arch width. This is in agreement with the studies by Kiliaridis et all and Katsaros where they affirm that the functional capacity of the masticatory muscles may be considered as one of the factors influencing the width of the maxillary dental Imasseter muscle increased the sagittal growth, while limiting the vertical growth of jaws. [75] It tended to make the face grow in a more horizontal pattern. Increased masseter thickness increased the length of the maxillary arch. Subjects with thicker masseter muscles had a wider maxillary dental arch. . In previous studieisit has been hypothesized that the increased loading of the jaws due to masticatory muscle hyperfunction may lead to increased sutural growth and bone apposition, resulting in an increased transverse growth of the maxilla and broader bone bases for the dental arches. Maxillary width is smaller in masticatory hypofunction individuals.

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Currently, it is widely accepted that masticatory muscle function is closely correlated with craniofacial morphology. During mastication and clenching, the masticatory muscles contract strongly but momentarily. On the other hand, the masticatory muscles work continuously to stabilize the position of the mandible, although the activity may be weak. Such muscle activity is induced widely during daytime in usual daily life. Thus, it would appear a reasonable, assumption that such low but widely induced masticatory muscle activity during daytime might play an important role in craniofacial morphogenesis. Given these considerations, Miyamoto et al(1996) recording the masseter muscle activity for a consecutive 24 hour period, demonstrated a number of low-amplitude bursts widely distributed during the whole day.[76] Furthermore, Ueda et al(1998) indicated a close interaction between masticatory muscle activity for 3 hours during daytime and vertical craniofacial morphology in adults. [77]

Previous studies, focusing on bite force, mandibular movement, and muscle activity revealed the differences in masticatory function between children and adults. Horikawa et al (1985) and Yashiki et al (1994) found that the temporal muscle works mainly in children, whereas the masseter muscle exhibits prominent activities in adults during maximum clenching and chewing. [78,79] Therefore, it is assumed that there might be two differences in the nature of masticatory muscle activity between children and adults; one is total duration of masticatory muscle activity during daytime, and the other is a significant relationship between the duration of muscle activity and craniofacial morphology. Thus, it is important to

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examine the relationship between masticatory muscle activity and craniofacial morphology and to reveal the difference between children and adults. children have longer temporal muscle activity and adults have longer masseter muscle activity during daytime, although the muscle activities essentially consisted of widely induced low-amplitude bursts in both groups. The duration of masseter and digastric muscle activities was related significantly with the vertical facial type in both children and adults, whereas the duration of temporal muscle activity presented no significant relationships .The total duration of masseter muscle activity on levels one and two was significantly longer in adults than in children. On the contrary, the total duration of temporal muscle activity on all levels was prominently longer in children than in adults. A possible explanation for such differences may be the fact that development of the dentition, temporomandibular joint and masticatory muscles has not been completed in children. The glenoid fossa is almost flat in the neonate. Therefore, the mandible can move freely in the horizontal direction, subsequently forcing the temporal muscle to work to stabilize the mandibular posture in children. It is also assumed from the present findings that children and adults may have different behaviors of the masseter and temporal muscles during the daytime. An interesting finding in this study was thatthe total duration of digastrics muscle activity was similar in children and adults. This may be accounted for by the role of digastric muscle. Activity of the digastric muscle is known to accompany the lateral pterygoid muscle activity during mouth opening. Because orofacial functions such as breathing, speaking, and swallowing do not require substantial jaw opening during the daytime, it may

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be reasonably assumed that the differences in these muscle activities are not significant between children and adults. Masseter muscle activity, in this study, was significantly longer in the low angle group than in the high angle group for both children and adults. Various studies demonstrated a negative correlation between the mandibular plane or gonial angles, and masseter muscle activity atthe maximum voluntary clenching.

In addition, the cross-sectional area of the masseter muscle, measured with ultrasonography, exhibited a negative correlation with the vertical facial height. Thus, it may be confirmed that comparatively low muscle activity during normal daily life as well as greater muscle activity or the corresponding muscle size is significantly related to vertical morphology of the craniofacial skeleton. On the other hand, no significant interrelations are found between temporal muscle activity and the vertical craniofacial morphology, as was also demonstrated in a previous study. [80]

In contrast, a negative correlation is revealed between the mandibular plane angle and temporal muscle activity during maximum clenching and chewing in other studies. [81,82] The temporal muscle has less prominent interrelation with the morphology of the mandible, playing a different role in the stomatognathic function from the masseter and digastric muscle. [83] Longer duration of digastric muscle activity is present in the low angle group compared with the high angle group, as is the case with the masseter muscle. [84]The duration of digastric muscle activity as well as opening force and muscle thickness might thus have a close relationship with craniofacial morphology.

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Masseter and digastric muscle activity during the daytime has similar interrelation with vertical facial type which can be explained by a positive correlation between the masseter and digastric muscle activities. Because greaterjaw opening force is required to extend the thicker jaw closing muscles, even if they are not under activation, it is speculated that high correlation may be found between the masseter and digastric muscle activities. [84] No significant differences in the duration of the masseter, temporal, and digastric muscle activities are found between both sexes. Miyamoto et al(1996) found no significant sexual differences in 24-hour masseter muscle activity. [76] This may be explained by the reference potential level, which was defined in this and previous studies to standardize the muscle activity for each subject and to eliminate the individual variations with a special reference to the maximum voluntary clenching. On the other hand, the maximum discharge voltage of the digastric muscle, used as the reference, was determined during maximum voluntary opening, while maximum voluntary clenching was used for the masseter and temporal muscles. Although both maximum voluntary opening and clenching may produce the greatest activity ofjaw opening and closing muscles, it remains unclear whether the present resultsmay be influenced by the difference in these performances to define the maximum discharge voltage Significant differences in the duration of masseter and temporal muscle activities were found between children and adults. Children and adults had longer total duration of the temporal and masseter muscle activity, respectively, during daytime, although the digastric muscle experienced almost the same duration in children and adults. Meanwhile, a significant correlation between the duration of masseter and digastric muscle activities and craniofacial morphology was revealed in both children and adults, whereas the temporal muscle presented no significant association with craniofacial morphology.

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Currently, the mechanisms by which nonsyndromic deviations in craniofacial morphology develop are not fully understood, but recent work has shown that altered masticatory functioning has significant effects on the face and neurocranium . [84] For example, mice with a hypermuscular phenotype due to loss of myostatin, a growth factor which negatively regulates muscle fiber size, have more brachycephalic and smaller cranial vaults, decreased maxillary length, and a distinctive mandibular shape, which replicates the "rocker mandible" described previously in some humans. The rocker morphology appears during the adolescent growth period when increasing muscle forces influence mandibular shape and a similar morphology seen in Inuit mandibles is attributed to the vigorous chewing characteristic of Eskimo populations. Masticatory muscle function is a key environmental influence on these bony craniofacial areas through force application during growth. Human craniofacial skeletal dimensions correlate with masticatory muscle volume because this is directly related to the loads generated during normal functioning. The intensity of masticatory activity in young adults in modern human populations (eating a highly processed diet) is extremely limited, with teeth estimated to be in occlusion for only about 6 to 7 minutes in a 24-hour cycle.20 Therefore, masticatory activity per se contributes relatively little to normal function of masticatory muscles in the population.

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By contrast, muscle tone for postural purposes appears to be more important as, even though the force is small and difficult to quantitate it undoubtedly maintains the freeway space between the teeth and helps to protect the airway—activities that have a much higher duty cycle. Perhaps the best demonstration of how variation in muscle activity affects craniofacial growth is the example of children with Duchenne muscular dystrophy who develop severe open bite malocclusions due to decreasing muscle forces transmitted to the face as the condition progresses.

Specific aspects of orthodontic treatment with reference to themandibular muscles and vertical facial pattern

Extrusive mechanics

Most orthodontic mechanics are extrusive, and this extrusion appears to maintain or even increase the vertical dimension during orthodontic treatment. It is not surprising, therefore, that there is a greater potential for the undesirable extrusion of molars in dolichofacial subjects compared with brachyfacials, who have stronger musculature that tends to resist extrusive forces during orthodontic treatment. [63] If molar extrusion does occur during treatment in brachyfacial patients, there is likely to be a strong tendency toward reintrusion through the influence of the muscles during swallowing and chewing. Thus, it might bedifficult to cause permanent extrusion of the molars and backward rotation of the mandible in such patients, even though this is a main aim of treatment. During treatment, extrusive forces with such mechanics as intermaxillary elastics or

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particular headgears should probably be avoided in patients with backward- rotating tendencies to try to limit, as much as possible, any undesirable backward rotation of the mandible. Vaden and Kiser(1996) advocated that, in such patients, it is crucial to really control the vertical dimension if stability, facial balance, and harmony are the ultimate goals of treatment. [85]

Extractions and timing of treatment

Staggers reported on the changes in the vertical dimension between premolar and second molar extraction groups and found no significant differences between them. It has been shown that, if premolars are extracted in dolichofacial patients, there is still likely to be a slight increase in the vertical dimension, whereas, in brachyfacial patients, there is likely to be no change or even a slight decrease. Extrusion of posterior teeth with growth and treatment has been shown to be the reason for this usual maintenance of the vertical dimension during treatmentinvolving premolar extractions. [63]

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The recognition of different muscular patterns, growth rotations of the mandible, and profile concavity or convexity will influence the premolar extraction decision in each patient. Pubertal growth and the E-spaces are important components of the orthodontic management of most brachyfacial patients, whose treatment often begins in the late mixed dentition without premolar extractions. In dolichofacial patients, treatment often begins later (unless severe crowding warrants early extraction with space maintenance). The aim of not only aligning teeth but also placing them in positions of muscular stability and facial balance will often require the extraction of premolars in dolichofacial patients. Although Gianelly

(1994) did not mention vertical facial pattern or the influence of the muscles on orthodontic treatment, he did discuss the notion of preserving the E-spaces by starting treatment in the late mixed dentition stage. [86] According to him, the leeway space would allow the relief of crowding in up to 75% of patients, enabling much orthodontic treatment to be carried out without premolar extractions. This might seem to be an ideal approach to the treatment of brachyfacial patients. Vaden (1998) however, claimed that, in most dolichofacial patients, the extraction of premolars is absolutely necessary. [87] The greater tendency toward premolar extractions in dolichofacial patients than in brachyfacials has been discussed previously [63]

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Surgical considerations

Jacobs and Sinclair (1983) suggested that the optimum in efficiency of treatment, stability, and esthetic change in orthognathic surgery patients would be obtained by postponing the levelling of mandibular curves of Spee until after surgery. [88] In Class II deep-bite patients, it is common practice to leave final levelling until after surgery so that, at least in theory, postsurgical extrusion of the posterior teeth will enhance any surgical increase in lower face height. Surgical manipulation of the jaws alters the environment in all three dimensions so the teeth can be placed in their final, well-detailed positions. If, presurgical levelling is attempted in brachyfacial patients, it would have to overcome the heavy bite forces associated with such patterns. In other patients with longer lower anterior facial heights, most of the levelling should probably be carried out before surgery to avoid, as

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much as possible, postsurgical extrusive effects. Arch coordination and preparation are generally more easily achieved in these longer-faced patients because of the decreased vertical muscular anchorage.

Muscular anchorage

Bench et al (1978) introduced the concept of muscular anchorage. [89] According to this concept, the facial type described by the cephalometric morphology reflects a particular underlying muscular pattern. The teeth would be controlled with natural anchorage in a brachyfacial pattern, where the musculature is strong, but there would be less muscular anchorage in dolichofacial subjects with weak mandibular musculature. Weaker musculature would be less able to overcome the molar- extruding and bite-opening effects of orthodontic treatment. Ricketts et al claimed that the values for the oral gnomon and facial gnomon were excellent indicators of mandibular morphology and the associated muscular function.

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Retention

The position and function of the lips are well accepted to influence incisor alignment and stability. The facial and mandibular muscles are also critical influences. Ricketts et al. suggested that preferred incisal positions and angulations at the end of active treatment might vary depending on the underlying vertical facial type, with brachyfacial patients tolerating more protrusive and proclined incisors than dolichofacial patients. It has been suggested that brachyfacial patterns might allow greater expansion of the arches during

treatment, in contrast to dolichofacial patterns with generally weaker mandibular muscle forces that might allow less expansion during treatment. Although the pretreatment vertical facial pattern has been discussed as a possible factor in determining occlusal stability after treatment, no direct relationship has beenfound. [63]

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Introduction

Masticatory muscle function and its influence on craniofacial growth have been investigated in animal experiments and clinical studies. These investigations commonly show that the elevator muscles of the mandible influence transverse and vertical facial dimensions. Increased loading of the jaws associated withmasticatory muscle function increases sutural growth and stimulates bone apposition, resulting in greater transverse growth of the maxilla and broader bone bases for the dental arches.

Animal Studies

Numerous experimental studies have examined the mechanism behind the interplay of masticatory muscle function and craniofacial growth. Various experimental methods have been used to modify masticatory muscle function, including denervation or resection of masticatory muscles, extraction or grinding of functioning teeth, insertion of devices in the mouth to alter mastication, and alteration of the consistency of the diet. [90] The advantage of the latter model is thatthe effects of an altered function can be observed in an intact masticatory system, significantly simplifying the interpretation of experimental results. Altering the consistency of the diet in laboratory animals induces changes in the demands of biting force level, masticatory activity and behavior, and these in turn alter the composition and diameter of the fiber types in the animal's masticatory muscles. These changes probably influence the tension that the masticatory muscles apply to the craniofacial skeleton, thereby altering its growth. However, experimental

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results with different animal species are not always consistent. The prevalence of malocclusions has increased among contemporary populations who have changed from a primitive to an industrialized and refined diet. Studies in macaques and squirrel monkeys fed soft diets have shown reduced maxillary and mandibular widths, palate heights, and poorer craniofacial growth. However, the maxillary and mandibular arch lengths were not significantly affected by dietary consistency in squirrel monkeys. Furthermore, baboons fed a soft diet showed relatively increased variability, reduced correlations in their oral-facial structures, and disruption of normal occlusion. [91] However, because of problems in experimental design, including lack of control of age, gender, genetic background, and nutrition of these animals, the results of these studies may not be suitable to explain the previously observed changes in man. Ciochon and coworkers (1997) followed the growth of 8 young female Yucatan minipigs fed hard or soft diets for 8 months. [92] The hard-diet minipigs had steeper frontal profiles, while the soft-diet ones presented more horizontal crania. The hard-diet group showed greater bizygomatic widths, shorter palates, and smaller minimum distance between temporal crests than the soft-diet animals. In the mandible, animals fed a hard diet showed wider posterior dimensions, as well as thicker, higher, and more vertically directed rami than the soft-diet group. Ogaard and Larsson (2003), studied 17 young domestic pigs of both sexes fed hard or soft diets for 22 months. [93] They found no significant differences in the morphology and dimension of the craniofacial regions between the groups. The small sample sizes of these two investigations, along with mixed sexes in the sample and the lack of the strict

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control of food consistency in the Swedish study, may have contributed to these conflicting conclusions. The experimental model of altering the consistency of the diet has been mainly used in small animals such as the rat. Although great variation exists in these studies concerning the strains, sex, and ages of the rats involved in these experiments, the duration of the experimental periods (range from 4 to 18 weeks), and in the consistency of the diet, they do share common findings that elucidate the role of masticatory function in the craniofacial growth of this animal model. The decreased functional demand of a soft diet causes structural changes in the masticatory muscles and alteration of their contractive capacity, as indicated by changes in the muscle fiber types and the smaller size of the fibers. These changes could explain the low biting forces measured in the soft-diet animals. Rats fed a soft diet generally have maxillae with smaller transverse dimension. [94,95] Low biting and chewing forces may induce changes in bone remodeling and in sutural growth of the craniofacial region. Behrents and coworkers (1978) for example, have proposed that bite forces could providetensile strain sufficient to cause a separation of the sagittal suture of the skull. [96] The fact that bone remodeling in sutures responds to functional alterations could explain why rats with less tension in the lateral part of their nasal bones (due to a reduced masticatory and biting function) showed reduced width of sutures in the anterior part of their snout and appearance of several synostoses in their internasal suture. A morphometric study verified a narrower sutural space, an almost parallel orientation of bony surfaces of the facial sutures, and reduced sutural bone apposition in rats after a reduced functional demand. This supports histological,

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histochemical, and biochemical studies showing that alterations in dietary consistency can result in changes of varying magnitude in the morphology and the metabolism of the intermaxillary suture cartilage. Reduced function also caused changes in the size and dimensions of the alveolar process, that is, the width, height, and thickness of alveolar bone. Changes in bone apposition were observed not only in the vicinity of the insertion of the elevator muscles, but also in areas where increased apposition reinforces the bone so that it is able to withstand the higher bending forces in animals fed a hard diet. [97] These alterations in bone modeling and sutural growth may underlie the greater upward rotation of the upper viscerocranium, the reduced growth of the angle of the mandible seen radiographically and the reduced transversal palatal width observed in dry skulls of animals fed a soft diet. [95] Reducing mastication in hypocalcemic rats, byfeeding the animals a soft diet, was a powerful determinant of remodeling behavior at certain sites, even with this metabolic bone disturbance. Rats fed asoft diet also have smaller and more posteriorly rotated mandibles. The cross-sectional area and width of the molar and incisor alveolar processes, and themolar periodontal spaces, are greater in rats fed hard diet, possibly an adaptation to support the increased incising and occlusal loading needed to process the hard diet. The response of the different functional units of the mandible to changes in functional strain was evaluated by using a computer-aided image-analysis system that measured the bone mass on roentgenograms (in relation to an aluminum step wedge, ie, “aluminum equivalent ” mass). Reduced muscle function decreased bone mineral mass in the alveolar bone of the molars and the incisors, at the

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angular process (the area of the insertion of the masseter and pterygoideus medialis), and at the bony bulk ascending to the condylar process, possibly in accordance with the strain distribution of the masticatory forces. Lower levels of bone mass in areas with a high bone apposition rate apparently result from decreased bone apposition, whereas in areas with a low bone apposition rate bone mass loss seemed to be an effect of decreased bone density. Because the condyle is considered to be a mandibular growth zone directly affected by functional alterations, several investigations have examined how changing the consistency of the diet affects the temporomandibular joint (TMJ) in growing animals. Significantly smaller condyles were found in the soft-diet.[98] Condylar cartilage was significantly thicker at the posterior part and thinner at the anterior part in soft-diet groups, indicating that low masticatory function, presumably with altered stress distribution in the TMJ area, decreased condylar growth and decreased the thickness of the cartilage. Although studies using rodents provide insights into the basic mechanisms of how masticatory function may influence craniofacial growth, direct extrapolations to humans are not appropriate because the masticatory system of rodents is quite different in terms of both anatomy and function. It is possible that the same alteration of masticatory function might have a different impact on craniofacial growth in species with different masticatory systems. For example, ferrets are carnivores and have a masticatory system that differs substantially from that of rats.[90] A rodent bites off solid food with its sharp upper and lower incisors, and grinds the pieces with its molars using mainly bilateral backward and forward mandibular movements. In contrast, the posterior

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teeth of ferrets perform a function mechanically equivalent to that of a pair of scissors; the far distal molars are only occasionally used to crush food items. The ferret is unable to grind food with its molars due to the anatomy of its TMJ. Therefore, ferrets have to struggle to crush hard pellets, applying great effort for a longer period than ferrets fed a soft diet, which is hardly crunched before swallowing. After 6 months of vigorous mastication the elevator muscles of the animals fed a hard diet showed a training effect in the form of thicker muscle fibers, not only in the temporalis and masseter muscles, but also in the digastric muscle.[99] These results confirm the findings for the masseter muscle in the rat, but differ from the findings for the digastric muscle where no differences were found in the size of the muscle fibers between the soft- and the hard diet groups in the rat. Presumably ferrets use the jaw depressors differently during mastication than rats, leading to different digastric muscle reactions to the alteration in diet. The ferrets fed a soft diet had the hard palate plane located further from the cranial base plane, they showed smaller interfrontal and interparietal widths, and they had more slender zygomatic arches than ferrets fed a hard diet. Furthermore, the coronoid process was generally shorter and narrower in the group fed a soft diet.[75] However, it should be emphasized that altered masticatory muscle function had less impact on craniofacial morphology of the growing ferrets than has been reported in growing rats. These differences are presumably related to different modes of mastication, craniofacial anatomy, and growth patterns of the two species. Sutural growth plays an important determining role in how craniofacial dimensions change in response to alterations of masticatory function.

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As a general rule, sutural growth is promoted by tension and retarded by compression. Sutural strains may vary between, and even within, given sutures during functional loading, depending on the suture's direction relative to loading forces, the attachment and orientation of the muscles, the location of the masticatory muscles in relation to the rest of the skull and the teeth, and last, but not least, the time and order of suture fusion. All these factors vary significantly among different species. In ferrets all the masticatory muscles are situated posterior to the orbital crest, while in rats the anterior deep masseter reaches as faras the medial wall of the infraorbital foramen.

The influence of the masticatory hypofunction on the craniofacial growth and development in rats

There are various opinions about the influence of the function on the maxillomandibular bone structure in the literature. Some authors reported that form and volumes of maxillomandibular bones were determined by genetic factors. Others reported that not only genetic factors but also functional stimuli are important and with the lack of these stimuli, the maxilla and mandible may not reach their full dimensions. Studies in human beings have shown a clear correlation between muscle function and facial structure. In recent studies, the size of the masticatory muscles was correlated with the facial structure and the masticatory muscle orientation was also related to the skeletal structure. The findings of human studies are in agreement with the results of the experimental animal studies on low muscle function, induced by feeding a soft diet. Decreased

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size of the mandible and a decreased transversal width of the maxilla were determined in these rat experiments. In other studies, it was shown that hardand soft diets influenced the craniofacial and mandibular growth and structure in the growing rats.[65]

There are three rat experiments studying the effects of masticatory hypofunction in the literature. Watt and Williams weighed cranial and mandibular bone weights in the hard and soft diet groups and they measured buccolingual thickness of the mandibular corpus. Watt and Williams found no difference in the cranial bone weight between the groups, but they determined that mandibular bone weight wasreduced and maxillary width, thickness of the mandibular corpus were also reduced in the soft diet group. Beecher and Corruccini studied the effects of normal and soft diet on the growth and development for 4months in 21-day-old rats. At the end of this experiment, they found no significant difference between animal weights but they showed that maxillary width was reduced because of masticatory hypofunction. Kiliaridis et al used 28 dayold rates in their study intwo separate normal and soft diet groups and followed up the experiment for 28 days. Rats were weighed at the beginning and at the end of the experiment and cephalometric analysis was carried out to evaluate craniofacial changes. Kiliaridiset al reported that body weights increased in both normal and soft diet group along the experiment, but that body weight increase in the soft diet group was less than the normal group and the difference between the two groups was statistically significant. Kiliaridis et al stated that the body weight differences could be an important causal factor in the craniofacial changes. At the end of 28 days of

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experiment time, in the soft diet group, total skull length and skull height measured in the occipital region were significantly reduced, upper anterior face height and lower incisor alveolar height were significantly increased compared with those of the control group. It was determined that appositional development of gonial angle in mandible was reduced. In the second article by Engstom et al., the material of the first study was used, sections taken from growth sites were stained by histochemical methods and bone remodeling in rats fed a soft diet has been assessed. This study m has shown that masticatory hypofunction causes a specific alteration in the bone apposition pattern in cortical bone and in sutures and the overall apposition pattern was decreased. In two of these studies summarized previously, few direct skeletal measurements were done. In the other two articles al mentioned previously, radiographic and histologic methods were used, whereas in the current study, the skeletal and dental measurements were made directly on the skulls of the animals.[65]

In study by Ulgen et al the diets of the normal function and hypofunction groups were very carefully planned to prevent the growth and development deficiencydue to malnutrition. For this purpose, rats in each group were weighed on day 30 and day 90 and no significant difference has been found between the mean body weights of the experimental and control group animals. This result showed that there was no growth deficiency because of nutritional deficiency in either the experimental or the control groups. The total skull length, lower anterior face height, and total anterior face height in the hypofunction group were significantly reduced compared with those of the control group. Kiliaridis et al also found a

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reduction in the total skull length in a previous report. As in agreement with the findings of the previous studies, %9 it was found that maxillary width , ramus mandibula height(Cond-GoT), and corpus mandibula height (Me-Ma) in the masticatory hypofunction group were smaller than those of the control group. In addition, it was determined that premaxillary length in the hypofunction groupwas also smaller than the control group. But foramen incisivum width in the hypofunction group was found greater than the control group. In the normal masticatory function group, the foramen incisivum has been narrowed because of the continuous appositions around itself, whereas in the hypofunction group less bone apposition, due to less functional stimuli, resulted in a larger foramen incisivum. Kiliaridis et al. found significant difference on the cranial growth. Kiliaridis et al has already reported that the body weight differences could be an important causal factor in the craniofacial structure changes in the soft diet group.[65]

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Human Studies

The animal experiments illustrate the influence of the masticatory muscles on the basic mechanisms of craniofacial growth (ie, on bone remodeling, and condylar and sutural growth). They also show that similar alterations of masticatory function can induce different craniofacial

growth changes among species with different masticatory systems. Thus, the direct extrapola- tion of animal experiments to humans is not valid. The literature showing associations between masticatory muscle function and craniofacial

morphology is enormous. Anthropologic studies have reported a low frequency of malocclusions in populations with primitive living conditions. [100,101] The frequency of malocclusions appears to have increased after human populations came under the influence of industrialized civilization. This is thought to be either a result of the premature loss of deciduous teeth due to caries or to hypofunction of the masticatory muscles due to alteration in the consistency ofmthe diet that reduced the forces applied to them jaws. [90] Medieval skulls show a lower frequency and lower severity of malocclusions than in contemporary individuals. These medieval skulls characteristically have a small intermaxillary angle, a small gonial angle, and broad jaws. The excessive attrition observed on the teeth of the medieval skulls suggests extensive function of the masticatory muscles, making it tempting to relate the high functional demands of the masticatory muscles of these individuals to the morphological characteristics of their skulls. [90] However, other factors, such as increased mouth breathing due toan increased prevalence of allergies, may have contributed to the morphologic differences. Some contemporary individuals also show advanced stages of dental wear and increased levels of masticatory muscle activity, mainly due to bruxism. These same individuals also have a low incidence of malocclusions and arecharacterized by a short lower faces, smaller intermaxillary angles, and small gonial angles. Similar phenotypes have been reported for wrestlers,who in general, are characterized by a well-developed muscular system and have, furthermore, undergone heavy resistance training. [90] Wrestlers have wide and well-developed dental arches and a low frequency of malocclusions. Their

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craniofacial morphology is characterized by a short lower face, small intermaxillary angle, and a decreased gonial angle, possibly a result of increased bone strain on the dentofacial structures during their growth period. This could have been caused either by the forces exerted directly during the sport or by occlusal forces generated by their well-trained masticatory muscles. The possibility of training masticatory muscles was tested in a group of young adults by introducing them to systematic chewing exercises using a hard chewing gum. After 1 month's training their maximal bite force had increased. Clinically, this had a positive effect in the treatment of anterior open bite. [102] In contrast, craniofacial morphology deteriorates in patients with myotonic dystrophy. These patients have low bite-force levels and reduced masticatory muscleelectromyographic activity, and their growth is characterized by a vertical growth pattern and a high incidence of malocclusions, including distal occlusion, anterior open bite, lateral cross bite, and crowding. Another method of investigating the relation between masticatory muscle function and facial morphology has been to relate the functional capacity of the subjects' masticatory apparatus to their facial morphology. Different methods have been used in adults to evaluate the relation between facial characteristics and their functional capacity, such as the maximal bite force,and morphological measurements of the masticatory muscles recorded by computed tomography, magnetic resonance imaging, or ultrasonography. A general consensus in all these studies is that subjects with strong or thick mandibular elevator muscles have wider transversal head dimensions. Tendencies toward parallelism between jaw bases and between occlusal smaller lower facial

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heights, and more rectangular shape of the face were also observed in some of the studies.

Proffit and Fields (1983) detected no statistical differences between the bite force of long-face and normal children, suggesting that long-face children had similar bite-force levels as normal ones.[103] However, this may have been a typical type II error due to a small sample studied and one large methodological error; it is not easy to motivate young children to bite with maximum force, and some of the "normal" children in the study produced maximal bite forces close to zero! Unless the children suffered from a muscle disease, such low levels of maximal bite force are probably not physiologic. The authors even noted that "some of the children found it difficult to cooperate with the laboratory procedures." In contrast, the bite-force levels of long-face adults were much lower than those of normal-face adults, approximately at the same level as the long-face children.

The long-face group is more homogeneous, with consistently thinner muscles and lower bite forces, while normal-face individuals vary widely in the thickness of their muscles and thus their bite-force levels. This means that individuals with thin masticatory muscles could belong to either the long-face or the normal group, whereas scarcely any individual with thick masticatory muscles could be found in the long-face group. The finding that individuals with strong masticatory muscles have a more homogeneous facial morphology than individuals with weak masticatory muscles lends support to this explanation.[104] Thus, it may be concluded that the masticatory muscles are able to influence craniofacial growth of man provided that the tension they apply to the facial bone structures is above a

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certain threshold, reaching what Frost calls “the mild overload window.” The principle that is valid for long bones, that “modeling drifts can adapt bone to overloads by changing bone architecture and adding bone, but apparently cannot adapt it to low loads or disuse could be also applied to the craniofacial complex.[105] Thus, the epigenetic influence of the masticatory muscle forces on craniofacial growth may only apply in the presence of increased muscle activity but not necessarily with decreased muscle activity.

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Introduction

Masticatory muscles are anatomically and functionally complex in all mammals, but relative sizes, orientation of action lines, and fascial subdivisions vary greatly among different species in association with their particular patterns of occlusion and jaw movement. Although mastication is a hallmark attribute of mammals, there is great diversity of all its components. Ignoring specialised feeding systems such as those of whales and anteaters, this discussion will concentrate on typical mastication, addressing differences among species commonly used in research. Masticatory muscle activation and coordination determine the direction of jaw movement, control occlusal force, and deform the skull in a variety of ways. The critical features to understand them are action line, force production, and relationship to the cranium. Action line and force production are not as straightforward in the complicated masticatory muscles as in limb muscles, which tend to be arranged more linearly. Similar difficulties with the irregularly shaped skull make the effect of muscles on the bones challenging to model. Thus, this short review will emphasise empirical data from electromyography (EMG) and in vivo recordings of bone strain.

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Complicated muscles

One feature in common among mammals is the size and complexity of the muscles of mastication, which occupy much of the head. In terms of size, it is customary to examine the relative mass of individual jaw muscles as a percentage of the whole. This procedure illuminates the contrast between species whose

masticatory apparatus is dominated by the temporalis muscle (typically generalised species and specialized carnivores with a hinge-like TMJ like cats) and those that emphasise the masseter and medial pterygoid (typically omnivores like primates or herbivores like rabbits, with anteroposterior mobility of the TMJ). However, standardizing each muscle mass to the total masticatory mass obscures whether there are differences in the relative size of the total masticatory mass relative to head size, which remains an unanswered question. Although the same basic terminology (e.g., ''masseter'' and ''lateral pterygoid'') is used for all mammals, it is important to realise that these names are based on bony attachment areas and not on function. The anteriorly directed, fascially subdivided superficial masseter muscle of rodents has little functional resemblance to its relatively vertical and unitary human counterpart.

The jaw muscles have broadly distributed origins and insertions on the skull and mandible, but the main factor that contributes to functional complexity is the fact that most muscle fibers attach to internal aponeuroses rather than to the bones directly. Necessarily, fibers that attach to different surfaces of an aponeurosis must have different orientations, raising the possibility that differential contraction of fibers could change the direction of muscle pull, a possibility that has been confirmed in a variety of masticatory muscles. Thus, action line is not a constant, but varies dynamically throughout a masticatory cycle. Distortion of aponeuroses from stretching or folding could alter fiber direction evenmore, but results from one muscle, the pig masseter, indicate that aponeurotic stretching is limited to no more than about 5% linear strain.

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Muscles and movements

Both the muscles and the dentition are determinants of the direction of the power stroke. Teeth play a larger role when they provide an inclined plane, keeping the direction of jaw movement medial even if the muscle resultant is vertical or slightly lateral. Examples include rabbits. Muscles become more significant when irregular occlusal surfaces do not define a plane, i.e., the low-cuspedmolars of pigs. Age changes in power stroke are independent of occlusal development in pigs but may relate to muscle vectors. Muscle anatomy both causes and reflects jaw movement. Muscles (or parts of muscles) may be mostly rotatory (open/ close) or mostly translatory (anterior/posterior or medial/ lateral). The relative importance of upward, medial, and anterior components in the power stroke is associated with startlingly different muscle anatomy. Thus, we can explain why the lateral pterygoid is small and unimportant in carnivorans such as cats and ferrets but huge in humans, and why the masseter of rodents is specialised and subdivided. There are some surprises. Parts of the medial pterygoid and/or masseter in several species open the jaw rather than closing it, raising some interesting questions about neural circuitry .Most mammalswith transverse masticatory excursions use a combination of muscles referred to as either ‘‘couples’’‘triplets’’ consisting of the superficial masseter and medial pterygoid of one side and the temporalis of the opposite side, with the jaw moving toward the temporalis side. This reflects the fact that the temporalis-side condyle moves posteriorly relative to the masseter-side condyle, i.e. the movement is a rotation.

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The deep masseter, which typically has a posterior vector, usually acts with the temporalis rather than the superficial masseter ‘‘zygomaticomandibularis’’ and is often called.

Muscles, mastication and the biomechanics of the skull Masticatory muscles, through their direct action on bony attachments and their indirect action in loading the teeth and the jaw joints, constitute the major biomechanical challenge to the skull. Direct effects of a muscle attachment are sensitive to the particular muscles used and to the pattern of muscle coordination. For example, the temporalis and masseter twist the pig braincase in opposite directions, and because these muscles usually act in opposite-side ‘‘couples’’, the effect is exaggerated rather than cancelled. Indirect effects depend on global features such as total muscle force and the particular teeth in occlusion. With regard to total muscle force, the point is simply that the muscles collide the mandible with the upper jaw and thus engender reaction forces at points of contact, specifically the teeth and the TMJs. The former is occlusal force, and its major influence on the skull is to shear the maxilla upward and the mandible downward. The reaction force on the TMJs arises from lever mechanics and the fact that the resultant muscle force rarely if ever passes through the bite point. Depending on the particular species, however, it is clear that there are major differences in the geometry of the muscle resultant and hence the relative magnitude of the TMJ reaction load. For deformation of the skull, an important determination is whether occlusion is unilateral or bilateral. Many mammals have

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jaws so anisognathous that only one side at a time can be in molar occlusion. Strain gage readings from the mandible and braincase are highly asymmetrical during chewing in such animals. For example, working and balancing mandibular bodies show opposite directions of bending because of the influence of the unilateral bite point. Other groups, including many rodents, pigs, and higher primates, have some probability of occlusal contact occurring on the balancing side, and may even have a bilateral bolus and true bilateral chewing. Thus, in pigs, mandibular and maxillary strains are identical on the working and balancing sides. In fact, the only part of the pig skull that strains differently depending on the side of chewing is the premaxillary, because incisor occlusion, unlike molar occlusion, is one-sided. Like occlusal force, TMJ loads are reactions to muscle pull. The balance between occlusal and joint force is a product of muscle anatomy and contraction pattern. In pigs, with bilateral occlusion and similar magnitudes of EMG on the two sides, bone strains at the TMJ are symmetrical. In contrast, mammals with anisognathous occlusion are expected to have heavier loading on the balancing side. A final location of interest is the mandibular symphysis. An unfused symphysis is the primitive condition and can act either as a facilitator of unilateral occlusion or as the means by which a bilateral occlusion can be maintained throughout the duration of the power stroke. Symphyseal fusion has been independently acquired in a number of lineages, including that leading to humans, and is associated with the timing and level of recruitment of the balancing side muscles. Like higher primates, pigs have strong recruitment of balancing side muscles as part of the force couple mechanism for moving the

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mandible laterally. The pig symphysis begins to ossify at about the time ofcomplete weaning. Strains recorded from the unfused symphysis are large, generally similar in magnitude to those from unfused sutures. After fusion begins,strain magnitudes drop to the same level as typically seen for solid bones. During jaw opening the pattern of deformation is generally consistent with medial transverse bending, which has also been reported in macaques and humans. This deformation is attributed to the medial pull of the lateral pterygoid muscles. However, during closing the pattern of strain reveals a tendency of themandibular bodies to rotate around their long axes. This may be a direct effect of muscle contraction, particularly the rotational forces arising from the masseter.

How does the masticatory system cope with loss of a muscle?

The choreographed interplay within and between the complicated masticatory muscles focuses attention on whether, and how, mastication would be changed if one muscle or even just one muscle compartment were incapacitated. This question might seem arcane, because most neuromuscular diseases attack indiscriminately and would not target single muscles. However, it is increasingly common these days for patients to have single muscles paralysed, not only for therapeutic, but also for cosmetic reasons. To some extent, the answer depends onwhich muscle and species. The loss of one masseter may be less of a problem for those taxa in which the inclined planes of the teeth guide the power stroke (suchas rabbits) than for those that depend on muscle choreography (such as pigs). In order to maintain occlusal force, however, all species should increase the

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recruitment level of synergists. Muscle weights suggest that the unparalysed masseter in rabbits hypertrophies. The short-term pig experiment showed tha tthe masseter's synergists for transverse movements, the ipsilateral pterygoids and the contralateral temporalis, were overactive, a prelude to hypertrophy.

It is also likely that such changes in muscle usage would alter skull loading. Both the masseter and medial pterygoid create similar strain magnitudes on the pig mandibular condyle, but the orientation of strain is unique for each muscle. Therefore, if one masseter were incapacitated, total joint load would not only be reduced, but also re-oriented. If such conditions were long maintained, as for example with botulinum toxin, bony adaptations would be likely. The growing rabbits in the study by Matic developed smaller condyles on the paralysed side, presumably because of decreased loading. Preliminary data on adult rabbits suggest that bone strain in the condyle is indeed reduced by paralysis of the ipsilateral masseter, and that this unloading leads to massive bone loss in the condyle.

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Our goal in preparing this review has been to highlight the classification, embryonic origin, differentiation and myogenesis, as well as the role of craniofacial muscles in growth of the craniofacial skeleton. The relationship of various craniofacial muscles in different growth patterns and it effect on orthodontic treatment has also been discussed.

The induction, differentiation, and morphogenesis of craniofacial muscles is a fertile and relatively untouched area for multifaceted experimentation with acascades of signaling cascades and regulatory genes that specify each group of craniofacial muscles. Various regulatory factors like Myf5, MyoD, Pax3, Pax7, Pitx2, Tbx1, Musculin and Tcf21 play a vital role in craniofacial muscle embryogenesis and morphogenesis. The challenges that lie ahead will be to precisely the signals that regulate the dynamic developmental processes underlying the specification, migration and differentiation of the different myogenic lineages in the head.

The relationship between the mandibular muscles and craniofacial morphology would seem to confirm the ever-present but still elusive relationship between form and function. A general consensus of the studies on the relationship between mandibular muscles and head dimensions is that subjects with strong or thick mandibular muscles have wider transverse craniofacial dimensions. In addition, tendencies toward parallelism between the jaw bases and between the occlusal and mandibular lines, as well as small gonial angles and smaller lower anterior facial height have also been noted. Although it is widely accepted that

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dolichofacial patients have relatively weak mandibular muscles compared with brachyfacials, it is still not known whether the strength of the mandibular musclesdetermines craniofacial morphology or vice versa. Bite-force differences between brachyfacial and dolichofacial subjects have been claimed to be related to the strength or the mechanical advantage of the mandibular muscles.

The effects of the mandibular muscles associated with different types of tooth movements should be considered during orthodontic treatment planning. The choice of treatment mechanics, the timing of treatment, and any extraction decision might well be quite different for different underlying vertical patterns, even for the management of similar occlusions. Subjects at either extreme of the vertical facial spectrum are likely to pose the greatest challenges to the orthodontist during treatment.

It was found that there was no significant effect of the masticatory hypofunction on the cranial growth and development in the growing rats but that masticatory hypofunction affected the growth and development of the maxillofacial skeleton. The regions where statistically significant changes were found because of masticatory hypofunction are as follows: total skull length, total anterior face height, lower anterior face height, ramus mandibular height, corpus mandibular height, premaxillary length, and maxillary width were reduced, but foramen incisivum width was increased.

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Muscle action and skull biomechanics are inextricably intertwined. In the evolutionary sense, the muscles of mastication are co-adapted with dental morphology and jaw movements to produce species-specific chewing patterns. In

the physiological sense, masticatory muscles comprise the major loading on theskull, influencing its growth and controlling its strength.

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Craniofacial growth has been of keen interest to anatomist,physiologist,endocrinologist,orthodontist, physician and many more. This book is a summary of various theories of craniofacial growth which includes Genetic theory, Sutural theory, Cartilagenous theory, Functional matrix theory, van Limborgs theory and Servosystem theory. No single theory is acceptable and a combination of all these theories help in better understanding of the complex nature of craniofacial growth and development.

Dr Alok Ranjan, currently Assistant Professor at Bharati Vidyapeeth Dental College, Pune has completed his Masters in Dental Surgery, Orthodontics in 2019. He has a keen interest in publications and research and has numerous publications to his credit.

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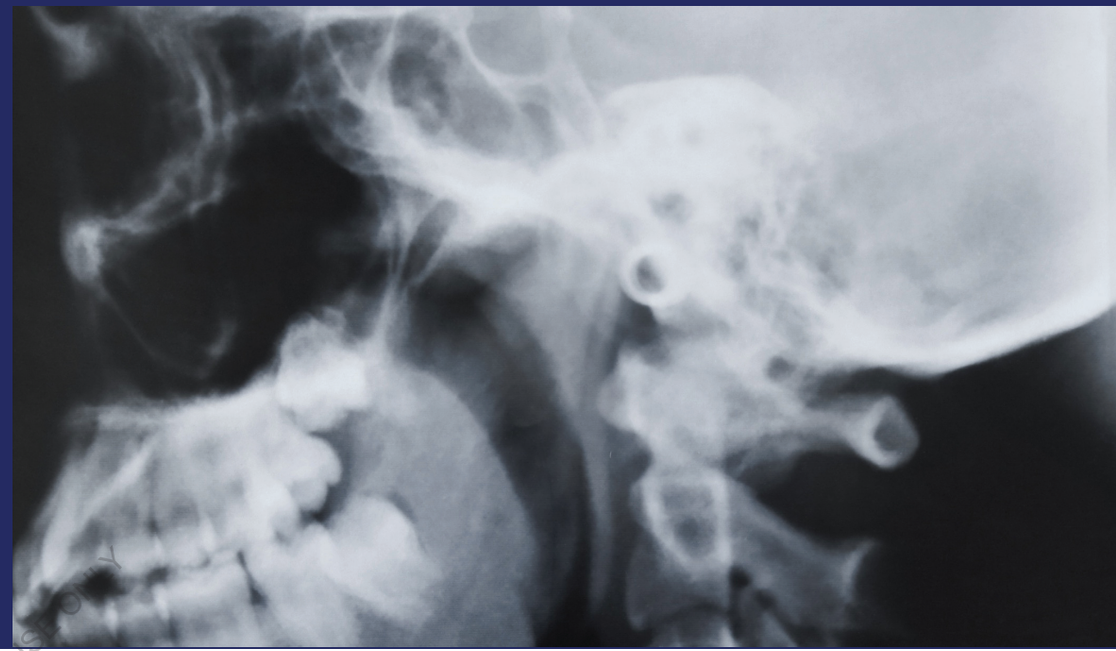

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Introduction

Conceptual terms Growth, Development, Maturation are synonymously used sometimes but they actually mean different.

Growth may be defined as the normal changes in the amount of the living substance. Growth is quantitative aspect of biologic development and is measured in units of increase per unit of time. Growth is the result of biologic processes by means of which living matter normally gets larger. It may be the direct result of cell division or the indirect product of biologic activity, for example bones and teeth.

We equate growth with enlargement, but there are instances in which growth result in a normal decrease in size, for example the thymus gland after puberty. Growth emphasizes the normal dimensional changes during development. Growth may result in increase or decrease in size, change in form or proportion, complexity, texture.

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Growth and development indispensable in orthodontics and dentofacial orthopedics because

- A conscientious practitioner should be able to manipulate facial growth for the benefit of the patient.
- It is important first to understand what is normal variation, and then the pathologic process.
- To understand the development of conditions observed in adults.

Definitions

Growth

According to **Meredith:**

Growth is the entire series of sequential anatomic and physiologic changes taking place from the beginning of prenatal life to the close of senility.

According to **Krogman:**

Growth is the increase in size, change in proportion and progressive complexity.

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According to **Huxley:**

Growth may be defined as the self multiplication of living substance.

According to **Moss:**

Change in any morphological parameter which is measurable.

According to **Moyers:**

Quantitative aspect of biological development per unit of time.

According to **Todd:**

Growth is increase in size of an organism.

According to **Salzmann:**

Growth is a physio – chemical process by which an organism becomes larger.

According to **Scott:**
Growth is three fold process in which cell multiplication, differentiation and organization takes place

According to **Webster:**
Growth is defined as progressive development (i.e. evolution, emergence, increase, or expansion)

Development

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According to **TODD:**
Development means progress towards maturity.

According to **MOYERS:**
All the naturally occurring unidirectional changes in the life of an individual from its existence as a single cell to its elaboration as a multifunctional unit terminating in death.

According to **PROFIT:**
Development connotes an increase degree of organization, often with unfortunate consequences for the natural environment.

According to **WEBSTER:**
Development is defined as going through natural growth, differentiation or evolution by successive changes.

According to **ENLOW:**

Facial growth and development is a morphogenic process working towards a composite state of aggregate structural and functional balance among all of the multiple, regional growing and changing hard and soft tissue parts.

Maturation

According to **MOYERS:**

Maturation means ripening the stabilization of adult state brought about by growth and development.

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According to **WEBSTER:**

Emergence of personal characteristics and behavioral phenomena through growth process.

The changes associated with ageing that is degeneration and senility is considered some as a part of maturation, while other consider it as a part of development. Still other considers these changes as a part of development and maturation.

Conclusion

Growth is largely an anatomic phenomena, whereas, development is physiological and behavioral.

Development is increased specialization at the loss of potential.

Basic Tenets of Growth

Pattern:

It reflects proportionality, usually of a complex set of proportions and change in these proportional relationships over time. In other words, the physical arrangement of the human body at any one time is a pattern of specially proportioned parts. Important aspect of pattern is its predictability i.e pattern repeats. The only difference between the geometric pattern and growth pattern is time dimension.

Cephalo-caudal gradient:

This simply means, there is an axis of increased growth extending from the head towards the feet.

Fig. 1

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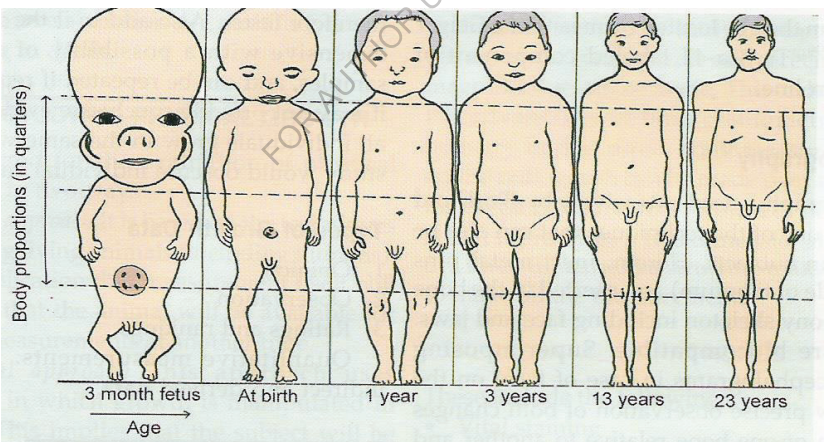
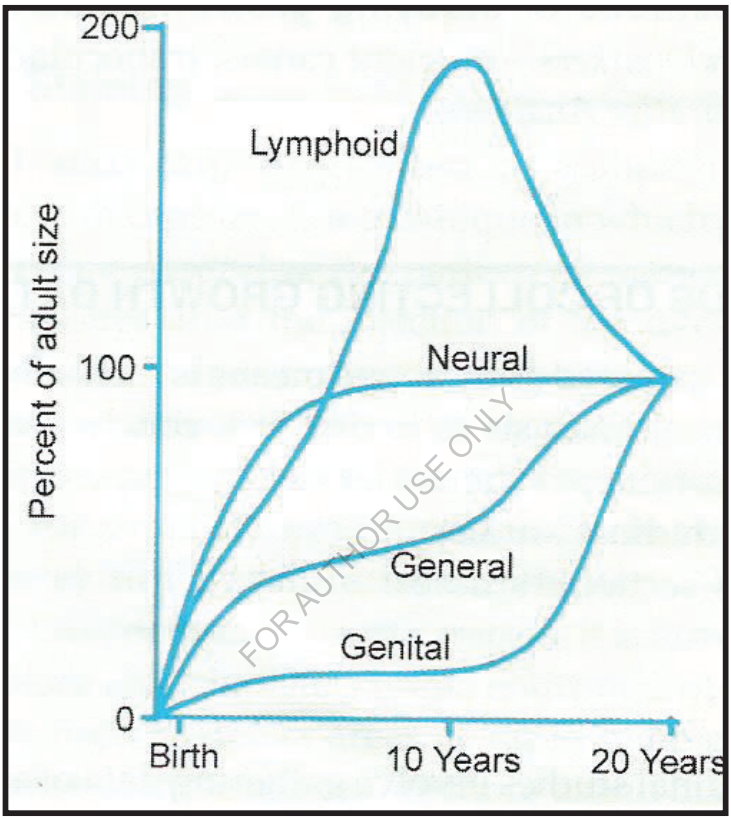


Scammon's Growth Curve:

Fig. 2



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The neurocranium follows the neural curve of growth. The lower face or splanchnocranium approximates the general or bodily growth curve. Thus for a particular age there is a difference in the total growth accomplished. By differential growth, the face emerges from beneath the cranium. The upper face under the cranial base influence moves upwards and forwards and the lower face moves forwards and downwards on an

expanding “V” principle. This divergent pattern permits vertical growth through tooth eruption and alveolar bone growth.

Table 1

Years	Cranium	Upper face	Lower face
o-5	85%	45%	35%
5-10	96%	65%	40%
10-20	Total	Total	65%

Significance of Scammon’s growth curve:

-Neural tissue grows early indicating neurotrophism or inductive influence of neural tissues on other tissues.

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-Negative growth shown by lymphoid tissue indicating regression of lymph organs after age of 10 years.

-‘s’ shaped general curve indicating change in velocity of growth.

-Steep increase in genital curve indicating puberty and maturation.

Variability

It can be difficult, but clinically very important, to decide whether an individual is merely at the extreme of normal variation or falls outside the normal range. It is important to express variability quantitatively. One way to do this is to evaluate a given child relative to peers on a standard growth chart. Variability may be because of illness or timings.

Timings

The biologic clocks of different individuals are set differently. Variation in timings arises because the same event happens for different individuals at different times.

Growth does not take place at the same rate through out life that is not at all times systems of body grow at same rate. There are certain periods when there is sudden acceleration of growth due to activation of more growth center. This sudden acceleration of growth is called as growth spurt.

All children undergo a spurt of growth at adolescence but the growth spurt occurs at different times in different individuals.

Classification of growth spurt:

PRENATAL:

In Prenatal life growth spurts occurs just before birth.

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POSTNATAL:

First peak: Greatest increment of growth occurs during third year age level.

Second peak: Pre pubertal, which is many times 6-7 years in female, 7-9 years in male.

Third peak: Pubertal, this is variable 10-12 years in female, 13-15 years in male. It occurs earlier and fro shorter duration in females but in boys it occurs at later age and is of long duration.

Growth spurt at adolescence can be seen more clearly by plotting a curve indicating change in height or weight and the resultant curve obtained is called as distance curve and acceleration and deceleration of the rate in the growth is indicated by velocity curve.

Girls Duration 3.5 years

Stage 1 Beginning of adolescent growth.	Appearance of breast buds, initial pubic hair.
Stage 2 Peak height in velocity (about 12 months later)	Noticeable breast development, axillary hair, more abundant pubic hair
Stage 3 Growth Spurt ending (12-18 months later)	Menses, broadening of hips with adult fat distribution, breasts completed

Boys Duration – 5 years

Stage 1 Beginning of adolescent growth	"Fat Spurt" weight gain, Feminine fat distribution
Stage 2 Height Spurt beginning (about 12 months later)	Redistribution in fat, pubic hair, growth of penis.
Stage 3 Peak velocity in height (8-12 months later)	Facial hair appears on upper lip only, axillary hair, muscular growth with harder and more angular body form
Stage 4 Growth Spurt ending (15-24 months later)	Facial hair on chin and lip, adult distribution of pubic and axillary hair, adult body form

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SIGNIFICANCE OF GROWTH SPURTS

Malocclusion can be treated during growth spurts taking advantage of active growth period. Arch expansion and rapid maxillary can be undertaken during period of maximum growth.

Malocclusion requiring surgical correction is to be undertaken after growth spurt is complete.

Growth modification of jaws can be done during growth spurts.

Before growth spurts are seen dental corrections can be undertaken by use of myofunctional appliances.

Growth spurts are obvious for orthopedic correction of maxillomandibular mal-relationship.

Growth spurt period is the best time for interceptive orthodontic treatment e.g. Treatment of class 2 malocclusion using activator therapy. Treatment of class 3 malocclusion using headgears.

Very few girls show mixed dentition growth spurts. Thus mixed dentition jaw changes are more likely to succeed in boys.

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Different kinds of growth that can be identified

- Size change
- Positional change
- Proportional change
- Functional change
- Maturational change
- Compositional change

STRUCTURE	FETUS	NEWBORN	ADULT
Skin & Fat	16%	26%	25%
Viscera	16%	16%	11%
Nervous System	21%	15%	03%
Muscle	25%	25%	43%
Skeleton	22%	18%	18%

During post-natal growth, there is 17% decrease in total body water. Protein & Fat both increase by about 40%. Minerals increase by nearly 250%.

- Timing and sequential change
- Physiological change

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Types of Growth

Cellular Types:

- Hyperplasia
- Hypertrophy
- Increase in intercellular matrix

Soft – Tissue Growth

- Interstitial growth: Process go on everywhere within the tissue, Combination of hyperplasia and hypertrophy. Secretion of extra cellular material can also accompany interstitial growth but hyperplasia primarily and hypertrophy secondarily are its characteristics.

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Skeletal growth

- Direct / surface apposition: Formation of new cells occurs in periosteum, and extra-cellular material secreted there is mineralized and becomes new bone.
- Interstitial growth:is a prominent aspect of overall skeletal growth because a major portion of skeletal system is originally molded in cartilage. Hypertrophy occurs in number of special circumstances but is a less important mechanism than hyperplasia in most instances.

Histological growth

Characteristics	Cartilage (endochondral)	Bone (intramembranous)
Calcification	Non calcified	Calcified
Vascularity	Non vascular	Vascular

Surface membrane	Non essential	Essential
Rigidity	Flexible	Inflexible
Pressure resistance	Tolerant to pressure	Sensitive to pressure

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Terminologies related to growth

Growth fields:

The outer and inner surfaces of bones are blanked by mosaic like pattern of soft tissue, cartilage or periosteum.

Growth field is responsible for bone enlargement and consists of remodeling and displacement.

Growth Site

Some growth fields have traditionally been signaled out for special attention. These special growth sites include the sutures of face and cranium, maxillary tuberosity, and alveolar bone. This site does not carry out the entire growth process but all other inner and outer surfaces of given bone also actively participate in the overall growth.

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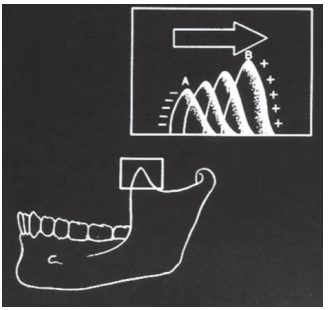
Growth Centre

Growth center having intrinsic growth potential, tissue separating force, and essentially endochondral in type Baume. Zone of growing cartilage that expands by swelling in particular plane are spoken of as dissuasion fields Baume1957. Cartilage by the virtue of its interstitial growth, turgidity and resistance to deforming forces can separate growing bone at sutures just as brain or eye ball can scott,1967 This growth centre concept has come into disfavor however, because it is now believed that such centers do not control the growth process, as they are not master centers.

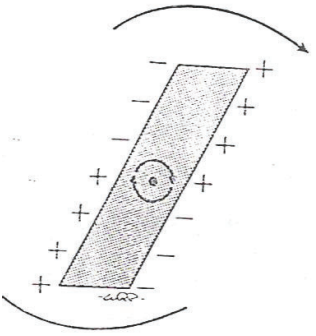
No part is developmentally independent and self contained; this is a fundamental and very important principle of growth -Enlow.

Growth Remodeling

Differential Growth activity involving simultaneous deposition (+) and resorption (-) of all inner and outer surfaces of bone.



Rotational Remodeling



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Types of Remodeling

- Biochemical Remodeling
- Secondary reconstruction of bone by haversian system

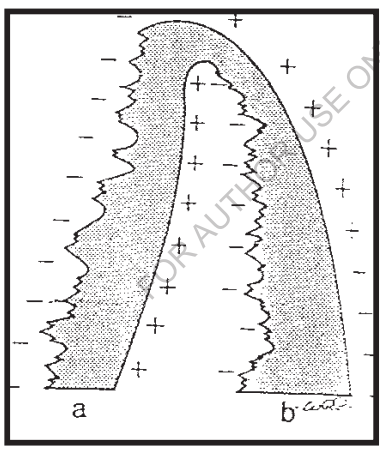
- Remodeling following disease and trauma
- Growth Remodeling

Growth movements

Growth movement occurring towards depository surface by combination of deposition and resorption. About half the total amount of cortical bone tissue is of endosteal origin and about half of periosteal origin.

Primary displacement:

The process of physical carry takes place in conjunction with bones own enlargement. The respective direction of growth and movement is always opposite.



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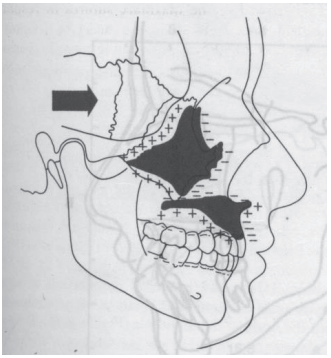
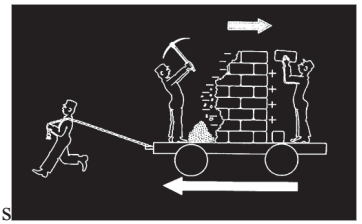
Secondary Displacement:

In secondary displacement the movement of the bone is not directly related to its own enlargement.

"Domino" effect – growth changes get passed on from region to region to produce secondary effect in areas quite distant. Such changes are cumulative.





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Although these growth movements are carried out by osteogenic membranes and cartilages, the bone contributes feedback information to them so that when size, shape, biochemical properties, and so forth, of the bone comes into equilibrium with functional requirements the histogenic activity then becomes turned off. - Enlow

Relocation

The relocation function of remodeling. Remodeling is the process of reshaping and resizing each level within a growing bone as it is relocated sequentially into a succession of new levels. E.g. Nasal floor & Mandibular ramus.

Methods of growth assessment

I)Direct:

Measure mental Approach (Craniometry, Anthropometry)

Experimental Approach (Vital Staining, Implant studies, Histological Studies, Histochemical studies)

II)Indirect:

Measure mental Approach (Serial cephalometry, Impression casts, photographs Serial radiographs & Implants)

Experimental Approach (Radioautograph)

a) MEASUREMENTAL APPROACHES:

Are based on techniques for measuring living animals including humans with the implication that the measurement itself does no harm and that the animal be available for additional measurements at another time.

b) EXPERIMENTAL APPROACHES:

Uses experiments in which growth is studied in more detail but it may be destructive so such experimental studies prefer to restrict non human species.

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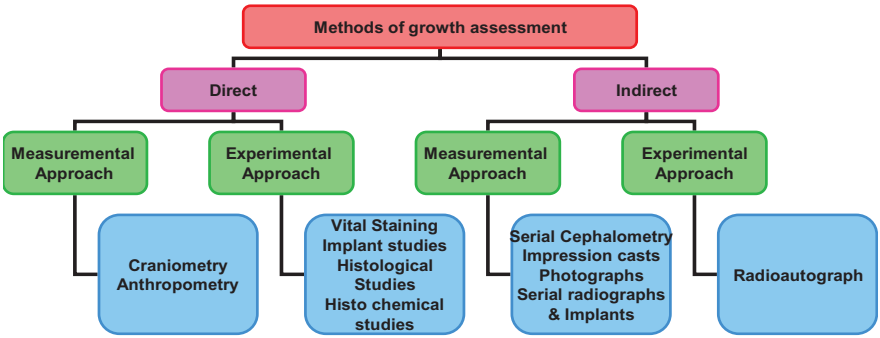

-Dixon

Other methods

- Digital subtraction radiography.
- Computerized tomography.
- Magnetic resonance imaging.
- Sonic interferometry.

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Newer method:

- Bi-orthogonal grids elliptical Fourier function and finite element.

1) CRANIOMETRY:

This is based measurements of skull found among human skeleton remains. It was originally used to study the skull of Neanderthal and Cro-Magnon people. Growth pattern is ascertained by comparing one skull to another. ADVANTAGE: Precise measurements can be made on dry skull.

DISADVANTAGE: All these growths must be cross-sectional means that all though different are represented in population; same individual can be measured at only point in time.

II) ANTHROPOMETRY:

By anthropometry, it is possible to measure skeletal dimension on living organism. Various landmarks established in studies of dry skulls are measured in living individuals by using soft tissue points overlying these bony landmarks.

ADVANTAGE:

It is possible to follow up the growth of an individual directly, making the same measurements repeatedly at different times. This gives longitudinal data that is repeated measurements on the same individual.

DISADVANTAGE:

The result would be different because of soft tissue thickness overlying the landmarks.

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III) CEPHALOMETRIC RADIOLOGY:

Introduced by Broadbent in the United States and Hoffrath in Germany in 1931. This technique depends on precisely orienting the head before radiograph is made with precisely controlled magnification.

ADVANTAGE:

This approach can combine the advantages of Craniometry and Anthropometry. It allows a direct measurement of bony skeletal dimensions,

since bone through seen through the soft tissue covering in the radiograph and it also allows the same individual to be followed over time.

DISADVANTAGE:

It produces a two dimensional representation of a three dimensional structure, so even with precise head positioning, not all the measurements are possible. But this can be overcome by making more than one radiograph at different orientation and using different angulations to calculate oblique distances.

Cephalometry has made possible standardization of the serial studies of living growing craniofacial skeleton and associated features used for the study of facial growth, orthodontic diagnosis, treatment planning and assessment of therapeutic results.

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IV) VITAL STAINING:

Belchier in 1736 reported that bones of animal which have been eaten the matter plant were stained red colored. John Hunter in 18th century discovered that the active agent was a dye called alizarin. Alizarin reacts strongly with calcium at sites where bone calcification is occurring and thus marks the location where active growth was occurring.

Dyes used are:

- Alizarin red 5
- Acid Alizarin blue
- Trypon blue
- Tetracycline
- Lead acetate
- Procion dyes
- Fluorocrom

- Sodium fluoride

Tetracycline used as vital bone marker. It binds to calcium at the growth sites. The major disadvantage of Tetracycline is the discoloration of teeth. Lines formed by vital dyes become colored as a subsequent bone growth occurs. Vital dyes stain only that bone which is actively being laid down during the period in which the dye is in the blood stream. Thus the thin colored line on the bone is seen and subsequently formed bone deposits are not colored.

ADVANTAGES:

This method of studying bone growth reveals the manner in which bone is laid down, the sites of growth, the direction of growth and relative duration at different sites and timings of growth.

DISADVANTAGES:

It does not provide direct evidence of bone resorption.

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V) RADIOISOTOPES:

Radioisotopes of certain elements or compounds often are used as in vivo markers for studying bone growth; such labeled material is injected and then after a time, located within the growing bones by means of Geiger counters by the use of auto radiographic techniques. In auto radiographic techniques, the bones or sections of bones are placed against photographic emulsions that are exposed by emission of radioactive substance.

Radioisotopes used are:

- Calcium 45
- Phosphorous 32
- Technetium 33

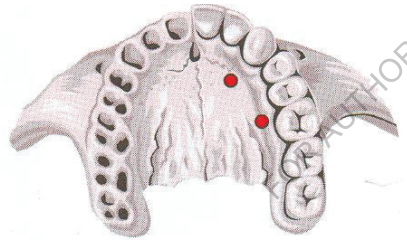
VI) IMPLANTS:

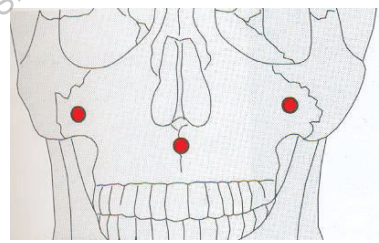
Bjork has devised an ingenious method of implanting tiny bits of Tantalum into growing bones of animal or human being. These serve as reference markers during serial cephalometric analysis and allow precise observations of both changes in the position of one bone related to another and change in the external contour of individual bones.

Following are sites for implantation:

In Maxilla:

- Hard palate behind deciduous canine.
- Below anterior nasal spine.
- Two implants on either side of zygomatic process of maxilla.
- Border between hard palate and alveolar process medial to 1st molar.





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In Mandible:

- Midline below root tips.
- Two pins on either side of mandibular body, one pin below 1st premolar and other below 2nd premolar.
- On the ramus in level with occlusal surface of molars.

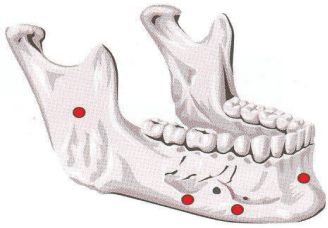

Table 6.2 Approximate Information Obtained from Various Methods Used to Study Postnatal Bone Growth

Method	Growth				Type of Study	Limitations
	Site	Amount	Rate	Direction		
Direct Measurements						
Osteometry						
Skeletal remains – craniometry	0	X	X	X	Cross-sectional	Material of unknown history, posthumous distortion
Living – Anthropometry	0	X	X	X	Longitudinal	Soft tissues restrict accurate measurement
Vital Staining[1]	XXX	XXX	XX	X	Longitudinal	Toxicity, method requires refinement
Implant markers[1,2]	XX	XXX	X	X	Longitudinal	Local reaction to implants, requires reoperation
Histological and histochemical methods	XXXX	X	0	X	Cross-sectional	Sections show conditions at time of death of tissue only
Indirect Measurements						
Impressions and casts	0	XX	XX	XX	Longitudinal	Soft tissues restrict accuracy of impression
Photographs	0	X	X	X	Longitudinal	Two-dimensional study of three dimensional process
Serial radiography	0	XXX	XX	XX	Longitudinal	Must obtain stable landmarks, three-dimensional information not entirely accurate, radiation exposure
Measurements in Combination						
Serial radiography and implantation[1,2]	XXX	XXX	XXX	XXX	Longitudinal	Three-dimensional information not entirely accurate, radiation exposure
Serial radiography and metaphyseal bands[3]	XXX	XXX	XXX	XXX	Longitudinal	Record of a toxic process, rate of growth not normal, radiation exposure
Radioautographs	XXX	0	0	0	Cross-sectional	Primarily of qualitative value

Note: 0, Gives no information; X, shows trends; XX, relatively accurate; XXX, grossly accurate; XXXX, microscopically accurate. Can be used to measure:

[1] sutural growth
[2] apposition and resorption
[3] endochondral growth

Modified from Sarnat, BG and Gans, BJ, *Plast. Reconstr. Surg.*, 9, 1952, 152. With permission.

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Types of Growth Data

- Opinion: at the best it is the cleaver guess based on experience. It is crudest form of scientific knowledge. They should be always being designated for what they are – one persons biased guess.
- Observations: useful in studying "all or non law". Used in limited way when quantification of data is not possible.
- Rating and ranking: data difficult to quantify and thus compared to conventional rating scales.
- Quantitative measurements: minimum mis-understanding and permits testing of hypothesis by other workers.

  Direct: measurements on living persons by means of measuring devices.

Indirect: measurements taken from images or reproduction of the actual persons. Eg.cast, photocopy.

Derived: comparison of at least two other measurements.

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Growth Data Collection

Cross Sectional / Prevalence Studies

- Simplest form of observational study.
- Single examination of cross section of population at one point in time.
- Results can project whole population provided sampling has been correct.
- But, average tends to obscure individual variation
- Usually for chronic diseases

Longitudinal Studies

- Repeated observations in the same population over a prolonged period of time, difficult to organize, time consuming, risk of losing subjects.
- Valuable information than the cross sectional studies
- Useful to study natural history of disease, future outcome, risk factors, and incidence.

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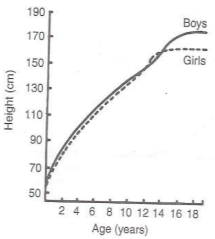
Semi Longitudinal Studies

- It is a combination of cross sectional and longitudinal types.
- Subjects at different age levels are seen longitudinally for shorter periods.

Graphic Interpretation of Growth Data

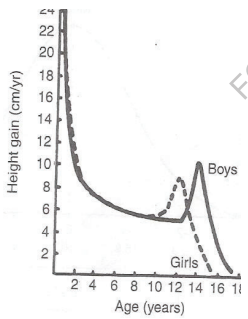
Distant curve/cumulative curve –

- Data can be derived from cross – sectional and longitudinal studies indicates distance a child has traveled along the growth path.



Velocity Curve/Incremental curve –

- Rate of growth of child is indicative that data is derived from longitudinal studies.



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Factors Affecting Growth

- Heredity
- Evolution
- Nutrition
- Illness
- Race(ethnic)
- Family size and birth orders
- Secular trends
- Circadian and seasonal effects
- Psychological disturbances
- Hormones
- Teratogens
- Neuromuscular functions
- Masticatory function
- Orthodontic treatment

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Heredity

- Progeny resembles one or both parents is often apparent.
- The primary basis for the similarity of MZ twins is genetic.
- These are probably primary control for initiation and formation.
- There are structural, modifier(regulator), oncogenes, orthogenes, pseudogenes, provirus genes and so on.
- Copy of all the genes is present in every cell but only the parts needed are used by that cell. (Beardsley,1988)
- Regulatory genes - homeotic genes
- Homeoboxes - short sequence of DNA

- Homeotic - like genes -Slavkin.
- Control hierarchy -Beardsley.
- Local feed back and intercommunication
  -adhesion molecules
  -humoral chemicals
  -gap junctions
- Genes for the muscles have a modifying effect on the bone.
- Thus what is environmental to the bone is genetic to the muscle.
- The correlation between upper and lower tooth size is 0.8 - Moorrees and Reed,1964

Conclusion

- Craniofacial growth have polygenic inheritance, continuous distribution of variable and it is agreed that environment changes all size components, at least in face.
- Parent can explain only 25% of size variation in faces of progeny.
- Even if mandibular size is inherited in the mendelian fashion, it is masked by environmental influence.

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Evolution

- Verticalization and cerabralization.
- Enormous enlargement of the brain have caused a "flexure" of human cranial base.
- Changes in the eye position.
- Rotation of the olfactory bulb and the nasomaxillary complex.
- Rectangular maxilla than the triangular in other mammalians.

- Control of the blood flow in the dermis, combined with sweat gland activity, provide equivalent for nasal thermoregulation.
- Evolutionary pressure on third molars-this is not the way evolution works, you have to die because of third molars before reproducing for there to be any evolutionary pressure.
- Evidence suggest that, within limits we have larger jaws than our ancestors 200 years ago. Teeth are getting larger.

-Garn et al, 1968.

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Nutrition

- Nutritional deprivation in utero may result in permanent retardation of growth.
- Significant Nutritional deprivation at the puberty exerts similar growth retardation effect.
- Nutritional deprivation at the other times in childhood dose not produce permanent impair linear growth potential.("catch up")
- Protein rich diet delays the onset of sexual maturity.
- Nine essential amino acids for growth.
- Calcium, phosphorous, magnesium and fluoride are essential for bones and teeth.
- Iron for hemoglobin.
- Vitamin A controls activity of both osteoblast and osteoclast.
- Vitamin C necessary for bone & connective tissue growth.
- Vitamin D for normal bone growth.

- Oxygen is also essential component of the normal growth.

Chronic Illness

- Skeletal growth occurs when all other body requirements have been met.
- Chronic illness alters this balance, leaving less of total energy available to support growth.
- Chronically ill patient fall behind that of the normal child in growth. Effect is cumulative.
- Females compensate better than the male following illness.
- Hormonal changes are responsible for growth changes observed in chronically ill patient.

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Race (ethnicity)

- No race represents a single, homologous grouping, but, rather a composite assemblage of many geographically, environmentally, and morphologically diverse subgroups.
- White people have convex profile, Blacks have bimaxillary prognathic or concave profile, and Indians are in between these two.

Family size and Birth orders

- First born babies have less weight, small stature but high IQ.
- Smaller the family better would be nutrition & other conditions.

Secular Trends

It is any change in size shape or timing that is consistent in direction over several generation or successive period of time –Garn1987

- Increased growth velocity.
- Increased final adult height.
- Earlier maturation.
- Causes:-improved nutrition

-improved health status

-decreased mortality

- Out breeding seems to be the most commonly mentioned genetic factor.
- Heterosis - demographic changes had an effect on stature by genetic phenomena.

-Tanner1978.

Males have broader faces and females have longer faces.

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Circadian and Seasonal variation

- Growth in height faster in spring.
- Growth in weight faster in autumn.
- Seasonal variations have shown to affect adipose tissue content and weight gain in new born.
- Growth in height and eruption of teeth is greater at night because of hormonal changes.

Psychological disturbances

- Maternal deprivation syndrome
- Cultural factors-psychological abuse.

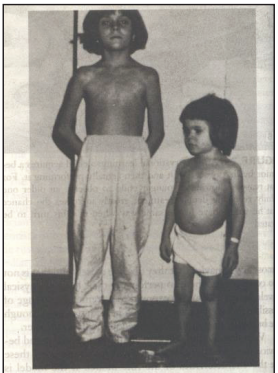

FIGURE 2-49 Both these girls are 7 years old. The one on left is normal, whereas the one on the right had extreme emotio neglect from a mother who rejected her. The effect on physi growth in this "maternal deprivation syndrome" is obvious; for nately, this condition is rare. The emotional response probl affects physical growth by altering hormone production, but mechanism is not fully understood. (Courtesy Dr. F. Debusk.)

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Hormones

Prenatal hormones:

- Chorionic somatotropine
- Fetal insulin: permissive action on growth hormone and increased affinity of fetal cells.
- Growth hormone.
- Somatomedins: actual mechanism of action of growth hormones through SM-A, SM-C and IGF I,II.
- Thyroid hormones: early extra uterine central nervous system development, normal linear growth and sexual development.
- Sex steroids
- Prolactin

Post natal growth:

- Somatotropines:alters the DNA, RNA synthesis &leading to increased production of proteins.
- Sex steroids : osseous maturation

Teratogens affecting Dentofacial development:

- Agent capable of producing embryological defect if given at critical time. Teratogens in first trimester leads to abortion mostly, in second trimester leads to organogenesis defect and in third trimester leads to the growth defect like hypoplasia.

TERATOGENS	EFFECT
Aminopterine	Anencephaly
Aspirine	Cleft lip & palate
Cigarette (hypoxia)	Cleft lip & palate
CMV	Microcephaly, Hydrocephaly, Micro-opthalmia
Dilantin	Cleft lip & palate
Ethyl alcohol	Central mid face deficiency
6-mercaptoupurine	Cleft palate
13-cis Retinoic acid	Hemi facial microsomia

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Rubella virus	Micropthalmia, cataracts, deafness
Thalidomide	Hemifacial microsomia, treacher collin syndrome
Toxoplasma	Microcephaly,hydrocephaly,micropthalmia
X-radiation	Microcephaly
Valium	Cleft lip & palate
Vitamin-d excess	Premature suture closure

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Neuromuscular functions

- Swallowing (congenital unconditional reflexes)
- Breathing (congenital unconditional reflexes)
- Speech (congenital unconditional reflexes)
- Conditional reflexes

Masticatory function

- Craniofacial growth is a dynamic phenomena whose structural-functional significance at any given time is transient expression of past and future as well as present condition
- Masticatory muscle - masseter

- temporalis
- medial pterygoid
- lateral pterygoid

Control Process in Facial Growth and Development or Theories of Growth Control

Introduction:

Since a major part of the need for orthodontic treatment is created by disproportionate growth of the jaws, it is necessary to determine how skeletal growth is and dentofacial deformity. However, exactly what determines the growth of jaw remains unclear and is the subject of intensive research. Through the year's no. of theories have been put forward to explain the determinant of craniofacial growth.

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The various theories of growth are listed below.

- Genetic Theory
- Sutural Dominance Theory
- Cartilaginous Theory
- Functional Matrix Theory
- Von Limborg's Theory
- Counterpart Theory
- Enlows Expanding V Principle

CONCEPT OF BIOMECHANICAL EQUILIBRIUM:

- Growing muscles exceeds the capacity of the bone to support it, and osteoblasts are thereby triggered to form the new bone in response. When muscle and overall body growth is complete, the bones attain biomechanical equilibrium with the muscle.But growth control is more complex than this explanation.

Wolf's law in 1899:

- "bone grows and develops in such a manner that composite of physiologic forces exerted on it are accommodated by the bones developmental process, thereby adapting its structure to its complex of functions."
- No explanation of the forces acting on the osteogenic connective tissue that actually remodels the bone.

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Genetic theory

This is one of the earliest theories put forward by Dr. Allen Brodie in 1927 and states that cranial differentiation is largely genetically determined and is preplanned. It is common that certain types of malocclusion run is families. E.g. Hapsburg jaw and prognathic mandible of the German royal family or similar malocclusion seen in parents & there children.

Malocclusion could be produced by inherited characteristics in two major possible ways.

- An inherited disproportion between the size of teeth and size of jaw producing crowding or spacing of teeth.
- Inherited disproportion between size or shape of the upper and lower jaw causing improper occlusal relationship.

The more independently there characteristics are determined, the more likely that disproportion could be inherited.

Primitive population characterized by genetic isolation and uniformity have less frequent malocclusion than the modern groups.

Urban areas have larger group people where opportunity for mating outside one's own small population usually have high prevalence of malocclusion and greater variety malocclusion problems.

This view of malocclusion as a primarily a genetic problem was strengthened by breeding experiments with animal MOST influential individual on this regard was professor STOCKARD.

He cross breed the dogs and indicated that dramatic malocclusion occurred in the dogs.

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- The orthodontic speciality is faced with the evidence that genetic factor play a predominant role in the aetiology of malocclusion (Markovic, 1992) .Unusual feature of vertebrate facial development is the origin of the facial mesenchymal which arise from neural crest cells. They disrupt the Ectodermal –Mesodermal junction and migrate into the underlying tissue as ecto-mesenchymal cell. During their migration they undergo a number of interactions with the extra-cellular matrix, and with adjacent epithelia to determine the nature and patterning of the neural, skeletal and connective tissue structures they will form.

- Their migration is under the control of homeobox genes. Homeobox gene is regarded as master gene. Genes interested in craniofacial development-hox family
  - -Msx1,Msx2(muscle segment)

- -Dlx(distalless)
- -Otx(orthodontical)
- -Gsc(goosecoid)
- -Shh(sonic hedgehog)

- The proteins encoded by these genes are transcription factor.Transcription factor can switch gene on and off.Therefore control the coordinated cascade of molecular events which, in turn, control patterning and morphogenesis (Thesleff1995).

Shortcomings

- Explanation only at the molecular level and no correlation to the macroscopic morph genesis. Explanation is till protein synthesis, no idea about nature, timing, amount, actual effect of proteins and Effect of environment is overlooked.
- However the results in the STOCKARD experiment were misleading because the dogs carry genes for achondroplasia. It is a condition in which there is a deficient synthesis and growth of cartilage. It is autosomal dominant trait with partial penetrance. Simply meaning that it is expressed more dramatically in some individual than in others. Hence most malocclusion produced in the stockyard breeding experiment can be explained not on the basis of inherited jaw size but by the extent to which achondroplasia was expressed in that animal.
- The results of out breeding in human population also cast doubt on the hypothesis that independently inherited tooth and jaw characteristic are a major cause of malocclusion e.g. investigation carried out in HAWAII by CHUNG et al.

HOWAII had homogeneous population of Polynesian people with large stature broad and well developed jaws, and distinctive form of lower

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jaw. ROCKER JAW. After migration of European, Chinese and Japanese group and arrival of small no. of other racial and ethnic groups it resulted in heterogeneous modern population. Tooth size Jaw size and jaw proportion were all different for the Polynesian, Oriental, European contributors to the Hawaiian melting pot. Therefore if teeth and jaw characteristic were inherited independently, high prevalence of severe malocclusion would be expected in this population.

However the prevalence and types of malocclusion in the current Hawaii population do not support this consult.

From the Bolton-bush growth study after examination of cephalometric radiographs and dental casts it was concluded that heritability of craniofacial (skeletal) characteristics was relatively high than that of dental occlusal characteristics. Skeletal characteristic heritability estimates increases with age while that of dental characteristics heritability estimates decreases indicating increases environmental contribution to dental variation.

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SICHER'S HYPOTHESIS (SUTURAL DOMINANCE)

Sicher deduced from the many studies using vital dyes that the sutures were causing most of the growth; in fact, he said " …the primary event in sutural growth is the proliferation of the connective tissue between two bones. If the sutural connective tissue proliferates it creates the space for oppositional growth at the borders of the two bones". Replacement of the proliferating connective tissue was necessary for functional maintainance of the bones. He felt that the connective tissue in sutures of both the nasomaxillary complex and vault produced forces, which separated the bones, just as the synchondroses expanded the cranial base and the epiphyseal plates lengthened long bones. Sicher viewed the cartilage of the mandible somewhat differently, stating that it grew both interstitially, as epiphyseal plates, and appositionally, as bone grows under periosteum. His ideas came to be called the "sutural dominance theory," but it would seem he held sutures, cartilage, and periosteum all responsible for facial growth and assumed all were under tight intrinsic genetic control.

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This theory was discredited for the following reasons

a. In an area of the suture between two facial bones is transplanted to another location , the tissue does not continue to grow. This indicates a lack of innate growth potential in the sutures.
b. If this theory were correct, growth at the sutures should occur independently of the environment and it would not be possible to change the expression of growth at the sutures very much. However it has been noted that growth at the sutures will respond to the outside

influence under a number of circumstances. If cranial or facial bones are mechanically pulled apart at the sutures, new bone fill in and the bones become larger than they would have been otherwise. If a suture is compressed, then bone growth at that site will be impeded. Thus sutures must be considered as areas that react but not the primary determinant of growth.

c. Translatory growth of the bones continue normally either in the absence of sutures or through extrepation in experimental animals.
d. In untreated clefts of palate, though suture is not present growth is taking place
e. Microcephaly and hydrocephaly gave doubts about the intrinsic genetic stimulus of the sutures.

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SCOTT HYPOTHESIS (cartilaginous theory)

Another major theory is that the determinant of the craniofacial growth is growth of cartilages. The fact that cartilage does the growing while bones merely replaces it, makes this theory attractive for the growth of the bones.

Scott noting the prenatal importance of cartilaginous portions of the head, nasal capsule, mandible and cranial base felt that they continued to dominate facial growth postnatally. He specifically emphasized how, the cartilage of the nasal septum during its growth paced the growth of the maxilla Scott felt that sutural growth came in response to the growth of other structures including cartilagenous elements, brain, eyes, etc

As mentioned earlier the proponents of the cartilage theory hypothesize that the cartilagenous nasal septum serves as a pacemaker for maxillary growth. If the sutures of the maxilla served as reactive areas, like they seem to do, they would react to this translation by forming new bone when the sutures were pulled apart by the forces from the growing cartilage. Although the amount of nasal cartilage reduces as growth continues, cartilage persists in this area throughout life the pacemaker role is certainly possible.

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Two kinds of experiments were carried out to test the idea that the cartilage can serve as a true growth center.

a. **Transplanting cartilage**: Transplantation experiments demonstrate that not all skeletal cartilages are the same when transplanted. If a piece of the epiphysial plate of a long bone is transplanted, it will continue to grow in new location or in culture showing that these cartilages do have update growth potential. It is difficult to obtain cartilage from the cranial base synchondroses to transplant, perhaps

this explains why cartilage from this area do not grow in vitro as well as the epiphysial cartilage. In the more precise recent experiments the nasal cartilage was found to grow nearly as well as the epiphysial cartilage in culture. In recent more precise studies the mandibular condylar cartilage showed significantly less growth than the other cartilages.

From these experiments, the other cartilages appear capable of acting as growth centers but the mandibular condyle does not.

b. **<u>Effect of removing cartilage at an early age on growth</u>**: The basic idea is that if removing a cartilagenous area stops or diminishes growth perhaps it really was an important center for growth. Extripating a young rabbit's septum caused a considerable deficity in growth of the midface. However it can be argued that the surgery itself and the accompanying interference with blood supply to the area, not the loss of cartilage, cause the growth changes. Even atraumatic removal of the cartilage of nasal septum resulted in a grossly deficient midface, leading most observers to conclude that the nasal septum does have some innate growth potential, whose loss makes a difference in maxillary growth.

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Two excellent studies carried out in Scandinavia in 1960 by Gilhuus Moe and Lund demonstrated that after fracture of the mandibular condyle in a child, there was an excellent chance that condylar process would regenerate to approximately its original size and a small chance that it would overgrow after the inury. In experimental animals after a fracture, all of the original bone and cartilage resorbs, and a new condyle regenerates directly from the periosteum at the fracture site. Although there is no direct evidence that the cartilage layer itself regenerates in

children after condylar fractures, it is likely that this occurs in humans also.

However 15% to 20% of the Scandinavian children studies who suffered a condylar fracture, there was a reduction in growth after the injury. This growth reduction seems to relate to the amount of trauma to the soft tissues and the resultant scanning in the area.

It appears that the growth at the mandibular condyle is much more analogous to growth at the sutures of the maxilla, entirely reactive, than to growth at the epiphysial plate.

Lantham elaborated on Scott's ideas about the nasal septum and the maxillary growth, emphasizing the role of the septo-premaxillary ligament beginning in the later part of fetal period. He felt that the maxillary sutures began as sliding joints adopting to initiating growth forces elsewhere, but later manifest increasing osteogenesis, contributing to the main displacing force at the force surface. Thus he combines ideas of Scott, Sicher and Moss.

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Scott feels that the cartilagenous parts of the skull must be recognized as primary centres of growth. The nasal septum is found to be major contributor in maxillary growth.

Histological research validates much of the Scott hypothesis. Both pressure and tension have little effect on cartilagenous growth.

Hunter and Enlow stated that the response of the cranial base to the growing brain is comparitively less than that of the bones of cranial vault. The view point that synchondroses are primary centres of growth is supported by research of Scott,, Burdi, Petrovic and others.

In cleft palate cases, the maxillary growth has been retarded by scar tissue, the nasal septum continue to grow and bends into a characteristic “S”shape. Thus according to Scott, the synchondrosis, nasal septum and condylar cartilage are the major growth centres which bring about growth of skull.

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Petrovics hypothesis (servosystem theory)

Cybernetics is a term applied to the interdisciplinary study of control and communication in animals, human beings,machines and organizations. Cybernetics talk about the connections between the individual components that the complex. It does not say anything about the components themselves but the components and the communication between them. This is another means that the physiological properties of the craniofacial skeleton and other units are not due to the action between cells and their intercellular substance but due to the interaction between the whole tissue and the organs which are connected with each other and through its feedback. The important point is that no local feedbacks are so far detected. So, the study of cybernetics is nothing but identifying and analyzing these feedbacks.

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On identifying the complexity of the process, Petrovic found out that only an electronic theory used to describe the communication and control mechanisms of a computer can atleast satisfactorily define the whole process of stomatognathic growth. The theory of cybernetics is mainly used in Robotics in engineering.

A physiological system designed for maintenance inspite of disturbances with a specific correspondence between the input and the output present is termed a closed loop control system.

Thus a closed loop system has a feed back loop and a comparator.

Comparator is a device which compares the feedback signal to the reference input. Thus a precision of a closed loop system depends on the comparator. The reference input is a signal established as a standard of comparison. Thus the closed loop system has a comparator and feedback loop whereas the open loop system has one.

The closed loop control system has two varieties:

1. **Regulator**:The main input is constant and the comparator detects the disturbances. The regulator is a negative feedback mechanism. i.e. any disturbance causing a change on this tends to restore the state of the disturbed system to its initial condition. In a servosystem the main input is not constant but it varies with time.
2. **The command**: It is a signal functioning independently of the feedback mechanism. It affects the behaviour of the control system without being affected by the results of the consequences of the behaviour (Eg:- Growth hormone, not being influenced by variations of the craniofacial growth).

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The Cybernetic Functional Diagram:

i. Command: The command is formed by variations in the level of growth hormone, testosterone, oestrogen, cortisone, etc.
ii. Reference input elements: This is a chain of elements establishing a relationship between the command and the reference input. These are formed by example, the septal cartilage, septopremaxillary ligament and the forward growth of maxilla.
iii. The reference input: The reference input is the signal established as a standard of comparison. Eg:- Sagittal positioning of the maxilla as felt by the mandible
iv. Peripheral comparator: It is the relation between maxilla and mandible through dentition
v. Performance : performance is the occlusion and location of teeth

vi. Performance analyzing elements: These are formed by the proprioceptive fibres of the periodontal, dental reticular, muscular tissue and the brain.

vii. Central controller: In the brain there is a sensory engram or a central controller which compares the position of the mandible in relation to the maxilla. This central comparator formed as a result of the repetitive positioning of the mandible in a particular position or nothing but the neuromuscular adaptation.

If there is any deviation between what the proprioceptive fibres pickup and the central engram, deviation signal arises. The deviation signal acts on the controller of the lateral pterygoid muscle to move the mandible such that the deviation signal is reduced.

The lateral pterygoid muscle acts on the condylar cartilage and the retrodiscal pad and alters the growth of the mandible. The signal from the actuator is not enough to bring about the increased growth. Some sort of amplification occurs at this level. This growth being controlled by actuator is known as the controlled system.

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What happens after this is the controlled variable or the output. This can be:

1. Change in the mandibular angle
2. Change in the condyle dental arch distance
3. forward growth of the mandible
4. forward positioning of the jaws

Now lets see what happens when a functional appliance is placed in a patient's mouth. Here an environment is created such that the mandible feels that the previous position of the maxillary has changed and it is now in a more anterior position. This is a reference input that says that the maxilla is in a forward position. The comparator finds out the error and informs the

performance analyzing system. In turn, a deviation signal is created and the controller tells the actuator to act and reduce the error. The final result is a variation in the controlled system in the form of an increased condylar growth and we get a new output, i.e. an anterior placement of mandible.

So, the changes brought about by a functional appliance not only changes the size, shape and position of the mandible but also creates a new neuromuscular environment for it to function.

Hence the result brought about by such a means must be more stable with less tendency towards relapse. As we know, one of the most important factors in determining the stability of the orthodontic treatment is the muscle balance.

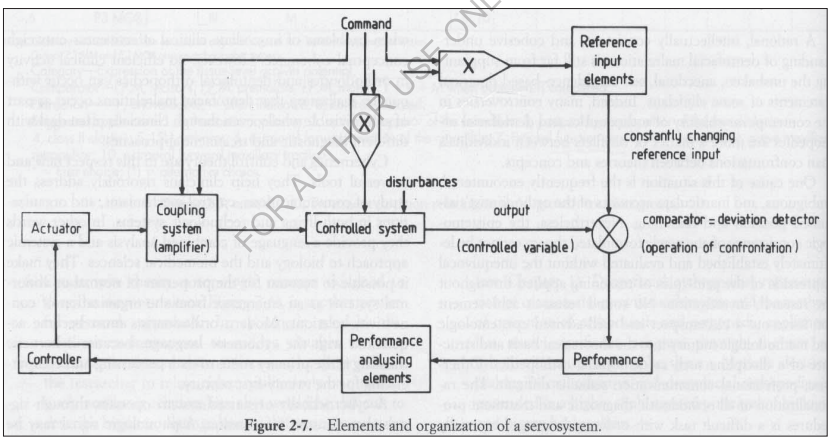

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Figure 2-7. Elements and organization of a servosystem.

VAN LIMBOURGH'S THEORY:

Limbourgh poses three main questions concerning the control of morphogenesis of the skull

1. Are there, in the embryonic phase, any causal relationship between the development of the skull on one hand, and the presence of the primordia of the other head structures on the other?
2. How is co-ordination between the endochondral and intramembranous bone growth brought about within the skull once it is formed?
3. In which way is co-ordination between the skull growth and that of the other structures realized?

To answer these questions, analysis must be made of the more obvious controlling and modifying factors.

1. Intrinsic genetic factors
2. Epigenetic factors
3. Local and general environmental factors

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According to Van Limbourg, the three popular theories of growth i.e. The Functional Matrix Theory by Moss, Sutural Theory by Sicher and The Genetic Theory were not satisfactory, yet each theory contains elements of significance that cannot be denied. He hence put forward a multifactorial theory that combines the views of all three theories.

Van Limbourg has suggested the following five factors that he believed controls growth:

Intrinsic genetic factors: they are the genetic control of the skeletal units themselves.

Local epigenetic factors: bone growth is determined by genetic control originating from adjacent structures like brain, eyes etc.,

General epigenetic factors: they are genetic factors determining growth from distant structures. E.g, Sex hormones, growth hormone etc.,

Local environmental factors: they are non-genetic factors from local external environment. E.g, habits, muscle force, etc.,

General environmental factors: they are general non-genetic influence such as nutrition, oxygen etc.,

The views expressed by van Limborgh can be summarized in the following six points:

1. Chondrocranial growth is controlled mainly by the intrinsic genetic factors.
2. desmocranial growth is controlled by any few intrinsic genetic factors.
3. The cartilaginous parts of the skull must be considered as growth centers.
4. Sutural growth is controlled mainly by influences originating from the skull cartilages and from other adjacent skull structures
5. Periosteal growth largely depends upon growth of adjacent structures
6. Sutural and periosteal growth are additionally governed by local non-genetic environmental influence.

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ENLOW AND BANG'S "V" SHAPED PRINCIPLE

Enlow and Bang applied the principle of area relocation to the multidirectional growth movement of the craniofacial bone.

As the dynamic process continues, specific local areas come to occupy actual positions in succession (or) as the entire bone enlarges. This growth shifts and changes involve corresponding and sequential remodeling adjustments in order to maintain the same shape, relative positions and constant proportions of each individual area.

A most useful and basic concept in facial growth is the "V" principle.

Many facial and cranial bones have a "V" shaped configuration.

Bone deposition occurs on the inner side of the "V" and resorption takes place on the outer surface of the "V" deposition also take place at the ends of the 2 arms of "V".

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The direction of movement is towards the wide end of the "V". Thus simultaneous growth movement and enlargement occur.

Eg: Base of a mandible, ends of long bones, mandibular body, palate etc

ENLOWS COUNTERPART PRINCIPLE OF CRANIOFACIAL GROWTH

This principles states that "the growth of any given facial or cranial part relates specifically to other structural and geometric counterparts in the face and cranium".

FACIAL GROWTH PROCESS

Multiple growth process parts of face and cranium is described as individual regions. These regional growth process take place simultaneously, even though they are presented here as a sequence of separate stages. Growth increases are shown in such a way that same craniofacial form and pattern are maintained, which is known as Balanced Growth in which form and proportions Remain Constant.

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However a perfectly balanced mode of growth never occurs in real life in all parts of face and cranium. The growth in real life is Imbalanced. Facial growth description are presented as a Balanced series because of Two Reasons:

a. To understand concept of growth balance.
b. To recognize and explain facial imbalance i.e. where and how much disproportion had taken place.

No face has yet been encountered that has perfect Anatomic and Geometric "Balance". Growth process outlined here follows the counterpart of principle of craniofacial growth.

The different parts and counter parts are :

a. Nasomaxillary complex relates to the anterior cranial fossa

b. Horizontal dimension of the pharyngeal space relates to the middle cranial fossa

c. Middle cranial fossa and breadth of ramus are counterparts

d. Maxillary and mandibular arches are mutual counter parts

e. Bony maxilla and corpus of mandible are mutual counterparts

f. Maxillary tuberosity and lingual tuberosity are counterparts

Growth process of each region is presented as two separate parts:

a. Remodelling
b. Displacement

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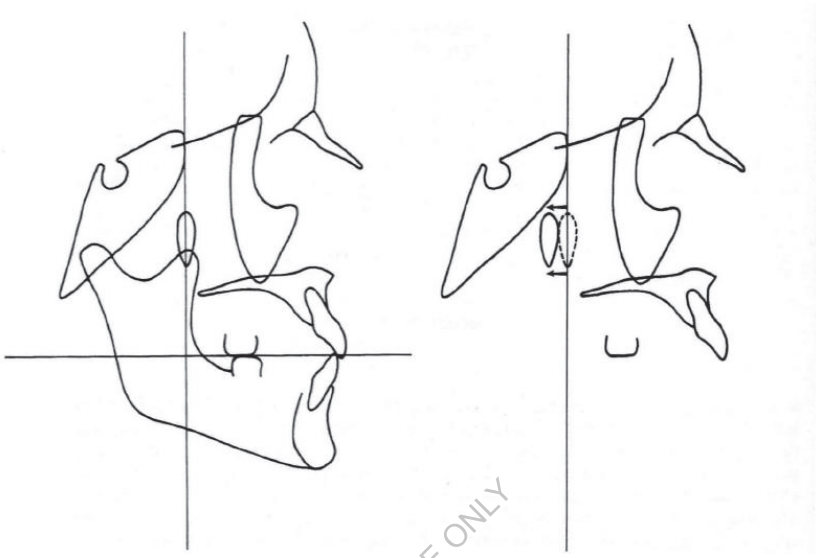
REGIONAL CHANGE1 : REMODELLING

There is bone deposition in the maxillary tuberosity region .this lengthens the maxillary arch in a posterior direction. This is shown by posterior movement of ptm.



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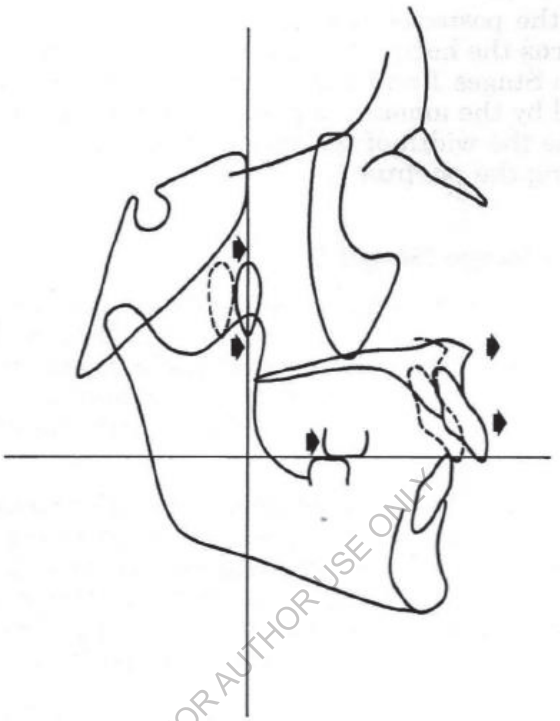
REGIONAL CHANGES 2:DISPLACEMENT

Primary displacement of maxilla in anterior direction by same amount as the growth in posterior region(tuberosity) takes place

As the bone is displaced ,it undergoes remodeling in order to keep pace with the amount of displacement.

REGIONAL CHANGE 3:

Body of the mandible relates specifically to the bony maxillary arch. Body of the mandible lengthens to match the growth of the maxilla by remodeling of the ramus by an amount equal to the growth of maxilla. However the maxilla is still prognathic and in a class.



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REGIONAL CHANGE 4:

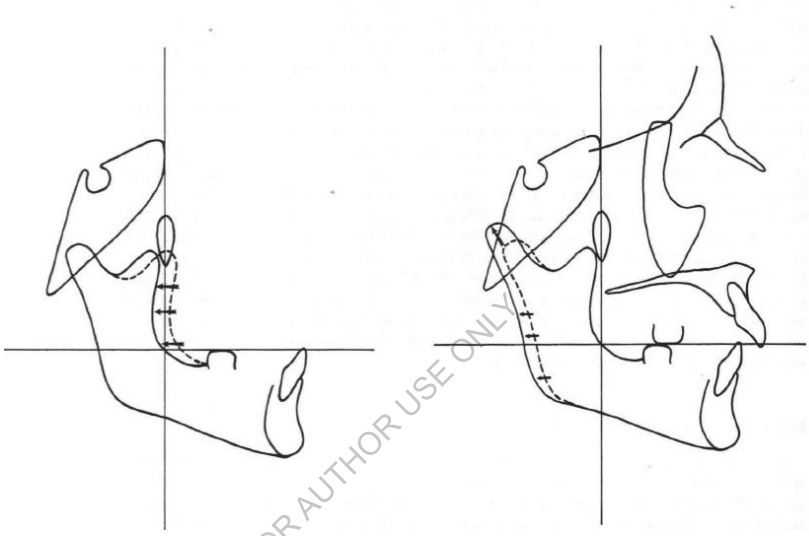
Condyle and posterior part of ramus grow posteriorly. Due to growth of posterior part of ramus, the original width of ramus is restored i.e. the amount of anterior ramus resorption is equalized by posterior ramus deposition.

REGIONAL CHANGE 5:

The whole mandible is displaced anteriorly by the same amount the ramus has relocated posteriorly due to primary displacement.

This places the mandibular arch in proper position relative to the maxillary arch just about it i.e. Class I Relation of teeth has returned.

However the occlusion is separated because the mandible is displaced inferiorly as well as anteriorly.



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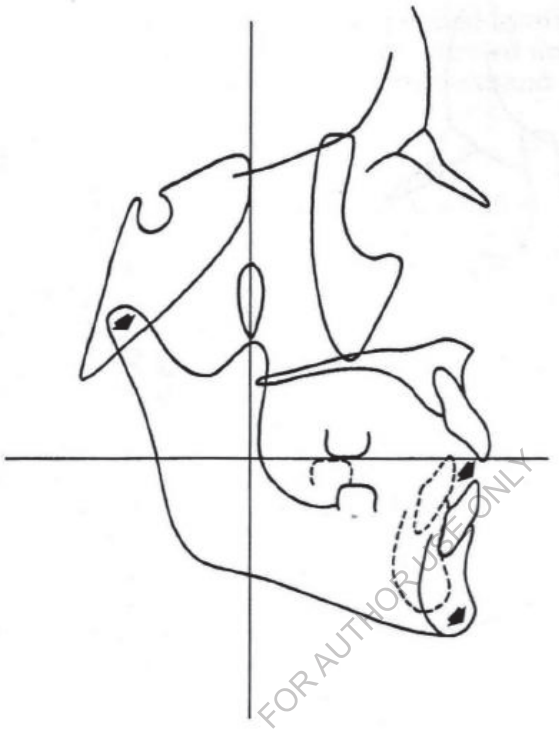
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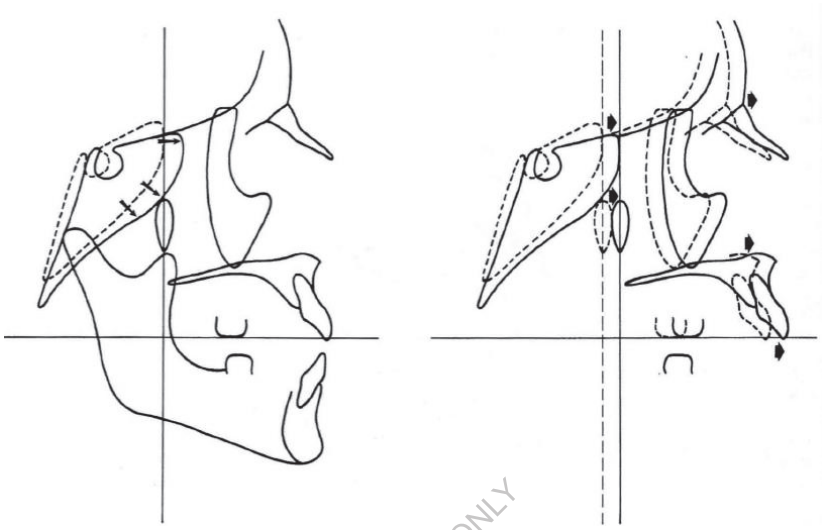
REGIONAL CHANGE 6:

When all the above-mentioned process is taking place, the dimensions of the middle cranial fossa have also been increasing. Increase in size is brought about the resorption on the endocranial side and deposition on the ectocranial side of cranial floor.

This projects it anteriorly beyond the vertical reference line.



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REGIONAL CHANGE 7:

All cranial and facial parts lying anterior to the middle cranial fossa become displaced anteriorly as a result.

The whole vertical reference line moves anteriorly to the same extent that the middle cranial fossa expands in a forward direction. This is a secondary type of displacement.

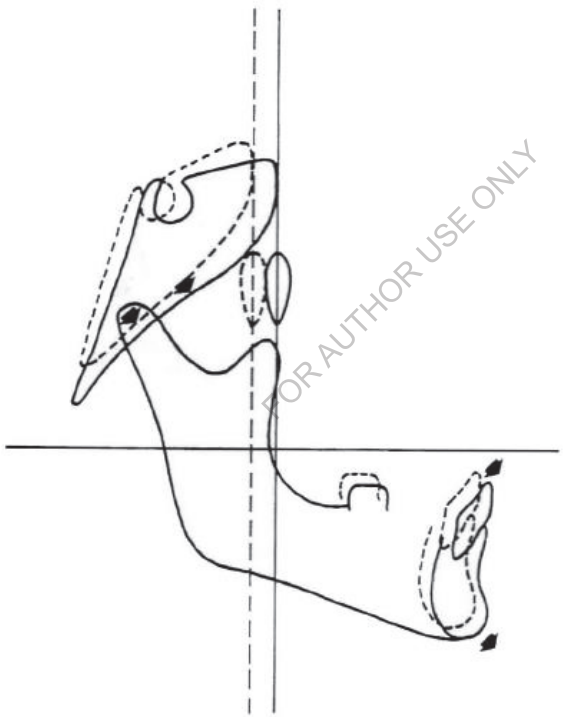
REGIONAL CHANGE 8:

Expansion of the middle cranial fossa displaces the mandible downward and forward but to a lesser extent than it displaces the maxilla. The result is an offset horizontal placement between the upper and lower arches. In this stage, the molars are in class II relation and the overjet is increased.

REGIONAL CHANGE 9:

Just as the lengthening of the middle cranial fossa places the maxillary arch in a more anterior position, the horizontal growth of the ramus places the mandibular arch in a like position.

The horizontal extent of middle cranial fossa elongation is matched by the corresponding extent of horizontal increase by the ramus.



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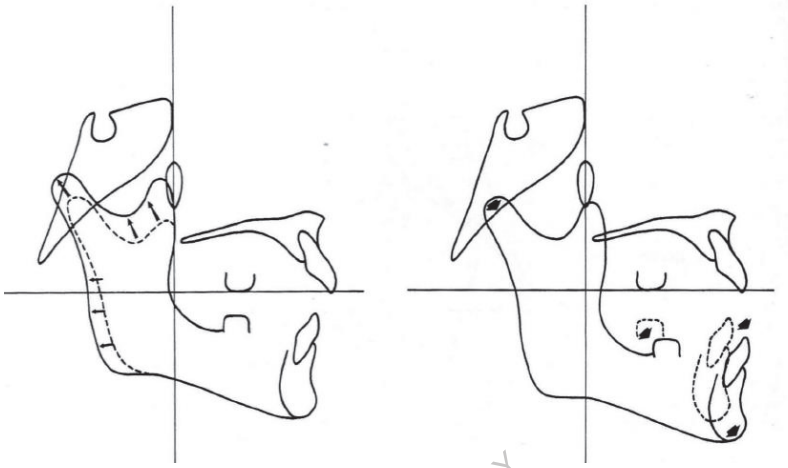

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REGIONAL CHANGE 10:

The entire mandible is displaced anteriorly at the same time that it grows posteriorly.

The amount of this anterior displacement equals:

a. The extent of posterior ramus and condylar growth
b. Amount of middle cranial fossa enlargement anterior to the condyle.
c. The extent of anterior movement of the vertical reference line
d. The extent of resultant anterior maxillary displacement.

The oblique manner of the condylar growth produces an upward and backward projection of the condyle with a corresponding downward and forward displacement of the mandible. The ramus thus becomes vertically and horizontally enlarged. This results in a further descent of the mandibular arch and separation of occlusion.

The total extent of this vertical growth must match the total vertical lengthening of the nasomaxillary complex and upward eruption and drift of the mandibular dentoalveolar arch if the same facial balance is to be achieved.

Now the protrusion of maxilla is matched by a corresponding protrusion of mandible. Now the molar relation is class I and the overjet has returned to normal.

REGIONAL CHANGE 11:

The floor of anterior cranial fossa and the forehead grow by deposition on ectocranial side with resorption from endocranial side. The nasal bones are displaced anteriorly. The postero –anterior length of the anterior cranial base is now in balance with its counterpart, the maxillary arch.

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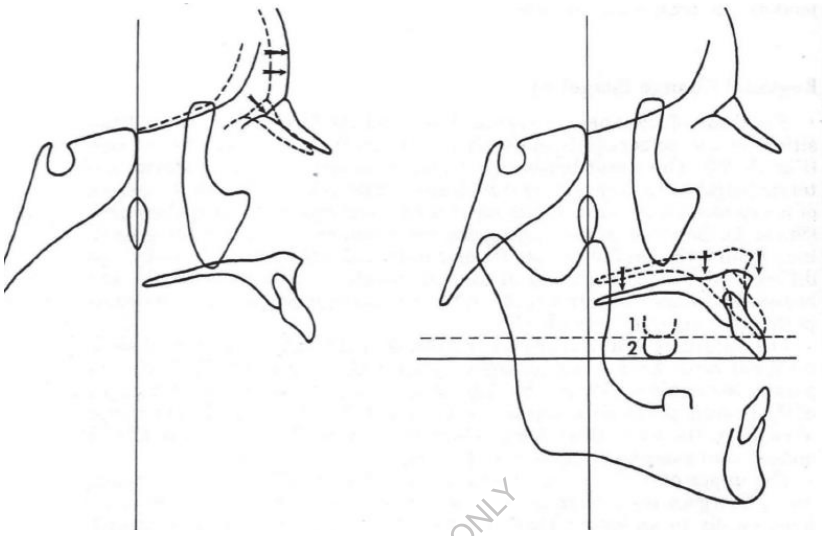
REGIONAL CHANGE 12:

The vertical lengthening of the nasomaxillary complex is brought about by a composite of:

a. Growth by remodeling i.e. resorption on the nasal side of the palate and deposition on the oral side, there by relocating it inferiorly and providing for the vertical enlargement of the overlying nasal region.
b. A primary displacement movement associated by its own enlargement.



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REGIONAL CHANGE 13:

Vertical growth by displacement is associated with growth at various sutures of the maxilla. The increment of bone growth in the sutures exactly equals the amount of inferior displacement of the maxilla.

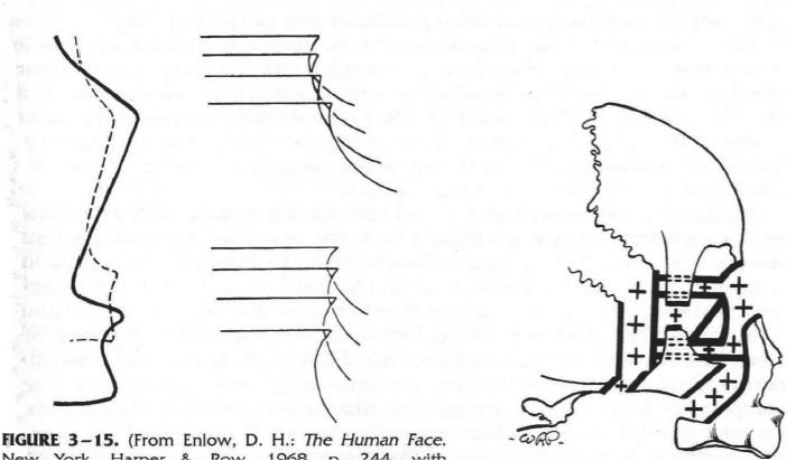

FIGURE 3–15. (From Enlow, D. H.: *The Human Face.*
New York, Harper & Row, 1968, p. 244, with

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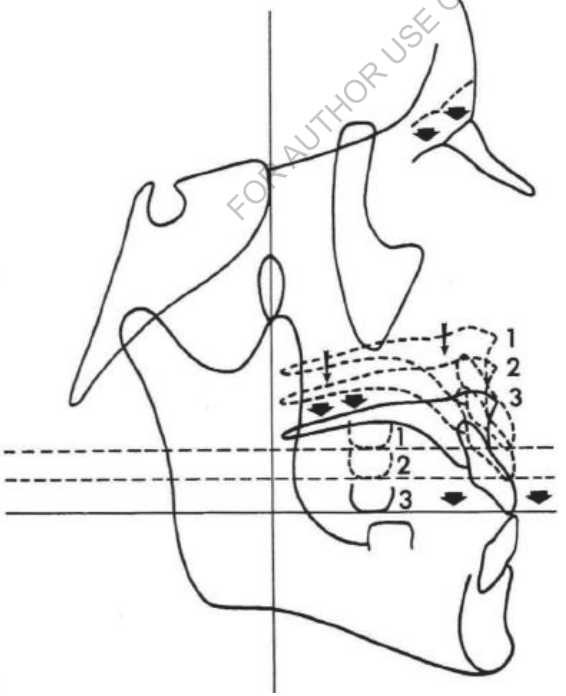

REGIONAL CHANGE 14:

The amount of vertical separation between the upper and lower arches caused by the vertical growth of the middle cranial fossa and ramus must be balanced by an equivalent amount of vertical growth in the nasomaxillary complex and the dentoalveolar region of the mandible. As the nasomaxillary complex moves downwards, the mandibular teeth (drift) and alveolar bone grow upward to attain full occlusion.

REGIONAL CHANGE 15:

While stage 14 is going on, there are remodeling changes in the incisor alveolar region, the chin and the corpus of mandible.

The lower incisors undergo lingual tipping so that there is proper overbite. This involves posterior rotation movement of lower incisors as they drift superiorly: Resorption on outside surface of alveolar region above the chin occurs, the alveolar bone moves backwards as the incisors undergo lingual drift. Bone is added on the external surface of the chin and on the corpus of the mandible.

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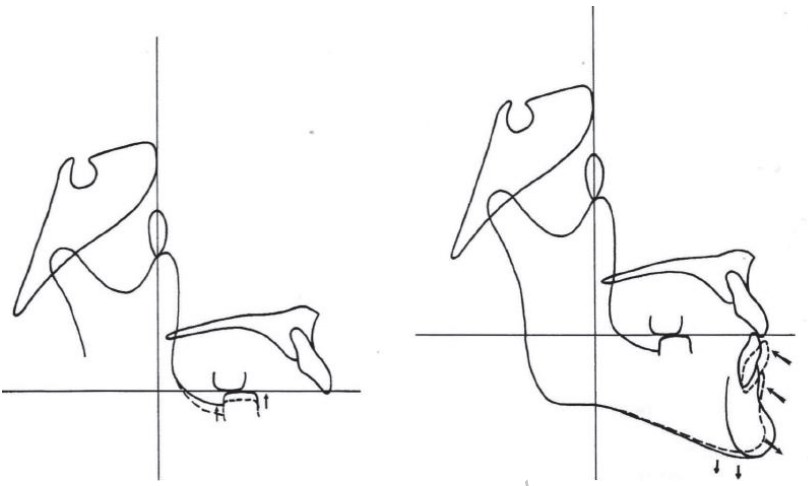

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REGIONAL CHANGE 16: Remodeling

Remodelling takes place in the zygoma and malar region. The malar region grows posteriorly by bone deposition on its posterior side and resorption on the anterior side. However since the deposition is more than the resorption, the whole malar protruberance becomes larger. The zygomatic process grows posteriorly by anterior resorption and posterior deposition (similar to coronoid process).

Zygomatic arch also enlarges considerably by bone deposition along its inferior edge. The arch increases in width, latterly by deposition on the lateral surface and resorption on the medial surface.

REGIONAL CHANGE 17: Displacement

As the whole maxillary complex is displaced anteriorly and inferiorly and as it simultaneously increases in size, the zygoma is moved anteriorly and inferiorly by primary displacement as it enlarges. The zygoma thereby

proportionately matches the maxilla in the direction and amount of horizontal and vertical growth and in the direction and amount of primary displacement.

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FUNCTIONAL MATRIX HYPOTHESIS

Functional matrix hypothesis was put forward by Melvin Moss in early 60s. He worked on the cocept put by Van Der Klauvw – The Functional Cranial Component.

In the year 1960 first paper was published in the American Journal of Physical Anthroplolgy by Moss and Young. In the year 1981, Moss in his classical statement defined his Hypothesis, as:

"The origin, growth and maintenance of all skeletal tissues and organs are always secondary, compensatory and obligatory to temporally and operational prior events or processes that occur in specifically related Non-skeletal tissues, organs or functional spaces".

According to Moss certain functions are carried out in craniofacial complex like:

1. Digestion

2. Respiration
3. Vision
4. Olfaction
5. Audition
6. Equilibrium
7. Speech
8. Neural Integration

Each function is carried out by a Functional Cranial Component. Each functional cranial component is composed of 2 parts:

1) A functional matrix, which actually perform the function, usually a soft tissue.
2) A skeletal unit, which biomechanically supports and protects its specific functional matrix.

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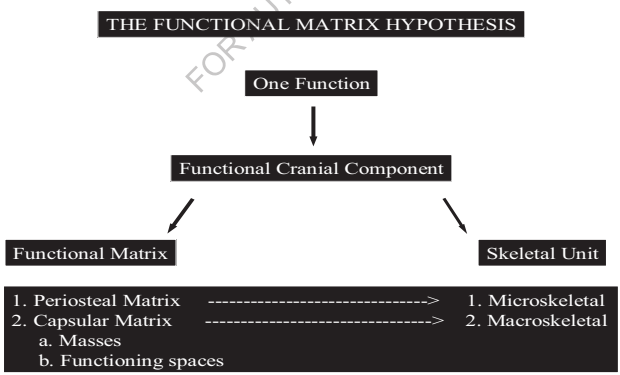

SKELETAL UNITS

Skeletal units are composed of variety of osseous, cartilaginous tendinous tissues. They are not the equivalents of the "bones" of formal classic osteology. As such, there is no biological reality in terms maxilla and mandible.

Skeletal units can be divided into:

a. Microskeletal units
b. Macroskeletal units

Macroskeletal units: When adjoining portions of a number of neighbouring "bones" are united to function as a single cranial component termed as Macro skeletal units.

E.g.

(I) The entire endocranial surface of the calvaria is one such Macroskeletal unit, serving to protect and support the enclosed neural mass

(II) The orbital surfaces of all the bones comprising the bony orbit, form another such macro unit subserving the functional demands of the orbital mass.

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Micro skeletal units: When a bone that makes up skeletal units consists of a number of skeletal units – these units are called Micro skeletal units.

The various Micro skeletal units in the mandible and the structures that are related to them are:

Coronoid process – temporalis muscle

Angular – Masseter and medial Pterygoid

Alveolar unit – Presence and position of teeth

Basal unit – Inferior alveolar neurovascular traid

Similarly, Maxilla include – Nasal

Orbital

Pneumatic

Palatal (both oral and nasal)

Some Micro skeletal units serve the same functional matrix but are separated in space. An example is the lateral surface of the mandibular angular process and a portion of the zygomatic arch, both of which are related to the functional demands of the masseter muscle.

The basic postulate is that the size, shape, position of each skeletal unit is a response to the demands for protection and or support of its specifically related functional matrix..

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FUNCTIONAL MATRICES

It is a basic postulate of the method of functional cranial analysis that with the exception of embryonic tissue differentiation all other aspects of cranial skeletal tissue growth (osseous, cartilaginous and fibrous) are secondary and compensatory reflections of the morphogenetically and temporarily prior growth and operation of cranial functional matrices.

Thus the primary growth of all these matrices, taken together with the secondary growth of all of the skeletal units, comprises the totality of head growth.

Two distinct types of functional matrices

1) Periosteal matrices and
2) Capsular matrices

Periosteal matrices – acts directly and actively on microskeletal units by the process of osseous deposition / resorption or by endochondral growth

process. They produce only change in size and shape of their specific microskeletal units. These growth processes are called transformations.

Such transformations are brought about by the inter related processes of deposition and resorption of bone

E.g. of such matrices are masseter, temporalis and pterygoid muscles.

Periosteal functional matrices are vertically self-defining. They are best exemplified by the effect of muscles upon the skeletal units i.e. blood vessels, nerves and glands also produce morphologic changes in their related skeletal units. The action of temporalis muscle and coronoid process upon their skeletal units (Moss and Salentijn; 1969).

Experimental removal of mammalian temporalis muscle, or its denervation results in actual diminution of size and shape of coronoid process. Similarly it is very well established that functional hyperactivity of the temporalis produce increased coronoid process size and alteration of its shape. It is also established that the experimental or clinical alteration of muscles attaching to the other mandibular ramal skeletal units can produce compensatory changes in the temporalis muscle function.

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Thus the total growth changes in all aspects of coronoid process form (size and shape) are at all times secondary and compensatory responses to the morphogenetically and temporally prior demands of the temporalis muscle function.

The complementary and interrelated process of osseous deposition and resorption bring about all responses of the osseous portions of skeletal units to periosteal matrices. The resultant effect of all such skeletal unit responses to periosteal matrices is to alter their size and / or their shape.

Such transformations are brought about by the inter related processes of deposition and resorption of bone.

Eg of such matrices are – masseter, temporalis and pterygoid muscles.

CAPSULAR MATRICES

It acts indirectly and passively on their related skeletal units, producing a secondary, compensatory "Translation" in space. These alterations in spatial position of skeletal units are brought about by the expansion of the facial capsule. Within which the facial bones arise, grow and are maintained. The facial skeletal units are passively and obligatorily moved in space as their enveloping capsule is expanded.

The oral, nasal and pharyngeal cavities, considered as functioning spaces are examples of such matrices. The enclosed capsular matrices act indirectly on macro skeletal units or on entire functional cranial component, which happen to be embedded completely within a specific capsule.

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Neurocranial

Orbital

Orofacial

Otic

They do not act by the process of osseous deposition or resorption or by affecting cartilage directly. They do not alter the size or shape of the skeletal units.

But they do change their location in space. Such growth processes are termed translations. Each of these capsules is an envelope that contains series of functional cranial components (skeletal units and their related functional matrices) that are sandwiched between two covering layers).

In case neurocranial capsule – skin of dura matter are the covering layers, in orofacial capsule, the skin to mucous membranes forms it.

All intervening spaces in functional component themselves as well those between them and the limits of the capsule are filled with indifferent loose connective tissue.

Each capsule surrounds and protects a capsular functional matrix. This exist as volumes

Eg: In neurocranial capsule – brain and leptomeninges and C.S.F

In orofacial capsule – oropharyngeal functioning spaces

Otic capsule – eyeball

The calvarial bones which lying within the neurocranial capsule has contiguous micro skeletal units – the outer table

- Inner table
- Diploic space
- Sinuses

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Expansion of neurocranial capsule occurs in response to the morphogenetically primary expansion of the enclosed neural mass. As this capsule expands, the enclosed and embedded calvarial skeletal tissues are passively translated in space in response to the capsular matrix.

At the same time, these same skeletal units respond to the altered demands of their periosteal matrices. They do so by expanding in area and in thickness, by altering the trabecular pattern of bone into inner and outer tables of compact bone with an intervening diploic area.

OROFACIAL MATRIX

All functional cranial components of the facial skull arise grow and are maintained in the orofacial capsule (splanchnocranial). The capsule surrounds and protects the oropharyngeal functioning spaces. It is the

volumetric growth of the functioning spaces, which is the primary morphologic event in facial skull growth.

The functioning reality of the respiratory and digestive system is their patency; and the volume of that patency is related to the general metabolic demands of the body as a whole.

The oral and pharyngeal regions have a primary function in maintaining patent airway. This is accomplished by a dynamic musculoskeletal postural balance, which is termed the "airway maintenance mechanism". The related functional cranial components are so dynamically balanced that this airway is maintained through out the range of motion of head and neck.

Growth of the enveloping capsule is produced by mitosis of its epithelial and mesenchymal cellular elements and the consequent increase in intercellular materials, which results in an expansion of the capsule as a whole. Within the capsule are the situated a number of mandibular functional cranial components, periosteal matrices together with their respective skeletal units. Because the mandibular cranial components arise and exist completely embedded within this capsule, they all necessarily are passively and secondary translated into a new position as the capsule expands. Such passive translation affects both the periosteal matrices and their skeletal units. Accordingly simultaneous with the passive translation, the individual periosteal matrices also alter their functional demands (muscle growth) these changes cause change in size to shape of their several skeletal units.

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Both this neural and orofacial function originate by the process of enclosure. The orofacial capsular matrix being in those embryonic stages during which the several facial processes (medial, lateral nasal, mandibular

and maxillary arise). The probably genetically controlled interstitial growth of their underlying mesoderm (ectomesenchyme) causes the several enlargements, swellings and movements. Therefore it is growth of primordial capsule that actually form the oronasal functioning spaces.

The substantial differences between the two types of functional matrices has been emphasized also by Frankel who referred capsular matrix as

"Developmental – Mechanical" influence on facial growth and periosteal matrices. "Functional – Mechanical" influences in facial growth.

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FUNCTIONAL MATRIX CONCEPT (REVISITED)

The initial version of the functional matrix hypothesis (FMH), claiming epigenetic control of morphogenesis, was based on macroscopic (gross) experimental, comparative, and clinical data. Recently revised, it now extends hierarchically from gross to microscopic (cellular and molecular) levels and identifies some epigenetic mechanisms capable of regulating genomic expression. This warranted revisiting our earlier analysis of the perennial genomic/epigenetic controversy.

The epigenetic position of the FMH may seem quixotic when molecular genetics is the premier ontogenetic research paradigm. Indeed, most clinicians and experimentalists—there are exceptions—subscribe to the two epigraphs above, stated more succinctly as "genes make us, body and mind."

Nevertheless, a continuing countercurrent of dissent claims morphogenesis is regulated (controlled, directed) by epigenetic mechanisms and processes. In addition, several new disciplines explicitly invoke epigenesis.

The epigenetic/genomic problem is a dichotomy, and dialectics is one analytical method for its resolution. The method consists of the presentation of two opposing views, a thesis and an antithesis, and of a resolving synthesis. Such a dialectic analysis is presented here in two interrelated articles that respectively consider

(1) The genomic thesis

(2) An epigenetic antithesis and a resolving synthesis. Because a comprehensive review of this problem would be encyclopedic, only selected relevant aspects of ontogeny (morphogenesis) and phylogeny (evolution) are considered here.

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An Odontogenic Example of the Genomic/Epigenetic Dichotomy

Odontogenesis provides a comprehensible example. The widespread diagnostic use of vertebrate dental coronal morphology in zoological systematics, vertebrate paleontology, physical anthropology, and forensic odontology suggests to many a rigid genomic control of odontogenesis, as reflected in the temporally sequential, and spatially restricted, expression of the genomically regulated production of specific molecules as exhibited, for example, in murine molar development.

Nevertheless, data exist strongly supportive of epigenetic regulation of odontogenesis. For example, Chiclid fish are polyphyodont (have continuously replacing dental sets) and can exhibit pronounced dental phenotypic plasticity. When the fish are fed on hard-shelled mollusks, the replacing teeth are large and molariform, but when soft food is fed, those

teeth are gracile, conical, and nonmolariform. Experimentally in aquaria, the two phenotypic states may be repeatedly and arbitrarily alternated in succeeding dental generations by alternately changing the diet's consistency. Because each dental replacement cycle involves identical odontogenic stages, it is postulated that

(1) Mechanical forces, related to differential diet "hardness," generate epigenetic signals, mechanotransductively processed by dental papilla cells;

(2) These signals control at least the temporal and spatial expression of genomic products related to the development of differential tooth form, such as size and shape.

If the epigenetic/genomic dichotomy of odontogenetic regulation is unresolved, how much more so the complex topic of cephalic morphogenesis where, parenthetically, mechanical loadings also play a significant regulatory role.

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The Genomic Thesis

The genomic thesis holds that the genome, from the moment of fertilization, contains all the information necessary to regulate (cause, control, direct)

(1) The intranuclear formation and transcription of mRNA

(2) Importantly, without the later addition of any other information, to regulate also all of the intracellular and intercellular processes of subsequent, and structurally more complex, cell, tissue, organ, and organismal morphogenesis: succinctly, "all (phenotype) features are ultimately determined by the DNA sequence of the genome."

In this thesis, morphogenesis is but the predetermined reading-out of an intrinsic and inherited genomic organismal blueprint where, in addition to molecular synthesis, the genome also regulates the geometric attributes of

cell, tissue, organ, and organismal size, shape, and location. For example, "specific patterns of gene regulation (cause, control, regulate, determine) the mechanisms by which a fertilized egg divides and progresses through the various decision points to yield groups of cells that are first determined to become and then actually differentiate to become specialized tissues of the right dimension and in the proper location."

The genomic thesis originated with classical (chromosomal) Mendelian genetics.Combined with the empirical data of animal breeders, it earlier provided a theoretical basis for certain human eugenic theories proposing reproductive inhibition for individuals with "undesirable and genetically (chromosomally) regulated" medical and social conditions: a policy that eventually reached historical genocidal depths.

Later, the blending of the classical chromosomal and vertebrate paleontological disciplines created the neo-Darwinian synthesis, a currently accepted paradigm of phylogenetic regulation.

Recently, molecular (gene) genetics extended the claims of the thesis to the regulation of all aspects of ontogeny (i.e., of "growth and development"). The mega-human genome project, called "the ultimate triumph of genetics, explicitly intends to:

(1) Describe the complete human genome;

(2) Demonstrate genomic controls of all developmental processes, at all structural levels, from the sub cellular to the organismal; and,

(3) In a societal context, possibly lead to some type of neoeugenics.

Many human activities now are claimed to be genomically regulated: e.g., psychological behavior; personality; alcohol and drug abuse; chronobiological cyclic behavior smoking, obesity, alcoholism, drug abuse, food-binging—indeed any attention-deficiency disorder, among many

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others. The further suggestion of genomic control of intelligence generates prodigious, biomedical controversy in the social sciences and politics. And note the frequent popular press reports of the "discovery" of yet another "gene" that "controls" yet another developmental, physiological, psychological, or sociological event, process, or state.

The Biologic Bases for the Genomic Thesis

While comprehensively considered elsewhere, a brief review is useful. The somatic cells of an individual metazoan inherit two classes of molecular information:

(1) An identical diploid DNA

(2) The maternal cytoplasmic constituents of the egg: e.g., mitochondria, cytoskeleton, membranes. Only approximately 10% of the genome seems related to phenotypic ontogenesis, whereas the human genome has approximately 100,000 genes, "well over 90% does not encode precursors to mRNAs or any other RNA." With regard to individual phenotypic structural attributes, while all somatic cells commonly share approximately 5000 different polypeptide chains, each specific cell type is characterized only by approximately 100 specific proteins. And it is claimed that "these quantitative (protein) differences are related to differences in cell size, shape and internal architecture."

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The encoding 10% of the DNA exists in two families; the vastly preponderant "housekeeping" genes and the nonabundant "structural" genes. The former regulate the normal molecular synthesis of agents involved in

(1) The common energetic (metabolic, respiratory) activities of all cells

(2) The specific activities of special cell types (e.g., neurons, osteoblasts, ameloblasts etc.).

These genes also regulate the synthesis of the specific molecular gene products, whose presence, absence, or abnormal molecular configuration are associated with the (human) pathologic conditions said to have a unitary genetic cause—the so-called Mendelian disorders and the single-gene disorders with nonclassic inheritance," such as Marfan syndrome, achondroplasia, osteogenesis imperfecta, and Duchenne muscular dystrophy, among many others. For some, such "disorders provide the model on which the program of medical genetics is built." In such conditions the absence of a normal type or the presence of a structurally abnormal type, of a specific biochemical or molecular structural entity is sufficient to initiate the cascade of subsequent abnormal developmental pathways, eventuating in a specific pathological state.

A physical analogy is the construction of a building wall where either the proportions of the concrete are incorrect or an insufficient number of metal reinforcing rods are used. In both cases, eventual structural collapse is possible. Substitution of intercellular proteoglycans, and of collagen fibrils, provides a corresponding skeletal tissue analogy. Here, alterations in the genomically regulated processes of molecular synthesis can produce an eventual "structural collapse" at the hierarchically higher level of a macroscopic bone. Anticipating an antithesis, note here that the claim of genomic control of the molecular syntheses underlying the formation of such elemental (molecular) skeletal tissue "building blocks" does not substantiate the further claim that the genome regulates the growth and development (the size, shape, location and histological composition) of the gross anatomical bone.

The Genomic Thesis in Orofacial Biology

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There is extensive support for the genomic thesis in the orofacial biology literature, with most genetic studies of cephalic or cranial morphogenesis explicitly or implicitly assuming genomic regulation of each anatomical structure.

A characteristic article claims that prenatal craniofacial development is controlled by two interrelated, temporally sequential, processes:

(1) Initial regulatory (homeobox) gene activity and

(2) Subsequent activity of two regulatory molecular groups: growth factor families and steroid/thyroid/retinoic acid super-family. For example, "homeobox genes coordinate the development of complex craniofacial structures" and in "both normal and abnormal development, much of the regulation of the development of virtually all of the skeletal and connective tissue of the face is dependent on a cascade of overlapping activity of homeobox genes."

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It is claimed that regulatory molecules can

(1) "Alter the manner in which homeobox genes coordinate cell migration and subsequent cell interactions that regulate growth"

(2) Be involved in the "genetic variations causing, or contributing to, the abnormal development of relatively common craniofacial malformations . . . perhaps modifying Hox gene activity."

Specific orthodontic implications of the genomic thesis include claims that "poorly coordination-ordinate control of form and size of structures, or groups of structures (e.g., teeth and jaws) by regulator genes should do much to explain the very frequent mismatches found in malocclusions and other dentofacial deformities." And "single regulatory (homeobox) genes can control the development of complex structures indicating that single genes can determine the morphology of at least some complex structures,"

including "how characteristic noses or jaws are inherited from generation to generation."

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Critical Definitions

Clarification of this dichotomy is assisted by defining the present use of four terms: epigenetics, hierarchy, emergence, and causation.

Epigenetics: Several millennia ago epigenesis described the process(es) by which increasing structural complexity gradually arose from an originally unstructured mass, for example the stages of in vivo chick development or the gradual appearance of a pattern during weaving on a loom. Over time, many alternate, often differing, definitions appeared. Earlier, they were macroscopic in scale and considered only the extrinsic, extraorganismal environment, such as food, light, temperature, and radiations. Nineteenth century physiology added the intrinsic, intraorganismal milieu interieur, such as hormones, blood gases, nutrients, and ions.

Epigenetics, as defined here, includes

(1) All of the extrinsic (extraorganismal) factors impinging on vital structures, including importantly mechanical loadings and electroelectric states

(2) All of the intrinsic (intraorganismal) biophysical, biomechanical, biochemical, and bioelectric micro environmental events occurring on, in, and between individual cells, extra cellular materials, and cells and extra cellular substances.

Hierarchy: Biological structures are hierarchically organized, with structural and functional complexity increasing "upward" from the ever-expanding family of subatomic particles to protons, electrons, atoms, molecules, sub cellular organelles, and on to cells, tissues, organs, and organisms. While a genomic thesis claims that each higher level is achieved by the predetermined activity of the genomic information, an epigenetic antithesis suggests that hierarchical complexity results from the functioning of epigenetic processes and mechanisms, as described in the disciplines of developmental mechanics, self-organization, complexity, and chaos, among others,—topics considered further in the following epigenetic antithesis.

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Emergence: This phenomenon occurs in all natural hierarchies. It consists of the appearance, at each successively higher and structurally and/or operationally more complex level, of new attributes or properties, not present in the lower levels, whose existence or functions could not in any way be predicted, even from a complete knowledge of all of the attributes and properties of any or all of the preceding lower organizational levels.

For example, full knowledge of all the attributes and properties of an osteocyte does not permit prediction of the attributes and properties of any

type of bone tissue. And full knowledge of all attributes and properties of all constituent bone tissue types does not permit prediction of the form (size and shape), growth, or functions of a macroscopic "bone."

Emergence is not genomically controlled. Instead, the integrated activities of all the attributes in a given hierarchical level self-organize to produce the next higher level of complexity. In every real sense, biologic structures "build" themselves; that is, bones do not grow, they are grown. Epigenetic processes and mechanisms are regulatory (causal) of hierarchical organization and of emergence and self-organization.

Causation: From this vast topic, we consider only how the attributes of a given biologic structural level "cause" (control, regulate, determine) the attributes of the next higher level. For example, what causes osteogenesis on the ectofacial surface the left mandibular angular process of a given 14-year-old male? The genomic thesis holds that this process was predetermined; i.e., that individual's osteoblastic genome contained, at the moment of fertilization, all the information necessary to regulate where, when, for how long, in what direction, in what amount, and at what rates, bone formation and remodeling will occur in that individual, given the absence of disease and the presence of the usual and necessary extrinsic (environmental) factors, such as adequate nutrition, and the customary normal physiological states, such as are presumed to exist in physiology's hypothetical normal human.

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The antithesis (and the FMH) suggests that epigenetic stimuli, created by operations of related functional matrices and their skeletal unit adaptive responses, create the "new" information sequentially, as mandibular ontogenesis proceeds. All ontogenesis exhibits developmental "cascades,"

with multiple branching points where decisions are made between alternate developmental pathways. Such decisions are not predetermined by encoded genetic information, but instead are responses to some epigenetic stimulus (i). Hierarchy, emergence, and causation are topics of the greatest significance in any critique of the genomic hypothesis, because the scope and content of molecular genetics is precisely that; it deals with only the molecular level of structural organization. The genomic hypothesis proposes no pathways from molecules to morphogenesis. Customarily, in craniofacial literature, the existence of two "facts" is stated:

(1) That at the molecular level, a particular gene (or group of genes) exists

(2) That at some higher, macroscopic level, some clinical state of normal growth and development or of malformation and/or malfunction is observed.

Without positing any specific mechanisms or processes at each intervening hierarchical level of the developmental cascade, it is simply stated that fact 1 is the cause of fact 2. For example, "it is demonstrated that synpolydactyly, an inherited human abnormality of the hands and feet, is caused [italics mine] by expansions of a polyalanine stretch in the amino-terminal region of HOXD13."

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In the genomic thesis morphogenesis is reduced to molecular synthesis.

The Classification of Causation: There are four principal causes of ontogenesis: material (with what?), formal (by what rules?), efficient (how?), and final (why?). These may be categorized as either intrinsic (material and formal) and extrinsic (efficient); final cause (teleology) is not considered further. Of importance, both material and formal causes are classified as prior causes, i.e., existing before the creation of some specific

state or structure. Efficient cause is proximate; i.e., its operation immediately causes the creation of a new state or attribute. Material and formal causes are intrinsic because they reside within vital structure (either intracellularly or intercellularly); efficient causes are extrinsic—they represent the entire spectrum of epigenetic processes, mechanisms, and events capable of being imposed on vital structures.

In biology, material cause is represented by all the levels of cellular and intercellular materials, without reference to any specific structural (anatomical) arrangement. Formal cause is the genomic code, i.e., a series of "rules" or "laws." These act at the molecular level to regulate the initial creation of the constituents of material cause. Efficient cause(s) are the epigenetic factors, as defined above, whose actions immediately regulate the next developmental branching point.

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A metaphor is helpful. Consider the use of a computer to prepare this manuscript. The material cause is the hardware: the computers, printers, disks, and papers. The formal cause is the software: a specific word processing program, both its apparent, user-friend form and, in reality, its ultimate expression in machine language code. No combination of hardware and software could ever write an article. Extrinsic, epigenetic input is required, i.e., the composition and input of the text itself. Both intrinsic causes must be present before (prior to) the textual input, whereas the extrinsic, epigenetic typing is immediately (i.e., proximately) followed by creation, on the hard disk, of the text itself.

Both prior (intrinsic) and proximate (extrinsic) causes are necessary causes; neither alone is a sufficient cause for the creation of this manuscript. Only the two integrated together furnish the necessary and sufficient cause.

In ontogenesis, genomic (intrinsic, prior) and epigenetic (extrinsic, proximate) factors are each a necessary cause, but neither alone is a sufficient cause. Only the interaction of both provides both the necessary and sufficient cause of morphogenesis. This conclusion foreshadows the resolving synthesis of this dichotomy, presented in the companion article, which also contains the comprehensive bibliography.

"It is a fallacy that the genome, the totality of DNA molecules, is the main repository for developmental information; I.e. that there exists a genetic program, or blueprint, theoretically capable of creating an entire organism."

Biological Mechanisms and Processes: This article continues the dialectical analysis of the roles of genomic and epigenetic processes and mechanisms in the control of craniofacial growth and development. Previously a genomic thesis was outlined and several critical terms were defined. The dialectic process concludes here with an epigenetic antithesis and a resolving synthesis, following two additional definitions:

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(1) A process is a series of actions or operations that lead toward a particular result. (2) A mechanism is the fundamental physical or chemical process(es) involved in, or responsible for, an action, reaction, or other natural phenomenon. That is, mechanisms underlie processes. For example, loading a femur is an epigenetic process: the possible resultant modification(s) of bone cell DNA (for example by methylation, or of chondrocytic DNA (for example as reflected in differential regulation of biosynthetic pathways, are epigenetic mechanisms. Similarly, the specific steps of the activation and deactivation of appropriate portions of the bone cell genome, associated with the trio of possible osteoblastic responses to loading (deposition, resorption, or maintenance of bone tissue) are further

examples of epigenetic mechanisms that control the genome. In this sense, the original versions of the functional matrix hypothesis (FMH) described only epigenetic processes, whereas recent revisions also described epigenetic mechanisms. The fundamental correctness of earlier FMH descriptions is supported by more recent research.

The Epigenetic Antithesis

Some of the principal strengths of this antithesis come from precise definitions of what a gene is and is not. For example: (a) "gene. The unit of heredity: one or more nucleic acid sequences incorporating information necessary for the generation of a particular peptide or RNA product"; and, (b) "enough is known about the genetic machinery [to know] that this is virtually the only kind of information which polynucleotide molecules are inherently capable of containing: nothing there at all about which proteins will be expressed in which cells at what time and in what quantities."

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The genomic thesis is denied because it is both reductionism and molecular; that is, descriptions of the causation (control, regulation) of all hierarchically higher and structurally more complex morphogenetic processes are reduced to explanations of mechanisms at the molecular (DNA) level. For example, the genomic thesis of craniofacial ontogenesis passes directly from molecules to morphogenesis: directly from DNA molecules to adult gross morphology, ignoring the role(s) of the many epigenetic processes and mechanisms competent to control (regulate, cause) the large number of intervening, and increasingly more structurally complex, developmental stages particularly, and there are additional similarly reductionist views of odontogenesis.

The epigenetic antithesis, detailing both processes and mechanisms, is integrative, seeking to clarify the causal chain between genome and phenotype. Its goal is to identify and describe comprehensively the series of initiating biological processes and their related underlying (biochemical, biophysical) responsive mechanisms that are effective at each hierarchical level of increasing structural and operational complexity.

This article reviews some of the clinically significant epigenetic processes and mechanisms, existing at several organizational (structural, functional) levels, that regulate (direct, control, cause) cephalic and craniofacial (musculo- skeletal morphogenesis).

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Craniofacial Epigenetics

"Broadly speaking, epigenetics refers to the entire series of interactions among cells and cell products which leads to morphogenesis and differentiation. Thus all cranial development is epigenetic, by definition." This view is supported here, despite continued expressions of genomic regulation of craniofacial morphogenesis.

As previously noted, epigenetic factors include

(1) All of the extrinsic, extraorganismal, macroenvironmental factors impinging on vital structures (for example, food, light, temperature), including mechanical loadings and electromagnetic fields

(2) All of the intrinsic, intraorganismal, biophysical, biomechanical, biochemical, and bioelectric microenvironmental events occuring on, in, and between individual cells, extra cellular materials, and cells and extra cellular substances.

In terms of clinical orthodontics, and of the FMH, all therapy is applied epigenetics, and all appliances (and most other therapies) act as

prosthetic functional matrices. Clinical therapeutics includes a number of epigenetic processes, whose prior operations evoke a number of corresponding epigenetic mechanisms. These latter, in turn, underlie the observed processes of tissue adaptations by both skeletal units and functional matrices.

Epigenetic Processes and Mechanisms

In craniofacial morphogenesis, more is known presently about processes than about mechanisms. Despite this, it is no longer sufficient to note, for example, that otherwise un-described epigenetic processes of "intrauterine environment" can regulate fetal mandibular growth. The future aim must be to elucidate the molecular, genomic, mechanisms whose activation underlies the adaptive growth processes of the mandibular functional cranial components (that is, of the mandibular skeletal units and their related functional matrices).

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Loading

Many different epigenetic processes can evoke mechanisms capable of modifying DNA. At clinically significant structural levels, physical loading is unquestionably of the greatest importance. "Among the numerous epigenetic factors influencing the vertebrate face is mechanical loading." It is useful to consider the epigenetic process of loading and some of the epigenetic mechanisms this process evokes.

Loading per se. Loads may be imposed at many structural levels. While clinical observations usually are macroscopic, the loadings act microscopically, at molecular and/or cellular levels. Loadings are able to regulate several alternative molecular (cellular) synthetic pathways (mechanisms) of many tissues, including bone for example, the mechanical

environment is important in maintaining the differentiated phenotype of bone cells. It should be noted that loading may be dynamic (for example, muscle contraction) or static (that is, gravity); and to be effective, loads may increase, decrease, or remain constant.

Mechanical loading is known to influence gene expression. Of clinical (and FMH) interest, extrinsic musculoskeletal loading can rapidly change

(1) Both articular cartilage intercellular molecular syntheses and mineralization

(2) Osteoblastic (skeletal unit) gene expression. Epigenetic loading processes include gravitational variations that evoke unique mechanisms of molecular synthesis.

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Extra cellular matrix deformation: Musculoskeletal tissue loading inevitably deforms an extra cellular matrix (ECM) that is not developmentally inert. Rather, in several ways, ECM regulates the formation, development, and maintenance of its included cells that synthesize the ECM. Further, ECM can regulate multicellular tissue morphogenesis and contribute to genomic regulation of its enclosed cells.

Cell-shape changes: Tissue loading can also alter cell shape. This inevitably deforms intracellular constituents, including the cytoskeleton. The epigenetic process of changing cell shape invokes the epigenetic mechanisms of **mechanotransduction** of biophysical forces into genomic and morphogenetically regulatory signals.

Cell-shape change processes can also activate several other epigenetic mechanisms, for example, stretch-activated ion channels in cartilage and

other mechanically initiated cell-signaling mechanisms. There is recent orthodontic interest in the cell-shape change of nonskeletal cells.

Cell-shape change may lead to nuclear shape deformation. This, in turn, is a mechanism that can directly cause (regulate) a consequent alteration of the mechanisms of genomic activity.

Epigenetic cell signaling processes: Several loading processes can regulate genomic expression. One, previously described, begins with cellular mechanoreception and mechanotransduction of the loading stimulus into an intercellular signal that undergoes parallel processing within a connected cellular network of bone cells. The details of cell-signaling are reviewed extensively elsewhere.

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Chains of intracellular molecular levers: A second epigenetic cellular process begins with deformation of the ECM. This matrix has an epigenetic regulatory role in morphogenesis, by virtue of integrin molecules that physically interconnect the several molecular components of the intracellular (cytoskeletal) and the extra cellular environment (for cartilage). While the form (size and shape) of the cytoskeleton may be physically controlled by a broad spectrum of loadings, it responds identically to all.

The epigenetic mechanism evoked consists of a physical array of intracellular macromolecular chains, acting as levers, extending from the cell membrane to multiple specific sites on each chromosome. The molecular chain acts as an information transfer system between the extra cellular environment and the genome, transmitting signals generated by deformations of the ECM directly to the intranuclear genome. Indeed, such

informational transfer between cells and ECM is dynamic, reciprocal, and continuous.

Other processes and mechanisms: (1) DNA methylation is a potent epigenetic event. It is involved in many intracellular, extra cellular and intercellular mechanisms. It can "introduce novel features of cellular function far removed from the classical Mendelian view of the gene, chromosome, and inheritance with information flowing back to the DNA level and changing gene expression," the genome now being considered as a sophisticated response system and a carrier of information, a system activated by several epigenetic processes and mechanisms.
(2) There are numerous examples of yet other processes and mechanisms of epigenetic regulation of the genome.
(3) In addition, it has been shown that (botanical) epigenetic factors can impose metastable inheritable changes in the plant genome, a nontrivial matter not considered further here.

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Epigenetic Regulation of Higher Structural Levels: In addition to the molecular and cellular processes and mechanisms noted, over a century ago the discipline of developmental mechanics (entwicklingsmechanik) established that the epigenetic process of extrinsic loadings play a major role in the regulation of bone tissue and bone organ growth, development, and morphology.

At the tissue level, there are several causal, strain-specific differences in bone tissue microstructure. Closely similar epigenetic mechanisms and processes are observed in the adaptation responses of all connective tissues, including cartilage, to loading.

At the organ level, the ability of the processes of motion and of articular function to regulate joint morphology is well-known and, of course, physical activity processes regulate organism skeletal adaptation responses. Other epigenetic processes affecting bone tissue include local vascular factors.

Regulation of functional matrices: Periosteal functional matrices are under closely similar epigenetic control. Mechanical loads regulate skeletal muscle (periosteal functional matrix) phenotype; and chronic muscle stimulation can change its phenotype. Numerous studies establish the neurotrophic role of neural innervations in muscle genome regulation. It remains only to note the truism that, for muscle as for bone, mechanical epigenetic factors, broadly termed function (or exercise) significantly control musculoskeletal growth, development, and maintenance of structural and physiological attributes.

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A Resolving Synthesis

"It seemed that the next minute they would discover a solution. Yet it was clear to both of them that the end was still far, far off, and that the hardest and most complicated part was only just beginning."–Anton Chekov. (The Lady with the Dog)

As the epigraph indicates, it is certain that no matter what arguments, theoretical constructs, and supporting experimental data are presented here, the prevailing tension between the genomic thesis and epigenetic antithesis will continue unabated. Nevertheless, a resolving synthesis will at least clarify the bases for continued discourse.

The fundamental argument of this resolving synthesis, based on an analysis of causation, was presented earlier, and later amplified. It argues that morphogenesis is regulated (controlled, caused) by the activity of both genomic and epigenetic processes and mechanisms. Both are necessary causes; neither alone are sufficient causes; and only their integrated activities provides the necessary and sufficient causes of growth and development. Genomic factors are considered as intrinsic and prior causes; epigenetic factors are considered as extrinsic and proximate causes. The data supporting this synthesis are provided here and above.

It is acknowledged that the validity of this dialectic synthesis is significantly dependent on the validity of its epigenetic antithesis. In turn, a defensible epigenetic antithesis should convincingly suggest some process(es) and/or mechanism(s) that can regulate (direct, control, cause) morphogenesis. It is argued here that these are provided by the newly emerging disciplines of complexity.

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Complexity and self-organization: The theories of ontogeny and phylogeny currently are being significantly reinvigorated by the new and evolving science(s) of complexity that integrate topics from mathematics (for example, cellular automata, fractals, strange attractors), biology (for example, genetic algorithms, artificial life simulations, neural networks, emergence, adaptive systems, connectivity), and physics, while minimizing distinctions between them. Complexity theory (CT) also integrates specifically related topics in bioengineering and the computer sciences; for example, chaos, information, and hierarchical theories, fuzzy logic, as well as cyto (tissue) mechanics and molecular (nano) mechanics.

Because epigenetic processes and mechanisms are best explained as examples of CT, a clear-cut demonstration of the role of CT in craniofacial ontogeny, at some point, is both necessary and possible. But in this place only this brief, intuitive preview is possible. Because fairness to both the novelty and conceptual richness of CT requires a comprehensive presentation to make it generally intelligible, it will be substantively reviewed subsequently.

CT provides descriptions of the behavior of complex biological systems that exist as "ensembles" of several tissues and organs, and not as clusters of individual cells and extra cellular substances. Such an ensemble (identical to a functional cranial component in the FMH) is termed here as a complex adaptive system (CAS), structurally arrayed as a vital continuum. This term is defined here as it is in the several analytical finite element methods (FEM) recently introduced into orthodontics and physical anthropology.

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CT provides compact, statistical descriptions of the collective growth behavior of such CAS continuity. During ontogeny, vital CAS exhibits the creation of robust, spontaneous, and emergent order.

An algorithm for control of such a CAS requires that it is able to alter itself in response to the (epigenetic) information produced by the system it is trying to control. In a CAS, minor changes in the epigenetic input can cause huge fluctuations in the morphological output.

CT, as it utilized information theory, assumed that a CAS processes information (both genomic and epigenetic) in a parallel, not a serial, manner. Where most previous biological theories of development were based on the methods of deterministic (genomically predetermined), classical mechanics, information theory, and CT, are probabilistic (epigenetically self-organized

and emergent), and are based on the methods of statistical mechanics. It is probable that ontogeny involves nonlinear processes and is not fully predictable; that is, growth and development, to a significant extent, exhibit both random behaviors and frequent perturbations. To clarify this point, note that previously most biological models were studied as if they were linear. That is, when their mathematical formulas were graphed they looked like straight lines. Linear systems are predictable: the calculus shows the changes in their state, and statistics (especially regression analysis) reduces their data to a line. However, CT makes it clear that most biological systems are nonlinear and are not most correctly described by these mathematical techniques; nonlinear formulations are necessary.

The highly ordered morphological properties of adult complex biological systems (for example, functional matrices and skeletal units) result from the operation of a series of spontaneous and self-organized ontogenetic processes and mechanisms. Such emergent self-organizing events can create phenotypic variability under constant genetic and other extra organismal epigenetic conditions.

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CONCLUSION -

Integration of pertinent advances in biomedical and bioengineering permitted an ongoing revision of the functional matrix hypothesis. The first two articles in this series, by emphasizing the roles of a number of biophysical and biochemical factors in the regulation of morphogenesis, implicitly argued for the correctness of the fundamentally epigenetic thrust of the FMH. However, because the conceptual tension between hypotheses suggesting the regulatory primacy of either genomic (genetic) or of epigenetic factors and/or processes in morphogenesis continues

unabated, it seemed useful to reevaluate this nontrivial matter, using the dialectical method of presenting a thesis, an antithesis, and a resolving synthesis.

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As early as 1000 BC attempts have been made to treat malocclusions. Appliances to move teeth have been found in Greek and Etruscan excavations. Aulius Cornelius celsus (25 BC – 50 AD) advocated the use of finger pressure to align the teeth as active treatment for correction of malocclusion. Pierre Fauchard, the father of Modern Dentistry, is generally given the credit for the first comprehensive discussion of "Regulating teeth". This book will discuss the evolution of orthodontic brackets and elaborate on the latest orthodontic brackets.

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Evolution of Brackets

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INTRODUCTION

As early as 1000 BC attempts have been made to treat malocclusions. Appliances to move teeth have been found in Greek and Etruscan excavations. Aulius Cornelius celsus (25 BC – 50 AD) advocated the use of finger pressure to align the teeth as active treatment for correction of malocclusion.

Pierre Fauchard, the father of Modern Dentistry, is generally given the credit for the first comprehensive discussion of "Regulating teeth". In his treatise on Dentistry, published in 1728, he discusses the "Bandelette", now called the expansion appliance.[1]William E Magill (1823-1896) was the first person to band teeth for active tooth movement in 1871.[2]It was during this period (1855-1930) where orthodontics saw a new era with the introduction of brackets. In orthodontics, bracket is a sort of attachment bonded to enamel, that provides the means to transfer the force applied by the arch wire to the tooth in the proper, precise and effective manner. The evolution of this appliance, originally manufactured from stainless steel, has demonstrated a unique progress curve characterized by extended quiescent periods interspersed with notably active periods.[3]

The original treatment approach utilized a slot attached to a stainless steel band that was cemented to the tooth, and early attempts to modify this attachment resulted in wide base surfaces onto which a slot was soldered. This appliance was then bonded to the tooth with epoxy resin. It was in the late 1970's that direct bonding to enamel was widely accepted as a standard procedure to replace banding.

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In orthodontics, all of the devices that project horizontally to support arch wires could be called as brackets. However due to differences in design and application the term is used only when referring to those devices that are open on one side usually on vertical or horizontal plane.

The term "Bracket" came into use in orthodontics when Dr. Edward .H. Angle introduced the Ribbon Arch appliance in 1916. This bracket is attached to the band close to its gingival margin and has a vertical slot facing occlusally.

As the need for horizontal, one directional placement and simultaneous engagement of all teeth became apparent Dr. Angle changed and rechanged bracket designs and evolved the edgewise bracket. This edgewise arch appliance is the last of the many contributions of Dr. Angle and was introduced to the profession by one of his last students Dr. Allen G Brodie, Sr. in 1928.

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After the death of Angle, this did not mark the end but saw a new beginning, which resulted in the evolution of different bracket systems. Some of the contributions were Steiner, Holdaway, Jarabark, Fizell, Ricketts, Tweed and many others.[1]

During the middle of the last century and a half the orthodontic profession had been stirred rather profoundly by the theories and new technique of Dr. P.R. Begg of Adelaide, South Australia. In Begg's differential force technique, modified ribbon arch type bracket with the slot facing gingivally is used with light round wires.

From time to time, a number of workers advocated the use of various types of bracket angulations to achieve built in tooth movement. Andrews in 1970, with the concept of slot angulation to its logical conclusion introduced the completely preadjusted straight wire appliance (SWA).

In 1979, Dr. Ronald Roth introduced a bracket set up containing modifications of the tip, torque, rotations and in-out movements of Andrews standard set up brackets. A number of modifications of the bracket prescriptions were made in the coming years. Self-ligating and Combination brackets were also introduced to improve the efficacy of treatment mechanics.

The design of the brackets is one of the important factors for efficient tooth movement and control of the complex force system acting when an appliance is worn by the patient. There are a large number of bracket designs meant to effect various tooth movement such as tipping, translation and torque. These brackets form the basis of all the orthodontic appliances.

The next stage of bracket evolution included modification of the base design to provide higher bond strengths with adhesives, while concurrent efforts focused on decreasing the base surface areas, which at that time covered almost the entire labial mesiodistal tooth surface.[3]Apart from these variations in designs, brackets also differ in the material. Brackets may be manufactured from stainless steel, Gold, Titanium, Cobalt-chromium, Polycarbonate and Fibre glass, Ceramic, Magnetic and metal reinforced plastic brackets. These brackets vary in certain factors such as bond strength, friction and fracture resistance. Brackets also vary in their dimensions and slot size. These factors influence treatment mechanics to a great extent.Thus, the wave of bracket design changes continues to mount, as varieties of brackets are available. The armamentarium of brackets for the present day orthodontist is formidable.

This is an attempt to review the journey of evolution of brackets and its current trends.

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CLASSIFICATION OF ORTHODONTIC BRACKETS

I) Based on the attachment to the tooth surface :

A) Weldable

B) Bondable

1. Laminated mesh
   - Regular
   - Mini
   - Open mesh
2. Porous powder
3. Honey comb - microlock
4. Chemically treated

II) Based on material constituent :

A) Stainless steel

B) Polycarbonate

C) Fiber glass reinforced

D) Ceramic

1. Alumina based
   - Monocrystalline
   - Polycrystalline
2. Zirconia based brackets

E) Titanium brackets

F) Magnetic brackets

G) Cobalt-chromium brackets

H) Composite brackets

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III) Based on technique :

A) Begg light wire bracket

B) Edgewise bracket

C) Straight wire bracket

D) Brackets used in combination technique

E) Universal bracket

F) Twin wire bracket

G) Bracket*s* used in BEDDTIOT

H) Tip-Edge bracket

I) Brackets used in Vari-Simplex Discipline

J) Brackets used in lingual orthodontics

IV) Based on bracket arch wire contact:

Ligating brackets

A) Self ligating brackets

1. Swirl lock bracket
2. Ford lock bracket
3. Slide pin bracket
4. Russel lock bracket
5. Edge lock bracket
6. Speed bracket
7. Activa bracket

V) Based on bracket manufacturing process

A) Milled bracket

B) Casted bracket

C) Moulded and sintered bracket

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EVOLUTION OF THE EDGEWISE APPLIANCE

Before the Angle system came into existence, orthodontics was being practiced in a highly individualistic manner. There were hundreds of different ways to treat patients, which began nowhere and ended nowhere. During this time the practice of orthodontics was in a chaotic condition.

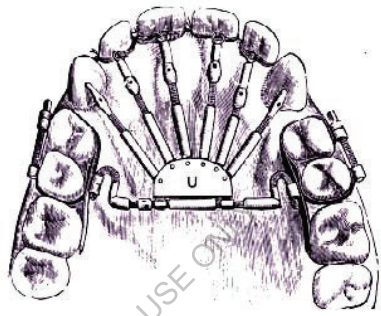

Fig. 11-2 An appliance used before the Angle system, often referred to by Dr. Angle as a monstrosity. (From Angle EH: *Treatment of malocclusion of the teeth*, Philadelphia, 1907, SS White Dental Manufacturing, p. 176.)

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There was a definite need to develop a standard appliance for precise tooth movements.[4]

Pierre Fauchard, a French physician in 1798 made the first attempt to move teeth. This appliance consists of a flat strip of metal, pierced with suitable holes to pass the wires to be tied around the crooked tooth. The metal strip was formed into an arch type which concurrently applied force after tying. Anchorage employed was simple anchorage and simple tipping movement was possible.[4]

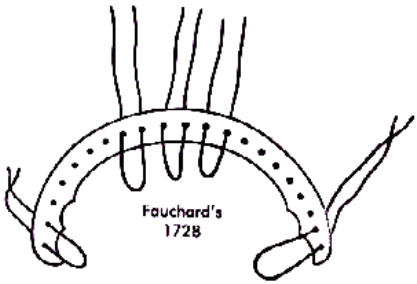

Fig. 11-3 Pierre Fauchard's orthodontic appliance. 1728. (From Angle EH: *Treatment of malocclusion of the teeth*, Philadelphia, 1907, SS White Dental Manufacturing, p. 196.)

In 1847, in New York, Dwinelle invented the regulating jack screw.

Fig. 11-4 Dwinelle's jack-screw, 1849. (From Steiner CC: *The Angle orthodontist*, Brooklyn, NY, 1933, E.H. Angle Society of Orthodontia, p. 281.)

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It delivered a pushing force on the teeth, which was later improved by Dr. Edward Hartley Angle to increase the range of action. During this time Angle developed the regulating retraction screw.[4]

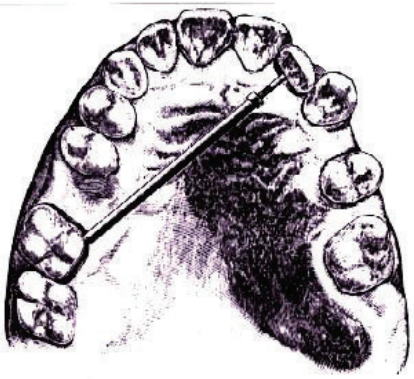

Fig. 11-5 Angle's jack-screw. (From Goddard CL: *The American text book of operative dentistry*. Philadelphia, 1897, Lea Brothers, p. 580.)

Fig. 11-6 Angle's jack-screw. (From Goddard CL: *The American textbook of operative dentistry*, Philadelphia, 189?, Lea Brothers, p. 567.)

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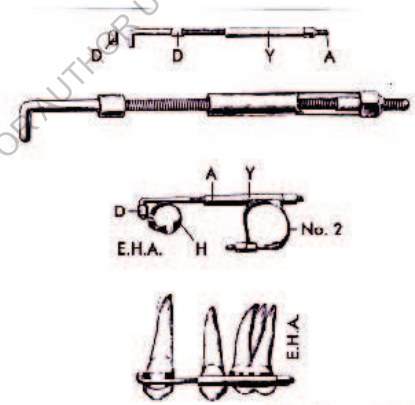

Fig. 11-7 Angle's retraction screw, 1887. (From Angle EH: *Treatment of malocclusion of the teeth*, Philadelphia, 1907, SS White Dental Manufacturing, p. 186.)

In 1887, Angle developed the prototype of the first bracket attachment (a delicate metal tube soldered to the band). Due to many technical problems and frustration in treatment, he was motivated and inspired to

develop a standard appliance which incorporated five important properties[4].

The appliance must be:

Simple → must push, pull and rotate teeth.

Stable → must be fixed to the teeth

Efficiency → must be based on Newton's third law and anchorage.

Delicate → must be accepted by the tissues and must not cause tissue inflammation and soreness.

Inconspicuous → must be esthetically acceptable.

With few exceptions the appliances used in contemporary orthodontics are based on Angle's designs from the early 20th century.

Angle developed four major appliance systems.

I. THE E ARCH APPLIANCE (1907)[4]

In the late 1800s, a typical orthodontic appliance depended upon some sort of a rigid framework to which the teeth were tied so that they could be expanded to the arch form dictated by the appliance. The E- Arch which was introduced in 1887, was a modification of this basic design.

APPLIANCE DESIGN

Clamp bands were used in the appliance construction. These clamp bands consisted of a metal band that nearly encircled the tooth crown. Each end was bent outward abruptly, perforated and thickened. The perforation in one flange was threaded, and a screw passed through it. The shaft or screw when turned, tightened the band around the tooth.

Clamp bands were placed only on the molars, and a heavy labial arch wire extended around the arch. The end of the wire was threaded, and a small nut placed on the threaded portion of the arch allowed the arch wire

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to be advanced so that the arch perimeter increased. Individual teeth were simply ligated to this expansion arch. If molar expansion was desired, the archwire was expanded.

TYPES OF E- ARCH APPLIANCE:

a) Basic E-arch: Used in the mandible with Bakers anchorage.

b) Ribbed E-arch: Used in expansion by tying brass ligatures to the arch.

c) E-arch without threaded ends: This fits into the molar sheaths with an attached ball for the high pull head gear in the incisor area.

d) E-arch with hooks: These are used in the maxilla. The entire maxillary dentition was moved distally and the mandibular dentition was moved mesially by the action of inter maxillary elastics. This approach also had a maxillomandibular growth guidance effect which was recognized later.

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ADVANTAGES OF THE APPLIANCE:

- Simplicity of construction

SHORTCOMINGS OF THE APPLIANCE:

- It could deliver only heavy interrupted force.
- It was capable of only tipping teeth.
- It was not able to precisely position any individual tooth.

To overcome these difficulties, the Pin and Tube appliance was introduced by Angle.

II. PIN AND TUBE APPLIANCE (1910)[4]

This was the first appliance that employed a bracket and used bands on most of teeth.

APPLIANCE DESIGN:

Bands were placed on all the teeth and a vertical tube was placed on each tooth into which a soldered pin from a smaller arch wire was placed. With this appliance, tooth movement was accomplished by repositioning the individual pins at each appointment.

ADVANTAGE OF THE APPLIANCE:

This was the first appliance with mechanism for root movement.

SHORTCOMINGS OF THE APPLIANCE:

- An incredible degree of craftsmanship was involved in constructing and adjusting the pin and tube appliance.
- Although this appliance was theoretically capable of great precision in tooth movement, it proved incapable in clinical use.
- It is said that Angle himself and one of his students ever mastered the appliance.
- The relatively heavy base arch meant that spring qualities were poor, and the problem therefore was compounded because many small adjustments were needed.
- The pins had to be expertly soldered, fitted perfectly into the tubes on the bands, removed, moved along the archwire, soldered again and fitted once more into tubes on the band.

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- Axial inclinations of the pins had to be altered and square ends of the archwire had to be fitted properly into square tubes on the molar bands.
- Patients were required to come for activations every few days.
- The appliance made rotational adjustments most difficult.

III. RIBBON ARCH APPLIANCE (1915)[4]

Angle's next appliance modified the tube on each tooth to provide a vertically positioned rectangular slot behind the tube. This appliance was introduced in 1915 due to difficulty in the use of pin and tube appliance.It was actually the first bracket, as such, to be used in an orthodontic appliance.

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APPLIANCE DESIGN:

-It was characterized by Bracket with a vertical slot and the arch wire was held in position by Brass pins.

- The teeth were free to move along the arch wire like a string of beads.

ADVANTAGES OF THE APPLIANCE:

- The archwire was small enough to have good spring qualities and was quite effective in aligning individual malposed teeth.
- The appliance had force control and a degree of stationary anchorage.
- It allows rotations to be accomplished readily.
- It offers control of buccolingual and labiolingual movements, and both incisogingival and occlusogingival movements are possible.

SHORTCOMINGS OF THE APPLIANCE:

- One of the important shortcomings of the ribbon arch appliance as originally developed, was that it made mesiodistal axial movements

difficult to obtain because anterior teeth could only be retracted at the expense of the anchorage provided by the posterior teeth.

- Although the ribbon arch wire could be twisted as it was inserted into its slot, the major weakness of the appliance was that it provided poor control of root position. The resiliency of the ribbon arch appliance simply did not allow generation of moments necessary to torque roots to a new position.
- The appliance was not suitable for en masse movements.
- Mesial and distal tipping bends could not be incorporated in the archwire and premolar teeth could not be moved bodily.

IV. THE EDGE WISE APPLIANCE:[4]

Two years before he died, with the knowledge born from experience and gained from his other appliance inventions, Angle set out to develop an appliance to overcome the difficulties of the previous appliances.

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The Edgewise appliance was Dr. Angle's final and greatest contribution to orthodontics. He changed the form of the brackets by locating the slot in the center and placing it in the horizontal plane instead of a vertical plane and inserted a rectangular wire rotated 90 degrees to the orientation it had with the ribbon arch- thus the name 'edgewise'. The new edge wise bracket consisted of rectangular box with 3 walls within the bracket, 0.022 inch by 0.028 inch in dimension. Its slot opened horizontally. This new design provided more accuracy and thus a more efficient torquing mechanism.

The Edgewise arch mechanism was designed to allow the orthodontist to place teeth in Angle's concept of "line of occlusion",

which is stated as ‘the line with which in form and position according to the type, the teeth must be in harmony, if in normal occlusion.’

Angle believed that there could be only one true line of occlusion and it must be the same as the architectural line on which dental apparatus were constructed. The ideal line was intended to govern the length, breadth, and peculiar curve of the dental arches along with the size and pattern of each tooth cusp and inclined plane comprising these arches. The unique contribution of the edgewise appliance in attaining a balanced occlusion is complete control over axial inclinations of all teeth in all directions. The classical mechanical means for exercising this control is the engagement of the archwire in the slot of the bracket on the tooth as shown below.

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MODIFICATION OF THE ORIGINAL EDGEWISE BRACKET

1. ORIGINAL SINGLE WIDTH EDGEWISE BRACKET[5]**:**

- The original edgewise bracket as designed by Angle was made of soft gold with a 0.022x0.028 inch slot that was readily deformed by the forces of occlusion and by tying ligature wires to the bracket.
- The bracket was 0.050 inch wide and soldered to the gold band material.
- Arch wire did not rest against the surface of the orthodontic band but only on the bottom of the bracket slot.

DISADVANTAGES OF THE SINGLE WIDTH BRACKET:

- Because of narrow width involved, the bracket itself was ineffective for tooth rotation.

  To overcome this problem, Angle soldered gold eyelets at an appropriate position on the orthodontic bands. Ligature wire tied from the eyelet to the arch wire rotated the tooth by means of deflection of the archwire and compression of the periodontal ligament.

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DISADVANTAGES OF THE EYELETS:

- Repeated tying of the eyelets was necessary to rotate the tooth to its final position.
- It was necessary to continue tying the eyelets throughout the treatment plan to prevent any relapse of rotation thus making the procedure time consuming and inefficient

2. TWO SEPARATE BRACKETS ON A SINGLE TOOTH[5]:

The next step in the development of the present day edge wise bracket began with the use of the two brackets on a single tooth spaced in a way that they would effect rotation of the tooth.

DISADVANTAGES OF TWO SEPARATE BRACKETS :

- Extreme care had to be taken to place the slots of the brackets in perfect alignment; otherwise, the archwire could not be seated into both the brackets.

3. TWIN BRACKETS [5]:

- The next step in the development was joining together of the two edgewise brackets on a common base.
- These were named as "Siamese twin brackets" by Brainerd Swain, the originator of this bracket.
- The space between the two brackets was 0.050 inch, equal to the width of one of the brackets.
- It gained popularity for use on upper central incisors and on molar teeth.
- The success of the early Siamese twin bracket led to the development of Siamese twin brackets that were not as wide as the original and were termed as the "Twin brackets".
- Basically there are four sizes of twin brackets:
  - Extra wide
  - Standard
  - Intermediate
  - Junior

POSTERIOR BRACKET[5]:

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- Another early development was the evolution of a solid bracket that was approximately twice as wide as the original edgewise bracket called a posterior bracket. Fig. 9.10
- It was approximately 0.100 inch wide and although designed to be used on molar teeth, it had gained popularity for use on practically all teeth.

4. CURVED BASE TWIN BRACKET[5] :

- The next evolutionary step was curving of the base of the twin bracket to reduce the deflection of the bracket from the base on teeth with curved contours of the buccal surface.
- These brackets conform to the buccal surfaces of the canines and premolars. Fig. 9,11.

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ADVANTAGES OF THE TWIN BRACKET:

- Main advantage was its ability to effect most of the tooth rotation without the use of auxiliary eyelet ties.
- Maintain control of axial tooth inclinations.
- "*Positive control*" which means that once the tooth has been rotated the mere tying of the bracket with ligature wire maintains the tooth in its corrected position. Thus a relapse of rotation is prevented and at the same time, the teeth that originally were not rotated are also prevented from rotation during space closing and retraction procedures.

DISADVANTAGES OF THE TWIN BRACKET :

- Interbracket span i.e the length of the archwire between brackets is decreased with the increased width of the twin bracket.
- Resiliency of the arch wire is decreased.
- Difficulty in employing closing loop archwires and second order bends because if the archwire is to slide posteriorly during activation of the closing loops, the decreased interbracket span interferes with the amount of closing action that can be obtained.
- Difficulty in obtaining final 10% of tooth rotation.

5. LEWIS BRACKET[5] :

- During the development of twin brackets, another approach to the problem of efficient tooth rotation was developed by Dr. Paul D Lewis, who soldered auxiliary rotation arms that abutted against the bracket itself and thus offered a lever arm to deflect the arch wire and rotate the tooth.
- The present Lewis rotation bracket is a one piece bracket with integral rotation wings. It is equivalent to the original edgewise bracket but, the tooth rotation deficiency of the latter is overcomed, while the "single width" feature is maintained.

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ADVANTAGES OF THE LEWIS BRACKET :

- The rotation wings on the Lewis bracket do not interfere with occlusogingival deflections of the archwire and therefore do not decrease the working interbracket span.
- They do not interfere with the activation of closing loops, second order bends and other arch wire fabrications that slide freely past the rotation wings.

- One decided advantage is 100% tooth rotation can be easily obtained and over correction of rotations is also possible. This can be accomplished by bending one wing closer to the tooth and the opposite wing farther away. Fig. 9.29.

DISADVANTAGES OF THE LEWIS BRACKET :

- Less control of axial inclination of tooth than to do twin brackets.

6. ANTI TIP LEWIS BRACKET :

- Incorporated Notches / slots in the ends of the wings of the brackets.
- Can be easily tied and is quicker.
- Deflection of the arch wire is quick effecting rotation of the tooth.

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7. VERTICAL SLOT LEWIS BRACKET [5]:

- A refinement in the Lewis bracket has been the incorporation of 0.020x0.020 inch vertical slot.

ADVANTAGE OF THE VERTICAL SLOT:

- Possible to use uprighting springs to correct axial inclination of the tooth adjacent to extraction spaces.

8. CURVED BASE LEWIS BRACKET[5]:

- This involved the curving of the base and wings of the bracket to conform to the canine and premolar teeth.

ADVANTAGE OF CURVED BASE LEWIS BRACKET:

- It allows greater contact with the band or bonding pad.
- The wings lie close to the tooth for most of their length, which reduces trapping of food around the wings.

9. STEINER BRACKET[5]:

- This was introduced shortly after the Lewis bracket and was designed by Cecil Steiner.
- These bracket incorporated flexible rotational arms and therefore did not depend entirely on the resiliency of the archwire for tooth rotation.
- Steiner bracket utilizes a single width edge wise bracket and therefore has the inherent advantage and disadvantage of this type of appliance.
- It is easy to tie and is quite efficient for tooth rotation. It works satisfactorily as long as the flexible arms do not undergo permanent deformation. Once a permanent deformation of the arms has occurred, complete rotation will not be effected unless the arms are readjusted to their original position.

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11. BROUSSARD BRACKET[5]:

- Designed by Garford Broussard for use in the Broussard technique.
- Modification of the edgewise bracket in which there has been the addition of a 0.0185x0.046 inch vertical slot to accept a doubled 0.018 inch auxiliary wire.

BURSTONE'S SEGMENTED ARCH TECHNIQUE

Segmented arch technique is a modified, full-banded edgewise orthodontic procedure which uses relatively light, constant force, with control over anchorage units as well as teeth to be moved. It was developed by Dr. Charles J. Burstone and Dr. James Baldwin in 1961.

It differs from therapy with continuous arches in that it consists of multiple wire cross sections so that varying wire sizes may be found in different portions of the arch.

Segmented arch technique set-up consists of[6]:-

- Wide Siamese brackets on the incisors.
- BURSTONE'S CUSPID BRACKET:
  - Consists of a basic 0.022 x 0.028 edgewise slot
  - Additional 0.017 x 0.025 vertical auxiliary tube placed gingivally for attachment of retraction springs.
- Bracket- tube combinations on bicuspids with the tube placed occlusally.
- Upper first molars carry a triple bracket tube combination consisting of:
  - 0.022 x 0.028 inches slot
  - 0.045 inches headgear tube
  - 0.017 x 0.025 inches horizontal auxiliary tube placed gingivally
- Lower first molars carry a double bracket tube combination consisiting of:
  - 0.022 x 0.028 inches bracket
  - 0.017 x 0.025 inches horizontal tube placed gingivally

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- Second molars carry a single 0.022 x 0.028 inches horizontal tube.
- Horizontal lingual sheaths on all first molars to accept a doubled over 0.036 inch wire.

UNIVERSAL APPLIANCE

The Universal Appliance was developed by Dr. Spencer R. Atkinson in 1928. It has undergone periodic refinements up to this day, keeping up with changing techniques, without losing its essential characteristics. In this technique there is no standard protocol to be followed in all cases. The needs of each individual case will determine which separate part or combination of elements may be used. The variety of combinations available with the Universal Appliance are many, and their proper selection will depend on the operator's good judgment.

It is essentially a labial and lingual type of appliance whose main elements are the bracket and the lingual arch, with contraction coil springs playing a very important role[7].

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THE UNIVERSAL BRACKET[7]:

The fundamental element is the Universal bracket, a combination of the edgewise principle and Angle's ribbon arch. This bracket gives the appliance control in three planes of space. This bracket seems to be ideal for orthodontic mechanics because of its versatility and its reduced size.

A very popular Universal bracket is called the "double action bracket". It has two transverse slots.

- The gingival or horizontal slot, into which an .008" up to an .014" round wire may be fitted, opens buccally. This slot controls the

mesiodistal inclinations and serves as a fulcrum for labio-lingual movements.

- The incisal slot is vertical and opens incisally, similar to Angle's ribbon arch bracket or Begg's light wire bracket. It will hold round wires from .008" up to .016" or flat wires from .008" .020" up to .015" .028". This slot controls the tooth bucco -lingually and also controls rotations. Both slots allow the tooth to move bodily during retraction.

- This bracket has a precurved base for better adaptation and is available in two sizes, a long one with a body height of .150" and a short one of .125".
- Both the gingival and the incisal wires are locked into the bracket by a single lock pin or by an .008" or .010" soft stainless steel ligature wire. The turned end of the lock pin or the pigtail of the ligature wire are tucked alongside the lateral tabs of the bracket to protect the soft tissues. These tabs are used to control correction of mesio-distal inclinations.

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- A variation of this bracket is the "root torquing bracket". Its tabs are an eyelet type which extend outward permitting extra ligation for severe rotations, extra leverage, and better support for the archwires. It is used mainly for wide teeth or severely rotated teeth. It also comes in two sizes and has a precurved base[7].

LIMITATION OF THE ORIGINAL UNIVERSAL BRACKET[8]:

- Problems of post treatment stability.
- The lateral extending tabs or wings were too bulky .
- The central vertical shaft was too narrow and shallow to accomodate the archwires and pins or ligatures comfortably.

The solution, then, was to eliminate the lateral extending wings and to make a bracket that was wider mesiodistally with more room buccolingually[8].

- These modifications would provide the Universal Appliance with a simple, practical bracket with greater built-in leveling, rotating and torquing potential and with more room for ligating or pinning.
- There would also be enough room for an auxiliary attachment such as an uprighting spring or for extra ligatures.
- Elimination of the lateral wings would provide the welding tabs with more welding space and, due to the width of the whole bracket, the forces applied to it would be distributed in a wider area, making the bracket more efficient and comfortable to work with.

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THE 3-D UNIVERSAL BRACKET[8]:

The next step towards evolution was to design a bracket with such specifications and to submit it to clinical test to prove its performance. The result was the latest Universal bracket called the 3-D Universal Bracket due to its tridimensional mechanical principle.

- This bracket is essentially a vertical hollow shaft with two lateral welding tabs. The central shaft has two slot openings.

- The horizontal one opens labially at the gingival third and will accomodate .008″ up to .016″ round wire.
- The vertical slot opens incisally near its base and extends gingivally one-third of the bracket height. It will accomodate a single wire, a double wire, a twisted bundle of round wires, or a single ribbon or flat wire ranging from .008″ .020 ″ up to .016″ .028 ″.
- The two curvatures of the base of the bracket provide a smooth adaptation to the band and to the surface of the teeth.
- Compared to one of the most frequently used Universal brackets, the 3-D Universal Bracket is wider mesiodistally and slightly deeper buccolingually. It has no extending or curling lateral tabs.

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ADVANTAGES OF THE 3-D UNIVERSAL BRACKET[8]:

1. Efficiency in leveling and correcting rotations and mesiodistal axial inclinations.
2. Permits bodily movement of teeth in a mesiodistal direction.
3. Retracts canines without tipping.
4. Torques automatically in most cases. Individual torque is also easily achieved.

Comparison of previous Universal bracket with the 3-D Universal Bracket.

A and AA, the difference in size and shape.

B and BB, incisal view.

C and CC, side view.

D and DD, the areas of torque application (shaded).

TWIN WIRE APPLIANCE

It was introduced by Joseph Johnson in the 1930's. The philosophy behind its use was that by virtue of *two* light wires placed in the same bracket, more physiologic tooth movement can be obtained than with *one* heavy wire.

The twin wire attachment and bracket permit rapid reduction of rotations with relatively little discomfort to the patient[9].

The twin wire appliance consists of:

I. Twin labial arch[10]:

- It is composed of two end tubes into which a doubled, fine, stainless steel wire is drawn.
- The end tube is made of stainless steel with an outside diameter of 0.036″, inner diameter is 0.022″ and is 1 1/8″ in length.
- A hook is soldered to this tubing when intermaxillary elastics are to be used.

II. Cap and channel bracket[10]:

- It consists of a locking device which is attached to the labial surface of the bands to be cemented to the teeth.
- This locking device is composed of a male and a female part.
- The male part is welded in the middle of and parallel to the edges of the bands. It has parallel walls forming a channel in which the twin wires are to be seated and the outside walls are dovetailed.
- The female part which is called a cap, slips over the male part and is held in place by friction.
- The locks are 1/8″ long and 1/16″ wide and 1/32″ thick and streamlined in shape.

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LIMITATION OF THE TWIN WIRE APPLIANCE[9]:

- Problem of anchorage.
- Lack of control of canine and premolar teeth after correction of rotations.

Today the twin-wired appliance finds less use in orthodontic speciality circles, largely because of its non-extraction orientation and greater difficulty in controlling teeth and achieving torque when teeth have been extracted.

BIOPROGRESSIVE THERAPY

This technique was introduced by Dr. Robert Ricketts and Dr. Ruel Bench in 1950's who combined contemporary edgewise mechanics with solid diagnostic principles and an innovative approach to sectional mechanics. This method may be considered an evolution from the original edgewise technique, with features of certain light-wire methods incorporated.

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BRACKET MODIFICATION BY RICKETTS[11]:

- Increased mechanical efficiency was desired over the staple, used in the original edgewise, for rotation correction.
- Ricketts designed a wide-flanged easy-tie 0.018" x 0.030" Siamese bracket for:
    1. Ease of ligating
    2. Uprighting access
    3. Flexibility of the elastic attachment

- This design was an evolution from the original Steiner design and the narrow slot was developed in consultation with Steiner and Lang.
- The bracket could be fabricated on bands or bonded directly.

DEVELOPMENT OF THE BIOPROGRESSIVE SET-UPS[11]:

There are three combinations of the bioprogressive set-up which use the basic bioprogressive percepts:

1. STANDARD BIOPROGRESSIVE:

- In the standard bioprogressive setup torque was built into the brackets of the upper central and lateral incisors as well as all four cuspids.
- The torquing of the lower buccal segment and step bends in the arch for the premolars and molars were relegated in the arch wires.

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2. FULL TORQUE BIOPROGRESSIVE:

- In this setup torque combinations were developed for the lower premolars and molars.
- Rotation tubes were placed on lower molars.
- Lateral step bends were needed, and even the bends were already placed in the preformed archwires.
- All torque requirements were eliminated from the wire except for the variations needed.
- First-order activations were avoided because of the need for bulking-up of the brackets, the danger of esthetic and hygienic

complications, and the need to prevent lever action against the band itself.

3. TRIPLE CONTROL BIOPROGRESSIVE:

- This setup combines the first order offset bends with the second order tip, and the third order torque, to present the complete "triple control" needed to place the teeth in all three planes of space to accomplish the necessary movements needed to reach the objective of the overtreated orthodontic occlusion.
- To accomplish this first, all the canine brackets were raised to produce the buccal step for the first premolars.
- Second, because the molar needs to be stepped bucally from the second molars and in order to obviate the step in the wire, the second premolar was raised so that it will be aligned lingually.
- This allows a continuous arch to be used as the final ideal finishing arch. With the Triple Control appliance, the finishing archwire does not require the offsets or torque, since they are now built into the appliance.

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APPLIANCE DESIGN[11]:

A) PROVISIONS FOR TIPPING(Second-order control)

All bands receive brackets parallel to the band margin except the following:

Upper lateral incisor	8° down on distal
Upper Canine	5° down on distal

Lower Canine	5° down on distal
Lower first Molar	5° down on mesial

B) PROVISION FOR TORQUE(Third-order control)

- For standard, full torque and triple control bioprogressive setup:

Upper Central Incisor	22° (root to palatal)
Lateral Incisor	14° (root to palatal)
Canines	7° (root to palatal)
Lower Canines	7° (root to lingual)

(For standard, full torque and triple control)

- For full torque & triple control bioprogressive setup:

Lower Second Premolar	14° (root to buccal)
Lower 1st Molar	22° (root to buccal)

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C) PROVISIONS FOR ROTATIONS & STEP OUTS

- Standard & full torque bioprogressive setup:

Lower Molar	12° (to the distal)

Rotation:

i) Ligation to eyelet, when simple bracket used.

ii) Figure of eight ligature ties for reciprocal rotation.

iii) With Siamese bracket as –

a) Band cemented slightly off centre: tying of any one bracket.

b) One bracket can be filled with elastic or squashed.

c) Reciprocal ties

d) Lingual cleats for counter movement.

RICKETT'S TRIPLE CONTROL BIOPROGRESSIVE PRESCRIPTION[11]:

Tooth		Angulation (Tip)	Inclination (Torque)
Maxillary			
Central incisor		0^0	22^0
Lateral incisor		8^0	14^0
Canine		5^0	7^0
First premolar		0^0	0^0
Second premolar		0^0	0^0
First molar		0^0	0^0
Second molar		0^0	0^0
Mandibular			
Central incisor		0^0	0^0
Lateral incisor		0^0	0^0
Canine		5^0	7^0
First premolar		0^0	0^0
Second premolar		0^0	14^0
First molar		5^0	22^0
Second molar		5^0	22^0

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SHORTCOMINGS OF THE STANDARD EDGEWISE APPLIANCE

- Too many wire bendings required to produce desired tooth movement. This made the job of the orthodontist tedious and increased the chairside time.
- Treatment priorities and results of a given orthodontist do not share characteristic features observed in other orthodontists' results. (Non-similar end results).
- The articulation of occlusal surface often did not match the classic textbook description, thus cases were under treated, in the sense that molars were not in true class I relation and incisors lacked torque.
- The long axis of the teeth on either side of the extraction site were often not parallel and also the teeth were rotated.
- The range of crown inclination and angulation of any tooth type varied considerably from one clinician to another.
- Dental casts were not mounted on an articulator to assess functional occlusal requirements.

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EVOLUTION OF THE STRAIGHT WIRE CONCEPT

The title 'Straight-wire concept' was developed purposely to emphasize the term concept. The concept or idea to be developed is that a more consistent, more ideal result can be obtained with less physical and mental drain on the operator, in less over-all treatment time, and with less discomfort to the patient, with the use of an appliance which places the primary source of tooth control within the attachment rather than in the archwire.

Another attribute of this concept is the simplicity involved. It has been said- *"In art-in all things, the supreme excellence is simplicity"*.

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Transition from the Standard Edgewise to the Preadjusted Edgewise system

"The birth of a new concept is never an all or none phenomenon. It is a slow evolution, with contributions from many. A new principle is an inexhaustible source of new views"

Various efforts were made to alter the design & positioning of the standard edgewise in order to reduce the necessity for wire bending.

- In 1927 Angle suggested angulating the entire bracket on the band in order to reduce the necessity for second order bends[12].
- In 1952 Reed Holdaway suggested bracket overangulation on either side of an extraction site, to reduce the second-order wire bends otherwise needed to promote both translation and angulation overcorrection[13].

- In 1957 Jarabak incorporated slot inclination to reduce the need for third-order archwire bends, so he is credited for being the first to actually build guidance into the bracket. Jarabak also recommended bracket angulation[14].
- Another attempt was made by Ivan Lee by milling torque in to the face of the bracket slot, of upper and lower incisors.
- In 1958 John J. Stiffer developed an edgewise appliance with male/female component. The female part was attached to the tooth; it was designed to receive one of many interchangeable male components with various combinations of inclination, angulations and prominence.

This was the first edgewise bracket designed to build guidance into all three plane of space. He was granted US patent for it.

- In 1960 Joseph Jarabak and Fizzell demonstrated a modified edgewise technique which incorporated 2nd and 3rd order mechanics (tip and torque) in the appliance and called it 'building treatment into the appliance'

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Thus, right after the introduction of edgewise appliance in orthodontics, people started thinking about ways to achieve high quality results with lesser wire bending and simplified mechanics.

However it was only in 1970 that the first fully programmed appliance was introduced in the field of Orthodontics by Dr. Lawrence F. Andrews.

The genesis of the straight wire appliance was not a result of a single stray discovery, but rather the result of numerous experiments. Many individual innovations were distilled and combined to form this intricate design.

The concept of fully programmed appliance was evolved from a series of five studies carried out between 1960-1970 by Lawrence Andrews and his associates.

ANDREW'S STUDIES

The concept that an edgewise appliance can be fully programmed evolved from a series of five studies.

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First study

It began in 1960. It involved examination of post treatment dental casts to assess the static occlusion.

By analyzing hundreds of post treatment cast in early 1960's following observations were made.

1. The articulation of occlusal surfaces often did not match the classic textbook description.
2. The long axes of teeth on either side of extraction sites were not always parallel.
3. Crown inclination and angulation varied considerably from one clinician to another.
4. Permanent second molars were routinely not included in treatment.

5. Interdental spaces (at extraction sites and other locations) occurred frequently and often seemed to result from incomplete treatment rather than from mesio-distal crown size discrepancies.
6. Teeth requiring translation were often rotated.
7. Functional occlusion was not accessed by mounting dental casts on articulator at the end of treatment, nor were intraoral photographs used.
8. There was no standardization as to whether the dental casts were registered in centric relation or centric occlusion.

Conclusion: -

This initial attempt to assess the study of art of orthodontics in terms of post-treatment static occlusion did not yield the consistent and adequate data required for firm conclusions. One implication, was clear: the paragon positions of natural teeth could be found by studying dentitions with naturally optimal occlusion.

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Second study[15]*:* -

On the hypotheses that naturally occurring optimal occlusion would be worthy of emulation, casts of such dentitions were collected over a 4-year period. By 1964 the sample comprised of 120 casts.

These dentitions presented the following common characteristics: -

1. They had never been subjected to orthodontic treatment.
2. The dentitions were well aligned and pleasing in appearance.
3. They appeared to have excellent occlusion.
4. They would not benefit from orthodontic treatment.

Third study[15]*: -*

The third and- in retrospect- the most important study that led to the development of straight wire appliance (SWA) was the discovery of the six characteristics that were consistently present in the collection of 120 casts of naturally optimal occlusion. These qualities were referred to as the *Six keys to Optimal Occlusion* and they are important because:

- They are a complete set of indicators of optimal occlusion.
- They can be judged from tangible landmarks.
- They can be judged from the facial and occlusal surfaces of the crowns.

Some of the terms which are necessary in the discussion of the six keys:

Andrew's plane: The surface or plane on which the midtransverse plane of every crown in an arch will fall when the teeth are optimally positioned.

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Clinical crown : The amount of crown visible in late mixed dentitions and adult dentitions with gingiva that is healthy and not recessed. However, Orban has defined the clinical crown as the anatomical crown height minus 1.8 mm.

Crown Angulation: The angle formed by the facial axis of the clinical crown (FACC) and a line perpendicular to the occlusal plane.

Crown angulation is considered positive if the occlusal portion of the FACC is mesial to the gingival portion, negative when distal.

Crown Inclination: The angle between a line perpendicular to the occlusal plane and a line that is parallel and tangent to the FACC at its midpoint (FA point). Crown inclination is determined from the mesial or distal perspective.

Crown inclination is considered positive if the occlusal portion of the crown, tangent line, or FACC is facial to its gingival portion, negative if lingual.

Embrasure line: An imaginary line at the crown's mid-transverse plane, that would connect the most facial portions of the contact areas of a single crown, or of all crowns in an arch when they are optimally positioned.

Facial axis of the clininal crown (FACC): For all teeth except molars , the most prominent portion of the central lobe on each crown's facial surface, for molars, the buccal groove that separates the two large facial cusps.

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Facial-axis point (FA point): The point on the facial axis that separates the gingival half of the clinical crown from the occlusal half.

ANDREWS SIX KEYS TO OPTIMAL OCCLUSION

Key I: Interarch Relationships

This key consists of seven parts.

1) The mesiobuccal cusp of the permanent maxillary first molar occludes in the groove between the mesial and middle buccal cusps of the permanent mandibular first molar, as explained by Angle.
2) The distal marginal ridge of the maxillary first molar occludes with the mesial marginal ridge of the mandibular second molar.

3) The mesiolingual cusp of the maxillary first molar occludes in the central fossa of the mandibular first molar.
4) The buccal cusps of the maxillary premolars have a cusp-embrasure relationship with mandibular premolars.
5) The lingual cusps of the maxillary premolars have a cusp-fossa relationship with mandibular premolars.
6) The maxillary canine has a cusp-embrasure relationship with the mandibular canine and first premolar. The tip of its cusp is slightly mesial to the embrasure.
7) The maxillary incisors overlap the mandibular incisors, and the midline of arches match.

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Key II: Crown Angulation, the mesiodistal "tip"

If viewed from labial/buccal aspect all crowns have positive angulations, i.e. the gingival portion of the long axis of the crown is distal to the occlusal portion.

Note: - All crowns of each tooth type are similar in the amount of angulation.

Key III: Crown Inclination, the labiolingual or bucco-lingual "torque"

Maxillary Arch:

- Most maxillary incisors (81.5%) have positive inclinations.
- Maxillary canine and premolars have negative and quite similar inclination.

- Maxillary first and second molars have negative and similar inclination but slightly more negative than those of the canine and premolars.

Mandibular Arch:

- Inclinations of the mandibular crowns are progressively more negative from incisors through the second molars.

Key IV: Rotations

The fourth key to optimal occlusion is an absence of tooth rotations.

If rotated, a molar or bicuspid occupies more space than normally— a condition unreceptive to normal occlusion. A rotated incisor can occupy less space than normal.

Key V: Tight contact

Contact points should abut unless a discrepancy exists in the mesiodistal crown diameter.

Key VI: Curve of Spee

A flat occlusal plane should be a treatment goal. Measured from the most prominent-cusp of the lower second molar to the lower central incisor, no curve was deeper than 1.5 mm in the nonorthodontic normals.

Discussion:

- Although the 120 dentitions with naturally occurring optimal occlusion show individual differences in arch form and teeth size, they generally possessed the six keys described above.
- The six keys are interdependent elements of the structural system of optimal occlusion and serve as basis for evaluating occlusion.

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- The six keys can be used as treatment objectives for most patients.
- To achieve these goals may not be feasible in all instances, but to stop short when they are attainable is unacceptable.

Fourth Study[15]*: -*

It includes thousands of measurements of the crowns of the 120-cast sample. The purpose was to learn the extent to which the position, and in certain ways shape were constant within each tooth type, and how relative size was consistent within an arch.

MEASUREMENTS MADE IN THE STUDY:

- The bracket area of each tooth type
- Vertical crown contour
- Crown angulation
- Crown inclination
- Maxillary molar offset
- Horizontal crown contour
- Facial prominence of each crown
- Depth of the curve of spee

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FINDINGS OF THE STUDY:

Teeth	Prominence	Angulation	Inclination
Maxillary			
Central incisor	2.1 mm	5^0	$+7^0$
Lateral incisor	1.65 mm	9^0	$+3^0$

Canine	2.5 mm	11^0	-7^0
First premolar	2.4 mm	2^0	-7^0
Second premolar	2.5 mm	2^0	-7^0
First molar	2.9 mm	5^0	-9^0
Second molar	2.9 mm	5^0	-9^0
Mandibular			
Central incisor	1.2 mm	2^0	-1^0
Lateral incisor	1.2 mm	2^0	-1^0
Canine	1.9 mm	5^0	-11^0
First premolar	2.35 mm	2^0	-17^0
Second premolar	2.35 mm	2^0	-22^0
First molar	2.5 mm	2^0	-30^0
Second molar	2.5 mm	2^0	-35^0

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VARIOUS DIMENSIONS OF THE MAXILLARY TEETH:

- Offsets in molars: -

The facial cusps of maxillary molars are not of equal prominence. The mesiobuccal cusp is more prominent than the distobuccal cusp. The angle between the measuring wire and embrasure line is the offset angle. Hence 10 degree of offset is given in maxillary molar bracket (buccal tube).

VARIOUS DIMENSIONS OF THE MANDIBULAR TEETH:

No offset is needed for mandibular molars because the middle and mesiobuccal cusps are equally prominent.

Conclusions:

This study revealed consistencies of position (except for incisor inclination), morphology and relative facial prominence for the crowns of each tooth type within an arch. The differences in the incisor inclination were attributable to interjaw disharmony. Thus, special considerations must be given in bracket design correlating the inclination of incisors with the interjaw relationships.

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Fifth study[15]*: –*

After evaluating the six keys to optimal occlusion and the measurements of the teeth in all dimensions, the next study began in mid 1960's and continued for a period of 10 years. In this study, 1150 post treatment dental casts displayed at the meetings of American Association of Orthodontics, Tweed foundation and the Angle society were compared with those in the untreated optimal sample, on the basis of the six keys of optimal occlusion. This study established the need for a fully-programmed appliance.

Following Conclusions were made[15]: -

Key I

Although majority of end results satisfied Angle's class I interarch relationship, however in 80% of them the true tripodal relation given by Andrews were lacking.

- In most of the cases the distal marginal ridge of the maxillary first molar did not occlude with mesial marginal ridge of second mandibular molar.
- The premolars and canines did not have a cusp- embrasure relationship.
- **Key II**

91% of the post treatment casts had one or more teeth whose angulation was different from those of the optimal sample.

- The maxillary lateral incisor and canine angulations were frequently negative, in contrast to the positive angulation in the optimal sample.
- Maxillary molar angulation often was negative or insufficiently positive in non-extraction treatment and excessively positive in extraction treatment.

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Key III

- The interincisal FACC Angle was more than 180^0 in 78% of post treatment casts and less than 180^0 in 81.5% of optimal samples.
- The maxillary posterior crown inclination was not always negative in post treatment casts, as it was in the optimal sample.

Key IV

In 67% of post treatment casts rotations were evident. Most of the rotated teeth were those that had required translation during treatment.

Key V

In 43% of cases one or more spaces were present due to incomplete treatment rather than due to tooth size discrepancy.

Key VI

A curve of Spee greater than 2.5 mm was present in 56% of the post treatment casts.

Conclusions:

1. Few of the post treatment results meet the Six Key standards.
2. Treatment priorities and results of a given orthodontist share
3. characteristic features not always observed in the results of other orthodontists.
4. During the 10-year span of the formal study no discernible improvement was observed in the presence of the Six Keys.

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Thus the need for an improved edgewise appliance was better understood when Angle's edgewise bracket design was examined in the light of the new information gathered from above studies about tooth shape and position, and from the new treatment goals concerning facial esthetics, which may require extractions and jaw surgery.

EDGEWISE APPLIANCE CLASSIFICATION

The several types of edge wise appliances are best differentiated by placing them into three categories[15]:

1. Non-programmed.
2. Partly-programmed.
3. Fully-programmed.

DEFINITIONS:

Non-programmed appliance :

A set of brackets designed the same for all tooth types, relying totally on wire bending (except possibly for angulation if the bracket is angulated) to achieve the optimal position for each individual tooth.

Partly programmed appliance :

A set of bracket designed with some built in features, but that always requires some wire bending (though less than in required by non-programmed appliance).

Fully programmed appliance :

A set of brackets designed to guide teeth directly to their goal positions with unbent arch wires.

THE NONPROGRAMMED EDGEWISE APPLIANCE

TERMINOLOGIES

- Angulated slot: A slot angled more or less than 90° to the bracket's vertical components.

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- Bracket base: The portion of the bracket stem intented to mate with the surface of the crown.
- Bracket stem: The portion of the bracket that includes the bracket base, the lingual half of the slot, and the portions between.
- Base point: The middle of the bracket base. It falls on an extension of the faciolingal axis of the bracket stem.
- Bracket siting: Any procedure that affects positioning the bracket. Bracket siting is influenced by bracket design and crown landmarks.
- Slot base: The surface of the slot closest to the tooth.
- Slot point: The midpoint of the slot and of the (buccolingual) slot axis.
- Slot Axis: The buccolingual (or labiolingual) centerline of the slot. It is equidistant from the gingival and occlusal slot walls and is centered mesiodistally. Extended lingually, the slot axis would include the base point and the FA-point; and it would be included by a labial or buccal extension of the Andrews plane.
- Slot siting: Any procedure that affects positioning the bracket slot. Slot positioning is influenced by bracket design, bracket siting and crown morphology.
- Horizontal bracket components: The occlusal and gingival sides of the bracket.
- Vertical bracket components: The mesial and distal sides of the bracket and the wings.

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DESIGN SHORTCOMINGS OF THE NONPROGRAMMED APPLAINCE[15]:

The Angle-designed edgewise brackets are “nonprogrammed” because of their bilaterally symmetrical design. For tooth movement not involving translation, six factors cause the slot of the brackets to be sited in ways that always require archwire bends. Each factor may cause the slot to be misdirected by more than 2° from its optimal angulation and inclination and by more than 0.5 mm occlusogingivally, mesiodistally, and faciolingually.

The six factors are:

1. Bracket bases are perpendicular to the bracket stems.
2. Bracket bases are not contoured occlusogingivally.
3. Slots are not angulated
4. Bracket stems are of equal faciolingual thickness.
5. Maxillary molar offset is not built in.
6. Bracket sitting techniques are unsatisfactory.

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1. PERPENDICULAR BASES:

The base of the nonprogrammed bracket is perpendicular to the faciolingual axis of its stem. This feature causes problems of slot inclination and occlusogingival position.

Each crown in an arch has its own optimal amount of inclination. Therefore, brackets having bases that are perpendicular to their stems, and sited base-point to FA-point of each crown, will target their slots to that many different inclinations and occlusogingival levels.

2. BASES NOT CONTOURED OCCLUSOGINGIVALLY:

Occlusogingivally, the bracket base is flat, but the facial surface of a crown is curved.

When such a bracket is being attached to a crown, either directly or with a band, it can unintentionally be rocked occlusally or gingivally . Not only is *torque* affected by any *rolling* motion during bracket placement. So is the *height* of the slot in relation to the occlusal plane or Andrews plane, destroying proper relationships between the LA-point and the slot axis. And third, the various positions involve the *distance* of the slot from the tooth's surface, affecting in/out requirements.

(A) Rolling potential of a flat-base bracket on curved surface of a crown, indicating effects on torque, on height of slot, and on horizontal distance of slot from intended bracket site- which affects in/out requirements.
(B) Three of the possible bracket positions inherent in the rolling potential described above

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Effect on torque of flat-base bracket's rolling potential.

MESIODISTAL BASE CONTOUR

The mesiodistal contour of the bracket base also does not match with that of the crown.

3. SLOTS ARE NOT ANGULATED[18]:

The slots of the nonprogrammed bracket are not angulated as per the optimal crown angulation of each tooth type thus second order bends are needed to achieve the optimal crown angulation.

- To reduce or eliminate the need for second-order bends for angulation, many orthodontists recommended angulating the brackets.
- The nonprogrammed bracket, however, was not designed for such a technique, because its base curves only horizontally.
- If any existing bracket with a horizontally curved base is angulated on the tooth to achieve tip, this creates a two-point contact between tooth and two diagonally-opposite corners of the bracket base, resulting in a potential for *rocking.*
- Under these conditions, the inclination and occlusogingival ranges for slot siting are greater than when the bracket is not angulated.

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(A) When tip is built into the slot, the bracket can mate solidly with the tooth.

(B) When bracket is angulated on tooth to accomplish tip, a rocking potential is created.

4. STEMS OF EQUAL PROMINENCE[18]:

The distance from the bracket base to the center of the slot is the same in each bracket. Therefore the slots are as irregular in facial prominence as are the crowns when the teeth are optimally positioned.

5. MAXILLARY MOLAR OFFSET NOT BUILT-IN:

- The mesiobuccal cusp of each optimally positioned maxillary molar is more facially prominent than the distobuccal cusp.
- This causes the midsagittal plane of the stem and the slot to be angular to the midsagittal planes of the crown with a resultant rotational effect on the molar.
- This feature has to be corrected by incorporating first-order offset bends in the archwire.

6. UNSATISFACTORY LANDMARKS FOR BRACKET SITING:

The five traditionally used landmarks are:

- Long axis of the crown
- Long axis of the tooth
- Incisal edges and cusp tips
- Marginal ridges
- Contact points

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These landmarks used traditionally for siting the bracket are unreliable and have their own deficiencies and no two orthodontist seldom agree about which landmarks are best for bracket siting.

Thus there was a need of an appliance whose design and siting system will reduce or eliminate the need for wire bending and it will also stimulate greater emphasis on diagnosis, treatment planning, and execution of treatment.

FULLY PROGRAMMED STANDARD BRACKETS

The simplest version of a fully programmed appliance consists of brackets designed to guide teeth that do not require translation. These brackets are referred to as standard brackets. There is one standard bracket for each tooth type except for the incisors and maxillary molars: for incisors there are three, for maxillary molars there are two.

To understand the design of fully programmed standard brackets, the following terminologies are required[15]:

- Auxiliary feature: A design feature that contributes to the biological aspect of treatment but is not involved in targeting the slot.
- Convenience feature: A design feature that facilitates use by the orthodontist or promotes comfort for the patient but does not contribute to the biological aspects of treatment or to targeting the slot.
- Inclined base: A bracket base that is angled more or less than 90° to the midtransverse plane of the bracket stem.
- Inclined slot: A slot whose midtransverse plane is inclined relative to the midtransverse plane of the bracket stem.
- Midfrontal plane of the crown: The plane that separates the facial from the lingual half of a clinical crown.
- Midsagittal plane of the crown: The plane that separates the mesial and distal portions of a crown at its facial axis.
- Midtransverse plane of the crown: The plane that separates the occlusal portion of a clinical crown from its gingival portion.
- Prominence plane of the crown: A plane that is at right angles to each crown's midtransverse and midsagittal planes and is 1mm farther

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facially from each crown's embrasure line than is the most facially prominent cusp of the first molar in that arch.

- Slot-target point: The midpoint of the slot site for a tooth type. It is located at the junction of the crown's prominence plane and facial extensions of the crown's midsagittal and midtransverse planes.
- Slot site: The area that the slot must occupy if it is to passively receive an unbent archwire when the teeth are optimally positioned.
- Mesiodistal base contour: The horizontal contour of the bracket's base.
- Occlusogingival base contour: The vertical contour of the bracket's base.

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DESIGN FEATURES OF THE FULLY PROGRAMMED APPLIANCE[15]:

The design of fully programmed brackets emanates from the slot site. The features of standard brackets include:

- Slot siting features
- Convenience features
- Auxiliary features

A. SLOT SITING FEATURES[15]:

The eight slot siting features are explained from the perspectives of the planes of individual teeth and brackets.

a) Mid-transverse plane
b) Mid-sagittal Plane
c) Mid-Frontal Plane

I. MIDTRANSVERSE PLANE[15]:

The midtransverse plane of the slot must coincide with a facial extension of the crowns midtransverse plane. To achieve this objective, the following 3 siting features are required:

Feature 1:The mid transverse planes of the slot, stem, and crown must be the same.

Feature 2: The base of the bracket for each tooth type must have the same inclination as the facial plane of the crown at the (FA) point.

Feature 3: Each bracket's inclined base must be contoured occlusogingivally to match the curvature of the crown. This feature eliminates the potential for the many slot siting variations inherent in brackets whose bases are occlusogingivally flat.

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ADVANTAGES:

These three features eliminate the need for:

- Second order bends to deal with occlusogingival disharmony in slot siting.
- Third order bends for inclination.
- Other bends to deal with the inherent side-effects of wire bending.

II. MIDSAGITTAL PLANE[15]:

The midsagittal plane of each slot must superimpose on a facial extension of the crown's midsagittal plane. To achieve this objective, the following 4 features are required:

Feature 4: The mid sagittal plane of the slot, stem and crown must be the same.

Feature 5: The plane of the bracket base at its base point must be identical to the facial plane of the crown at the FA point. In maxillary molars the angle is 100^0 because of unequal facial prominence of molar buccal cusps. In all crowns other than the maxillary molars, this plane bears 90° to the midsagittal plane.

Feature 6: The base of each bracket must be contoured to match the mesiodistal radius of the area of the crown it is designed to fit. This prevents any play between the base and the crown that might cause the mid sagittal plane of the bracket to be directed mesially or distally to the crown's mid sagittal plane.

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Feature 7: In each fully programmed bracket:

- The vertical components (mesial and distal borders of the bracket stem and tie wings) are designed to parallel one another. These components, when the parallel-and-midpoint bracket-siting technique is used, are to parallel and straddle the vertical landmark of the crown-the FACC.
- The horizontal components of the bracket (superior and inferior sides of the bracket stem) should be equidistant from the crown's gingiva and cusp tip which makes the base point of the bracket to mate with the crown's FA point.
- Thus, the slot point, base point and the FA point will be on a plane that coincides with the crown's midtransverse plane.

- The bracket slot is angular to each bracket's vertical component to the same extent that the mid transverse plane of the crown is angular to crown's FACC and the mid sagittal plane.

ADVANTAGES:

These three features eliminate the need for:

- First-order maxillary molar offset bends.
- First order bends to deal with errant mesiodistal slot sitting.
- Second-order bends for angulations, errant occluso-gingival slot siting caused by bracket design and by angulated brackets.
- It eliminates the side effects related to these wire bends.

III. MIDFRONTAL PLANE[15]:

The midfrontal plane of each slot must superimpose on its crown's prominence plane. To achieve this objective, the following feature is required:

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Feature 8: Within an arch, all slot points must have the same distance between them and the crowns embrassure line.

ADVANTAGES:

This feature eliminates the need for first-order wire bends to accommodate for varying crown prominence.

B. CONVENIENCE FEATURES[15]:

These features make the appliance easier for the orthodontist to use and sometimes more comfortable for the patient.

Some of the convenience features incorporated are as follows: -

i. The gingival tie wings on posterior brackets are designed to extend farther laterally than they do on nonprogrammed brackets. This eliminates gingival impingement and also facilitates ligation of arch wire to the bracket.

ii. The bases of fully programmed brackets are inclined, so on mandibular molars and premolars the stem and tie wings are directed more gingivally than in the nonprogrammed brackets. This feature eliminates or reduces the occlusal interference.

iii. The facial surfaces of incisor and canine brackets are designed to parallel their bases, which in turn parallel the crown's faces. This feature is for lip comfort. For the mandibular canine it also reduces the potential for occlusal interference with opposing teeth. The occlusal tie wings of mandibular incisors are designed with the least amount of occluso-facial prominence to reduce the potential for occlusal interference with the opposing incisors.

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iv. There is a convenience feature incorporated for easy bracket identification:

- Fully programmed brackets are as different as are tooth types.
- Since the brackets are smaller than teeth, their differences are not readily visible without special marking.
- Thus brackets are often marked by dots, dashes, numbers for easy identification.
- These markings enables one to identify the bracket as to:

- Which arch it is for
- Which quadrant
- Which class
- Which type
- Whether it is standard or translation bracket
- For incisors the category of inclination
- For maxillary molars whether it is for Class I or ClassII relationship.

C. AUXILIARY FEATURES[15]:

These features contribute to the biologic aspect of treatment .These are power arms, hooks, face bow tubes, utility tubes and rotation wings. Casting permits these features to be integral parts of the bracket rather than separate elements that must be added later.

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INCISOR BRACKETS[15]:

- The inclination range for the incisors is greater than for any other teeth. This presumably does not reflect differing tooth morphology, but differing skeletal patterns that exist even in patients with exemplary occlusion.
- There must be atleast three standard brackets, each with a different base inclination to accommodate one of the three acceptable but different posttreatment interjaw relationships.
- To some extent, orthodontists can predict the posttreatment interjaw relationship for any patient. The base inclination for incisor brackets

selected at the beginning of treatment should conform to the crown inclinations that are harmonious with the anticipated interjaw relationship.

- As shown by *Steiner* the inclination (torque) requirement of incisors is directly related to ANB angle. Therefore proper incisor torque can be determined at the beginning of the treatment. Therefore SWA has three sets of incisor brackets designated as A, S, and C.

  Set A - for ANB Angle more than 5^0 [class II tendency]
  Set S - for ANB Angle Between 0-5^0 [class I tendency]
  Set C - for ANB Angle less than 0^0 [class III tendency]

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- For maxillary central incisor, an unpublished study by Andrews (1968) of 100 cephalograms showed an average difference of 18° between the inclination of FACC and that of the the long axis of the tooth. The correct maxillary incisor bracket can be selected by subtracting 18° from the projected post-treatment inclination of the tooth's long axis relative to a line 90° to the occlusal plane.
- For class I interjaw conditions the inclination of the maxillary incisor must be approximately 25^0 ; this minus 18^0, converts to a bracket base inclinations of 7^0.
- For class III interjaw tendencies the inclination of the maxillary incisor must be 30^0, so the bracket base inclination should be 12^0.
- For class II interjaw tendencies the inclination of the maxillary incisor must be 20^0, so the bracket base inclination should be 2^0.

- In the same measurement study, the maxillary lateral incisor's inclination was found to average 4^0 less than that of the maxillary central incisor, regardless of the latter's inclination. So whatever bracket-base inclination is prescribed for the maxillary central incisor, the lateral's bracket base inclination should be 4^0 less.
- The same study indicated that the mandibular central incisor has an average difference of 16^0 between the facial axis of clinical crown (FACC) and the long axis of the tooth. The correct mandibular incisor bracket can be determined by subtracting 16^0 from the projected post treatment inclination of the tooth's long axis, relative to a line 90^0 to the occlusal plane.
- For class II interjaw tendencies the postreatment value should be approximately 20^0, so that the bracket base inclination should be 4^0.
- For class I interjaw tendencies the post treatment value should be approximately 15^0, so the bracket base inclination should be -1^0.
- For class III interjaw tendencies the post treatment value should be approximately 10^0, so the bracket base inclination should be -6^0.
- This study also indicated that the crown inclinations of the mandibular central and lateral incisors are approximately equal, so whatever inclination is prescribed for mandibular centrals would also be prescribed for laterals.
- The angulation and prominence remain the same for each incisor tooth type, for each of the 3 differing base inclinations.

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POSTERIOR BRACKETS[15]:

Except for maxillary molars, only one standard bracket is needed for each tooth type. Maxillary molars require two brackets: one for class I interarch relationship and one for class II.

This is because sometimes the treatment plan calls for only first or second premolar extractions to be done in maxillary arch. In that case it is preferable to leave maxillary molars and premolars in class II molar relationship while treating rest of the dentition to class I (canine relation to class I).

Under these circumstances, the mesiobuccal cusp of maxillary molar articulates in the embrasure between the mandibular first molar and second premolar. The distobuccal cusp of the maxillary molar articulates with the mandibular molar's mesiobuccal groove, which extends farther occlusally than does the distobuccal groove.

Hence for perfect occlusal settlement, the maxillary molar should be upright rather than usual 5^0 tip present in maxillary first molar when they settle in class I molar relationship.

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Thus there are two sets of maxillary molar tube: -

i. For class II molar relationship FACC of molar is kept 90^0 to occlusal plane.
ii. For class I molar relationship FACC of molar is kept approximately 5^0 to line perpendicular to occlusal plane.

FULLY PROGRAMMED TRANSLATION BRACKETS

The fully programmed standard brackets are primarily meant for non-extraction cases. If these brackets are to be used for extraction cases, then their application requires the use of first order, second order bends to carry out translation i.e. bodily movement of teeth[15].

The SWA translation brackets have built in tip, torque and in-out like standard brackets in addition to that they have a power arm and two additional slot-siting features: “counter-mesiodistal tip” and “counter-rotation”. Maxillary molar brackets include a third feature: “counterbuccolingual tip”. These features ,along with the archwire and mesial or distal force, provide countermoments for translation and the guidance needed for overcorrection in all the three planes of space. The formulae for the mesiodistal length of the brackets, length of the levers, and the amounts of countertip and counterrotation are based on moments and distances.

To understand the design of fully programmed standard brackets, the following terminologies are required[15]:

- Counterbuccolingual tip : A slot-siting feature for maxillary molars that counter acts buccolingual tip during translation and then overcorrects.
- Countermesiodistal tip : A slot-siting feature that counteracts mesial or distal tipping during translation and then overcorrects.
- Counterrotation : A slot-siting feature that counteracts rotation during translation and then overcorrects.
- Minimum translation brackets : A translation bracket for the teeth that has to be translated less than 2 mm.
- Medium translation brackets : A translation bracket for the teeth that has to be translated more than 2mm but less than 4 mm.
- Maximum translation brackets : A translation bracket for the teeth that has to be translated more than 4 mm.
- Power arm : A lever arm extending gingivally from the bracket, and used for delivering force towards the crown’s center of resistance.

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- Translation bracket : A fully programmed bracket for teeth that require translation. It is designed to promote bodily movement during mesial or distal movement, and to overcorrect in proportion to the distance moved.

TRANSLATION PROBLEMS[15]:

Translation is defined as "uniform motion of a body in a straight line." For such a movement to occur, the force must be applied to the object's center of resistance. Unfortunately, a tooth's center of resistance is in its root while force is applied to the crown's labial surface through the medium of a bracket.

From the stand point of physics, a bracket located on a crown's face is in the "wrong" place in two ways:

- The bracket is occlusal to the center of resistance of the tooth, so when a mesial or distal force is applied, the tooth, instead of translating, will tend to tip around its horizontal center of rotation.
- The bracket is also located laterally to the tooth's center of resistance, so instead of translating when a mesial or distal force is applied, the tooth will tend to rotate around its vertical center of rotation.

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TRANSLATION SOLUTIONS[15]:

There are two fundamental methods of moving a tooth mesially or distally, and they involve different amounts of force, bone and efficiency.

The two methods are 1) Translation

2) Tipping and angulating

Tipping & then angulating compels a portion of the root to go through the same bone twice, such a waste of energy, movement and efficiency is avoided if the tooth is translated.

LEVERS: [15]

A few principles concerning levers:

- For tooth translation, optimal lever lengths are dictated by the distance between the bracket site and the tooth's center of resistance.
- An optimal length is one in which a force of any amount capable of moving a tooth in one plane of space can be applied without causing the tooth to rotate in that plane.
- Principles concerning the potential effectiveness of levers for tooth translation are shown in the figure below.
- The edgewise bracket slot can be considered to have three levers which are present within the slot and are activated by the wire.

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SLOT SITING FEATURES: [15]

Counterrotation and countermesiodistal tip are two slot-siting features common to all translation brackets. In addition maxillary molar translation brackets have counterbuccolingual tip.

The criterion for incorporating an amount of counterrotation, counter mesiodistal tip, and counter buccolingual tip is distance, because the farther the tooth needs to be translated the greater the rebound potential.

I. COUNTERROTATION: [15]

- For counterrotation the slot is rotated in the direction of translation.
- Rotation of the slot is done in one of the three specified amounts around its vertical axis.
- This feature, coupled with the flex of the arch wire, counteracts tooth rotation caused by the mesial or distal force during mesial or distal movement and overcorrects when the mesial or distal movement is complete.
- To transfer the force efficiently from the bracket slot to the centre of the crown, the mesiodistal length of the bracket should equal the distance from the slot point to the tooth's vertical axis.
- The rationale for the three increments of slot rotation is that the farther a tooth must be translated, the greater is the amount of rotation overcorrection needed.
- *The counter-rotation formulae*: --

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  - 2^0 of slot rotation for teeth requiring 2mm or less of translation.
  - 4^0 of slot rotation for teeth requiring 2-4mm of translation.
  - 6^0 of slot rotation for teeth requiring more than 4mm of translation.
- Slot rotation + mesiodistal slot length + archwire flex + mesial or distal force equals counterrotation and rotation overcorrection.

II. COUNTERMESIODISTAL TIP: [15]

- The slot-siting feature for countermesiodistal tip involves rotating the slot in one of the three specified amounts around its faciolingual axis.

- The mesiodistal length of the slot is not as long as the distance from the slot point to a tooth's center of resistance.
- The countermoment produced by the angulated slot and flexed arch wire will counter act some- but not all- of the tendency for the root to lag behind the crown when a mesial or distal force is applied.
- Hence to produce pure translation, a lever as long as the distance from the slot point to a tooth's center of resistance is needed, and for every tooth this distance is greater than the mesio distal length of the slot. For example:

- Center of resistance of a typical maxillary canine is approximately 9m from the brackets slot point.
- For translation to occur, the length of the lever arm should also be 9mm.
- If the mesiodistal length of the bracket is 4mm, it will provide only 4/9 of the needed length.
- To increase the length of the lever, a gingival extensions called a power arm of 5mm is added to the bracket.
- If only the power arm is activated, the moment and counter moment will be still out of balance.
- Hence together the power arm length and the mesiodistal slot length provide the 9 mm lever needed for the counter moment to equal the moment, a condition needed for translation.

- By angulating the slot more than the standard amount provides the right amount of over angulation at the end of translation. Ultimately the tooth assumes the desired degree of angulation after rebound.

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- The rationale for adding slot angulation to provide for countermesiodistal tip is the same: the farther the tooth is translated, the greater the need for angulation overcorrection.
- The amount is added to the standard amount of angulation for distal translation, or subtracted for mesial translation. *The counter-mesiodistal formulae:-*
    - Add or subtract 2° for 2 mm or less of translation.
    - Add or subtract 3^0 for more than 2mm but not more than 4 mm of translation.
    - Add or subtract 4^0 for more than 4mm of translation.
- The optimal power-arm length for each tooth type is the distance from the bracket slot point to the tooth's center of resistance, minus the mesiodistal slot length.
- The power arm for a molar bracket is shorter than that for canine because mesio-distal length of molar bracket is longer, and molar's center of resistance is more occlusal.
- The power arm for a premolar is shorter than it is for the canine because the premolar is a shorter tooth.
- The power arm extends from the gingival tie wing that is on the side of the intended direction of movement.
- In 1921 Calvin Case referred to extension soldered to bands as "power arms". Hence they are named power arms in honour of Dr. Case.
- Slot angulation + mesiodistal slot length + power arm length + activated arch wire and power arm equals countermesiodistal tip and angulation over correction.

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III. COUNTERBUCCOLINGUAL TIP: [15]

- The slot-siting feature for counterbucccolingual tip involves rotating the base of the bracket in one of the three specified amounts around its mesiodistal axis.
- This feature is needed only for maxillary molar translation brackets.
- The maxillary molar is a three rooted teeth.
- When a mesially directed force is applied to a non programmed or fully programmed standard bracket, it not only predisposes this tooth to tip mesially and to rotate just like other teeth, but also tips it buccally because of the drag imposed by the tooth's dominant lingual root.
- Clinically this results in the buccal cusps becoming more gingivally oriented and the lingual cusps more occlusally positioned.
- This buccolingual tipping is resolved by the counterbuccolingual tip feature.
- This feature targets the slot to provide a more negative base inclination than would a standard bracket.
- The increased negative base inclination positions the slot so that a flat, rectangular arch wire will provide both the counterbuccolingual tip moment needed during translation, and inclination overcorrection at the end of translation stage.
- The rationale for the amount of counterbuccolingual tip is the same: the farther the tooth is translated, the greater the need for overcorrection.
- *The counter-buccolingual formulae:-*

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- When the translation is to be 2mm or less, 4^0 more of negative base inclination than the standard amount.
- When the translation is to be more than 2mm but less than 4mm, 5^0 more of negative base inclination than the standard amount.
- When the translation is to be more than 4 mm, 6^0 more of negative base inclination.

➢ Base inclination + faciolingual slot length + rectangular arch wire deflection + mesial or distal force equals counterbuccolingual tip and inclination over correction.

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ADVANTAGES OF THE STRAIGHT WIRE APPLIANCE[19]

1. Ease of arch wire construction. Since there is no need for bends of the arch wire other than arch form or reverse or compensating curves, bending of arch wires becomes rather simple and quick regardless of wire size.
2. No need for inter-bracket span. Since there are no bends in the arch wire, an inter-bracket span of any greater magnitude is unnecessary to reduce the force level; therefore, wide siamese brackets can be employed to control rotations.
3. Ease of arch wire placement. When the teeth are properly aligned into ideal positions, all the bracket slots lie parallel to the occlusal plane. Therefore, during leveling, the placement of the next arch wire size can be done without torquing the rectangular wire to get it to slide into

the posterior tubes. The torquing key never has to be used to place the wire into the anterior or posterior brackets.

4. Less "round-tripping." Since the teeth move in more direct vector lines from their maloccluded positions to their individualized positions, there is less "round-tripping" of the teeth.
5. Better control of tooth positions. Since all requirements for idealized tooth positions are built into the brackets rather than the arch wires, tooth positioning is better controlled and self-limiting. Missed appointments usually result in no untoward tooth movement. In fact, the actual result is improved tooth positions, which leads one to wonder whether many times arch wires are changed too soon and too often.

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6. Better and more consistent results with shorter treatment time. The movement of teeth in direct vector lines to their final positions, limited by what is engineered into the appliance, results in shorter treatment time for the patient and less chair time for the orthodontist.
7. Patient comfort. Placing of large rectangular arch wires is easier for both the patient and the orthodontist with less jiggling of the teeth and therefore much less discomfort.
8. Complete space closure in both extraction and non-extraction cases can be accomplished with one set of arch wires since there are no bends in the arch wires to interfere with the brackets themselves during space closure.
9. Ease of Ligation. The gingival wings of the brackets are constructed so that they stand away from the gingiva labially and buccally.

10. Bracket Identification. Easy bracket identification due to the identifying markings that are cast into the brackets.
11. Easier, more accurate bracket placement. Specific bracket base compound curvature ensures consistent, reliable fit. Tip within bracket and torque in base permits bracket-to-crown referencig for consistent bracket placement and level slot lineup.
12. Advantage in surgical cases. The Straight-Wire Appliance offers great advantage in surgical cases where the jaw relationship discrepancy is such that occlusal forces are working against the ultimately desired tooth positions prior to surgical correction of the jaws.

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DR. RONALD ROTH'S PRESCRIPTION

Over a time and through clinical testing, the values built into the original Andrews straight wire appliance were modified by Dr. Roth to what is currently known as "The Roth setup"[5]. The Roth prescription was devised in 1975 and was marketed commercially in 1976[44].

PURPOSE OF THE ROTH SETUP[5]:

- To provide idealized tooth positions prior to appliance removal that would allow the teeth in most instances to settle to what was found in the non-orthodontic normals studied by Andrews.

BASIC ASSUMPTIONS OF THE ROTH SETUP: [5]

- With appliances in place, it is virtually impossible because of bracket interference to position the teeth precisely into the occlusion shown by the non-orthodontic normal sample.

- After appliance removal, no matter how well treated the patient may be, the teeth will shift slightly from the positions they occupied at the time the appliances were removed.

Dr. Ronald Roth was using Andrews SWA since its introduction in early 1970. However after using Andrews appliance for more than 4-5 years he noted certain drawbacks in it.

DRAWBACKS OF ANDREWS APPLIANCE

1. Andrews' idea was a total concept- of which the appliance was one part- the "guidance system". Andrews' objective was to move teeth in straight-line vectors from their malpositions to their final positions by translation or bodily movement. However, the ideal force system to accomplish this has not yet been developed[6].
2. Inventory[44]:
   - In order to accomplish Andrews' goals with the force systems currently available, Dr. Andrews suggested three categories of brackets depending upon the amount (distance) of translation – *minimum, medium, maximum.*
   - Andrews later introduced different series and sets of brackets for different combinations of extractions, ANB differentials, and anchorage requirements. He developed a special classification of malocclusions and prescribed various bracket series for treatment of each, to allow translation of teeth without the need for bending offsets and also to allow for overcorrection in view of relapse tendencies[20].

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- Thus if the clinician were to buy band kits for all of Andrews sets and series, it would need a very extensive as well as expensive inventory.

3. Anchorage loss[44]:

- Whenever mesially angulated brackets were placed on the posterior teeth, the teeth tend to tip mesially and migrate forward.
- The original standard Straight-Wire brackets were designed to treat only nonextraction cases with an ANB differential of less than 5° without the necessity of putting offset bends into the wire.
- However, the mesial inclination in the buccal segments creates an anchorage loss problem, especially in extraction cases.

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MODIFICATIONS SUGGESTED BY ROTH:

1. Translation of teeth during orthodontics was not Roth's priority. He thought that whether an orthodontist moves a tooth by 2mm or 10mm and then fills the bracket slots with large rectangular wires and waits, the tooth eventually will attain the same position regardless of the distance it was moved. [44] He thought that the answer to this problem of extensive inventory was to come up with a prescription for a special set of overcorrection brackets that would be applicable to most cases.[20]
2. To conserve anchorage, he decided to achieve an upright position of the upper molars and premolars, and maintain the upper molars in an

overrotated position. Also the lower buccal segments are made upright and rotated distally to maintain anchorage.

3. The general overcorrection built into the Roth prescription has to do with the concept of where the teeth should be at the end of appliance therapy. According to Roth, the following factors must be considered in making the decisions regarding the amount of overcorrection.[44]
4. Overcorrection must be done very subtly so that the tooth positions will relapse to the desired positions consistently after appliance removal.
   - Overcorrection must be done because there is an angle of deflection between the largest archwire size and the bracket slot size.
   - Overcorrection must be done to compensate for the relapse of root positions that occurs after the appliance removal.
   - Overcorrection is also done because of the mechanical adversities that make it difficult to achieve proper tooth positions axially.
   - Overcorrection must be done to overcome the most common posttreatment tooth positioning errors in many cases.

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ROTH PRESCRIPTION:

- In the Roth Prescription of the Andrews Appliance, the anterior brackets were placed slightly more incisally from Andrew's "middle of the clinical crown", and the ingredients of those brackets were adjusted accordingly. This was to eliminate the need to place reverse and compensating bends into the finishing wires[20].

- The Tru-Arch Form was developed to play a role in this over-correction concept, because arch form affects the rotational positioning of the teeth as well as the brackets.
- Auxiliary attachments were added to the brackets, such as double and triple tubes for headgears and lip bumpers and rectangular auxiliary tubes for Burstone or Bioprogressive mechanics.
- Additional hooks on each bracket evolved for the use of short Class II or Class III elastics, so that less unfavorable canting of the occlusal plane and less posterior interference would be created with interarch elastics.
- Placing all the four incisors at the same height overcorrects overbite and improves anterior contact during function.
- Placing bicuspid brackets 0.5 mm gingivally to the molar attatchments levels the marginal ridges.
- With open bite problems the anterior brackets may be placed more gngivally.
- In case of long clinical crowns, all brackets may be placed farther gingivally with use of a uniform increase for each that is consistent with the bracket heights listed above.

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I. MAXILLARY PRESCRIPTION[20]:

- The Roth Prescription has extra torque in the maxillary incisors (5° more than normal). There is correspondingly less negative torque in the upper canines to offset the reciprocal effect of building more positive torque into the incisors.

- The upper canines have 2° more distal tip, because they are being retracted in most treatments. In addition, they have a 2° rotation to the mesial.
- There is a "Super Torque" set of maxillary anteriors to be used in the following instances:
    1. Two upper premolar extraction- only cases where a tooth size discrepancy is created (because half of a molar is smaller than an upper premolar). The additional torque and tip makes the upper anteriors occupy more space. These are used in conjuction with the zero-rotation upper molars as the mesial molar rotation created causes the molars to occupy more space in the arch. In this way the tooth size discrepancy is compensated for and proper overbite and overjet can be established and the upper extraction sites remain closed.
    2. In Class II division 2 cases and in any case that requires 6mm or more of upper anterior retraction.
- The upper buccal segments are distally uprighted to 0°, the bicuspids are rotated 2° mesially to offset the rotation that accompanies distal traction, and the upper molars have 14° distal rotation (twice the amount found on the non-orthodontic normals) and 14° buccal root torque (5° more than normal).
- There is a 0° upper molar rotation set for cases where only two upper bicuspids are extracted as explained above.
- The Zero tip canine brackets are used for segmental surgical cases to ensure space between the canines and premolars for the osteotomy cut. After healing from surgery has occurred, the

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standard Roth treatment canine brackets are placed to achieve final finishing[44].

II. MANDIBULAR PRESCRIPTION[20]:

- In the mandibular arch, the incisor brackets are the same as the non-orthodontic normals.
- The lower canines have 7° mesial tip and 2° distal rotation. The entire lower buccal segment has a 3° distal tip from normal and a 4° distal rotation. These teeth settle more mesially than the uppers and simultaneously rotate mesially, thus necessitating extra distal rotation.
- The torque in the lower buccal segments remains normal, because over-correction in this plane only leads to problems and interferences.
- The two lower molars have exactly the same degree of root torque since the appliance rests on the mesiobuccal cusp (the torque measurement for the non-orthodontic normals was taken from the buccal groove).

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ROTH'S PRESCRIPTION[20]

Tooth	Angulation (Tip)	Inclination (Torque)
Maxillary		
Central incisor	5^0	12^0

Lateral incisor		9^0	8^0
Canine		13^0	-2^0
First premolar		0^0	-7^0
Second premolar		0^0	-7^0
First molar		0^0	-14^0
Second molar		0^0	-14^0
Mandibular			
Central incisor		2^0	-1^0
Lateral incisor		2^0	-1^0
Canine		7^0	-11^0
First premolar		-1^0	-17^0
Second premolar		-1^0	-22^0
First molar		-1^0	-30^0
Second molar		-1^0	-30^0

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- <u>According to Roth one has to accept certain Core beliefs[44]:</u>

1. Each tooth type, if reasonably normal morphologically, has identifying characteristics that make the study of dental anatomy feasible.
2. Teeth are either more curved or less curved, large or small but they are shaped similarly from one person to the next.
3. If teeth of two individuals are shaped similarly, they must occupy similar positions to fit together properly and function properly.

4. Anatomically misshapen or unidentifiable teeth will not fit properly into the arch or occlude properly with their antagonists. These teeth must be reshaped properly by the appropriate treatment.
5. Teeth belong in the alveolar process, preferably surrounded by bone and adequate gingiva.
6. The condyles should be seated in their respective fossae when the teeth meet in maximal intercuspation.
7. The anterior teeth should glide and the posterior teeth should separate on protrusive or lateral movement. This requires adequate overbite of incisors and canines (4mm) and proper overjet (2 to 3mm for incisors and 1mm for canines).
8. The face should look optimally or atleast acceptably good as a result of treatment.
9. Only minor dental compensations for skeletal discrepancy will permit a

proper occlusion; major dental compensation for skeletal discrepancies is unacceptable.

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These brackets have been described as the second generation of the preadjusted brackets , Andrews brackets being the first one.

VARI-SIMPLEX DISCIPINE

The Vari-Simplex Discipline was introduced and developed by Dr. R.G. Wick Alexander. His main concern was with simplicity to encourage cooperation, comfort, and control. He believed that patient cooperation is important in any treatment, and that

complicated appliances make it more difficult for patients to succeed. Complicated systems with heavy wires, heavy elastics, auxiliaries, and complex wires and elastic placements make patient cooperation more difficult and greatly contribute to patient discomfort. One of his major goals was to make treatment easier and more convenient for the patient. That, in turn, reduces stress on the orthodontist and staff. Complicated treatment can also result in excessive treatment time for the practitioner and the patient. So, his major goals were[21]:-

- High-quality results
- Patient comfort
- Reduced chair time.

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With these goals in mind, he developed an appliance called the Vari-Simplex Discipline where[21]:-

1. "Vari" refers to the variety of bracket types used.
2. "Simplex" relates to the KISS Principle (Keep It Simple, Sir). The appliance is kept simple in the following way:

- Archwire fabrication is simplified, with first-, second-, and third-order bends placed in the bracket instead of the archwire. Simpler archwires afford fewer archwire changes, and easier ligation and activation.
- Multiloop arches are rarely used because they are time-consuming, create food traps, and often impinge upon the gingival tissue.
- Hooks are rarely soldered to the archwire. Soldering is also time-consuming and can reduce archwire effectiveness. Ligature hooks are used instead, when necessary.

- All this adds up to "Simplex".

3. "Discipline" was chosen, rather than "Appliance", to reflect the idea that the orthodontist must be knowledgeable in edgewise mechanics and must play an active role in the application of the appliance to the individual patient.

CONCEPT OF THE VARI SIMPLEX DISCIPLINE: [21]

The most important factors in determining the design of the Vari-Simplex Discipline are:

1. Size and shape of the teeth, especially the mesiodistal width and curvature:-
   - These affect interbracket width, which, in turn, affects the ability to rotate the teeth and level the arch without using time-consuming vertical springs, multiloops, or extra archwires.
   - Selecting the proper bracket to fit the size and shape of each tooth will also influence ease of ligation and the ability to obtain complete bracket engagement.
2. Accessibility of the tooth and whether it is located in a curved or straight area of the arch.
3. Patient comfort
4. The frequency of bracket wing breakage.

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The system evolved around five factors related to brackets: bracket selection, bracket height, bracket angulation, bracket torque, and bracket in-out.

I. BRACKET SELECTION: [21]

Each tooth has a particular bracket that is most effective.

TWIN BRACKETS: [21]

- Twin brackets (Diamond brackets) are used on large, flat-surfaced teeth— maxillary central and lateral incisors.
- The Diamond bracket is designed so that all the horizontal lines are placed parallel to the incisal edge of the tooth, and the rhomboid design makes it possible to align the vertical lines parallel to the long axis of the tooth.

Diamond twin bracket

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- The flat surfaces of maxillary centrals and laterals permit full archwire engagement in the twin brackets. The accessibility of these teeth negates the usual difficulty in tying twin brackets.
- Twin brackets on the incisors allow 5-6mm of interbracket width, which is sufficient for flexibility, rotational control, and torquing ability.
- As the maxillary lateral incisors erupt, they frequently remain high relative to the normal position of the centrals, presenting a significant incisogingival interbracket discrepancy. Twin brackets on these teeth provide additional tie wings for easy initial wire placement, whereas the rotation wing of a single-width bracket might cause interference with the archwire.
- Twin brackets allow additional handles for placing power chains, ligating anterior teeth together, and placing hooks for elastics.

- A final factor is patient comfort. Twin brackets are smooth and minimize irritation of labial tissue.

LANG BRACKETS: [21]

Lang brackets were invented by Dr. Howard Lang.

- These brackets with the Diamond design are used on large, round-surfaced teeth at the corners of the arch— maxillary and mandibular cuspids.
- It is a single bracket with flat rotational control wings, each containing a circular hole. This hole increases the flexibility of the wing and could be used for ligation. Alexander design of the Lang wing has changed slightly from the original design, in using a stiffer metal for the wings, and the hole is smaller in size and closer to the base of the bracket.
- The pad is contoured so that this bracket fits beautifully on most cuspids. The straight wing of the Lang bracket eliminates interference with complete archwire engagement at this most curved position in the arch.
- The single bracket allows for easy ligation and increased interbracket width.
- The wing can easily be activated for rotational control. In extraction cases, the cuspids can be retracted on round wire with very little tipping or rotation.

LEWIS BRACKETS: [21]

- Lewis brackets are used on large, round-surfaced teeth that are not at the curve of the arch— maxillary and mandibular bicuspids— and on small, flat-surfaced teeth— mandibular incisors.

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- The basic Lewis design with a wedge shape is used, which puts the tie wing close to the tooth occlusally and far out gingivally. This makes it easy to tie, to use as a hook for elastics, and to keep clean.
- The wedge shape is excellent for the application of up-and-down elastics on posterior teeth.
- The Lewis bracket is a fixed-wing single bracket, which produces sufficient interbracket width. The wings provide maximum rotational control and can be activated for additional rotation.
- The fixed wing Lewis bracket is preferred over the flexible wing Steiner bracket for the following reasons:
    1. The fixed wing is more capable of exerting additional force, especially on a rectangular wire.
    2. The fixed wing saves adjustment time, since the archwire need not be removed to activate the wing.
    3. The Lewis brackets are less sharp, so it is not necessary to tie in the archwire at the banding/bonding appointment, if, for example, we are doing indirect bonding.
    4. Breakage is not a concern when using the fixed wing Lewis bracket.
- An additional benefit offered by the single bracket with wings is that, on a tooth that is badly rotated, the wing in the direction of the rotation can be removed. The bracket can then be positioned properly, with the remaining wing serving to rotate the tooth into proper position.

Removing the interfering wing of Lewis bracket on badly rotated tooth permits proper bracket placement.

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OTHER ATTACHMENTS: [21]

- Twin brackets with a convertible sheath are used on maxillary and mandibular first molars, which are usually banded.
- The convertible sheath is easily removed when second molars are banded, converting the attachment to a bracket.

II. BRACKET HEIGHT: [21]

- Bracket height is extremely important in the design of a fully activated appliance.
- Each bracket is placed at a predetermined position on each tooth relative to the other teeth.
- Bicuspid bracket height is the key factor because its clinical crown height is so variable. Its normal height is 4.5mm. It is designated as X. The other bracket heights are calculated in relation to X, as shown on the chart.

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MAXILLARY ARCH

Centrals	X
Laterals	X – 0.5mm
Cuspids	X + 0.5mm
Bicuspids	X
1st Molars	X – 0.5mm
2nd Molars	X – 1.0mm

MANDIBULAR ARCH

Centrals	X – 0.5mm
Laterals	X – 0.5mm
Cuspids	X + 0.5mm
Bicuspids	X
1st Molars	X – 0.5mm

- An obvious deviation from these measurements would be in an open bite case. Since the treatment plan would be to intrude the posterior teeth and extrude the anterior teeth, the bracket height would be increased on anterior teeth by 0.5mm and decreased on posterior teeth by 0.5mm.
- It is important to position brackets in the center of the tooth mesiodistally on flat surface teeth, so that the rotating wings will be able to function properly. On bicuspids and cuspids, it is necessary to place the brackets at the crest of the contour on their buccal surfaces so that the rotating wing will be able to function optimally.

III. BRACKET ANGULATION (Tip or Second Order Bends): [21]

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- The objective is to position the teeth in the most ideal axial inclinations.
- This allows the roots to be parallel to each other and the crowns to be placed in their most esthetic and functional positions.
- The Diamond bracket with angulations measured to the long axis of the crown is preferred because it simplifies bonding placement and assures accuracy.
- The horizontal incisal and gingival portions of the bracket are parallel to the incisal edge and the vertical portions are parallel to the long axis of the crown, so only the height has to be measured while bonding the bracket.
- When banding, the band is placed parallel to the incisal edge or occlusal plane of the tooth, and the bracket is angulated on the band.

- Two sets of measurements are used for angulation , depending on whether the incisal edge reference is used for banding or the long axis reference is used for bonding Diamond brackets.

IV. BRACKET TORQUE (Third Order Bends): [21]

- The pretorqued brackets for use with the Vari-Simplex discipline were introduced in 1978.
- The approach used was to measure the torques in rectangular archwires usedo finish well-treated orthodontic cases.
- The system is designed so that the best results are achieved when an .017"x .025" archwire is used to fill the .018" bracket slots.
- This leaves enough play to permit easy archwire engagement to the base of the bracket slot, which increases patient comfort.
- The rule of thumb is that .001" of play equals about 4° of torque, so each of the torques listed below should be considered to be plus or minus 4° due to play.

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MAXILLARY ARCH	
Centrals	14°
Laterals	7°
Cuspids	– 3°
Bicuspids	–7°
Molars	–10°
MANDIBULAR ARCH	
Incisors	– 5°
Cuspids	– 7°
1st Bicuspids	– 11°
2nd Bicuspids	– 17°
1st Molars	– 22°

2nd Molars 0° or – 27°

These measurements differ from commonly used torques in three major respects:

- The -3° torque on maxillary cuspids— compared to extremes of + 7° to - 7° in other appliances— eliminates the need for adjusting the torque later in treatment and is enough to prevent these teeth from tipping out.
- No torque is placed in the mandibular second molar tubes as omega loops are used. As the omega is bent out to avoid impingement on gingival tissue and to create less of a food trap, the torque is automatically placed into the second molar. If the omega stop is not used, the second molar buccal tube should have the torque and the distal tip angulation built into it.
- The most important difference between the torques in this appliance and those of other appliances is that - 5° of lingual crown torque or labial root torque is built-in into the mandibular incisors brackets. This was validated in an unpublished thesis done by Dr. Dwayne Trammell as a graduate student at Baylor in 1980. This along with the rectangular wire holds the mandibular incisor in its original position.

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V. BRACKET IN OUT (First Order Bends): [21]

- The appliance incorporates a system of interrelated, compensating bracket base thicknesses to replace the usual first-order bends or offsets.

MAXILLARY ARCH	BASE
Centrals	*Standard*
Laterals	*Thick*
Cuspids and	
Bicuspids	*Thin*
Molars	*Thinnest*
MANDIBULAR ARCH	BASE
Anteriors	*Thick*
Cuspids and	
Bicuspids	*Thin*
Molars	*Thinnest*

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ALEXANDERS PRESCRIPTION[21]

Tooth	Angulation (tip)	Inclination (torque)
Maxillary		
Central incisor	5^0	14^0
Lateral incisor	8^0	7^0
Canine	10^0	-3^0
First premolar	0^0	-7^0
Second premolar	0^0	-7^0
First molar	0^0	-10^0
Second molar	0^0	-10^0
Mandibular		
Central incisor	2^0	-5^0

Lateral incisor		3^0	-5^0
Canine		6^0	-7^0
First premolar		0^0	-11^0
Second premolar		0^0	-17^0
First molar		-6^0	-22^0
Second molar		0^0	$0^0 / -27^0$

CREEKMORE'S THE NEW TORQUED APPLIANCE

The New torque appliance was built by incorporating torque and other features into the brackets with the intention of building in 90% of treatment into the bracket, leaving 10% for adjustments in archwire required for individual cases. It was introduced by Thomas Creekmore in 1973[22].

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BRACKET CONFIGURATION: [22]

- The basis for this technique is the Steiner Spring-Wire bracket, which is supplied with .018 and .025 channels.
- A difference between the Steiner and the Lewis brackets is in the texture of the wings. The Lewis bracket wing is rigid, whereas the Steiner Spring-Wing is flexible, which gives some flexibility from the wings in addition to the archwire.
- A modification is made in the attachment of the Steiner bracket and wing to the band. They don't weld through the wing.

- The bracket is placed over the wing and welded to the band using welds around, but not through, the wing. It has been a most important step in preventing breakage of the wings.
- The brackets are available on band strips or on preformed bands, and they can be fitted directly or indirectly.

MAXILLARY	STANDARD ANGULATION		STANDARD TORQUE (in degrees)
	Band Mat. (in degrees)	Preformed Bands (in degrees)	
Central	2 ½°	3°	+7°
Lateral	5°	5°	+3°
Canine	2 ½°	4°	-7°
1st PM	0°	0°	-7°
2nd PM	0°	0°	-7°
1st Molar	0°	0°	-10°
2nd Molar	0°	0°	-10°

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MANDIBULAR	STANDARD ANGULATION		STANDARD TORQUE (in degrees)
	Band Mat. (in degrees)	Preformed Bands (in degrees)	
Central	1 ½°	2°	0°
Lateral	2 ½ °	2°	0°
Canine	2 ½°	4°	-7°
1st PM	2°	3°	-15°
2nd PM	2°	3°	-15°

1st Molar	6°	6°	-25° - -30°
2nd Molar	6°	6°	-25° - -30°

(+) Lingual Root torque

(-) Labial Root torque

- For lower bicuspids in non-extraction cases, 2° of mesial root tip is build-in.
- In first bicuspid extraction cases, 5° angulation on the second bicuspids is build-in.
- In second bicuspid extraction cases, 2° of distal root tip is build-in on the first bicuspids.

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THE LEVEL ANCHORAGE SYSTEM

The Level Anchorage system given by Terrell L. Root in 1981, is a complete orthodontic treatment system designed for those goal oriented orthodontist's who would like to treat efficiently to a predetermined goal and reach that goal on a routine basis. It is designed to quantify the anchorage requirements of the orthodontic problem and thus clarify the necessary treatment steps needed to reach the goal. The system consists of a banded or bonded edgewise appliance with built-in tip, torque, and offset and an analysis and treatment planning chart with a step-by step treatment procedure for seven different extraction and nonextraction choices[5].

APPLIANCE PHILOSOPHY: [5]

Charles Tweed was the first person to advocate anchorage preparation. He placed tip-back bends in the lower arch to vary the amount of distoaxial inclination of the lower posterior teeth. The amount of tip varied depending on the severity of the malocclusion. When this anchorage preparation was used with the standard edgewise appliance, the tip, torque and offset bends had to be placed in each edge wise arch. These bends were to be duplicated or increased in succeeding arches as the case progressed. This procedure was a challenge to even the most dedicated orthodontists.

In order to help reduce the wire bending requirement for anchorage preparation, Reed Holdaway described preangulation of the edge wise appliance in the mandibular buccal segments. He varied the angulation depending on the severity of the malocclusion. This was done based on his experiences as an instructor of the Tweed course in Tuscon. Terrell Root followed his concepts of preadjusted tip in the edgewise appliance since 1954.

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Larry Andrews introduced the first completely preadjusted appliance called the Straight wire appliance. The Level A nchorage system could be described as utilizing a straight wire appliance with anchorage preparation as described by Holdaway.

PREADJUSTMENTS OF THE LEVEL ANCHORAGE SYSTEM: [5]

1. TIP:

- All the maxillary anterior teeth have a mesial crown tip:

Central incisor 4^0

Lateral incisor 7^0

Canine 6^0

- There is no tip in the maxillary premolars or first molars, but the maxillary second molars have 15^0 of distal crown tip.
- All the mandibular anterior teeth have a mesial crown tip:

Central incisor 2^0

Lateral incisor 2^0

Canine 6^0

- The mandibular 1^{st} premolar have 4^0 of distal crown tip.
- There are two choices of distal crown tip for the mandibular buccal teeth: regular and major. The choice depends on the severity of malocclusion and is determined by use of the analysis chart.

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MANDIBULAR	REGULAR ANCHORAGE	MAJOR ANCHORAGE
Second premolar	4^0	6^0
First molars	6^0	10^0
Second molars	10^0	15^0

2. BRACKET AND TUBE HEIGHT: [5]

	MAXILLARY	MANDIBULAR
Central	4.5 mm	4 mm
Lateral	4 mm	4 mm
Canine	5 mm	4.5 mm
1^{st} Premolar	4 mm	4.5 mm

2nd Premolar	4 mm	5 mm
1st Molar	3.5 mm	4 mm
2nd Molar	3 mm	3 mm

3. TORQUE: [5]

	MAXILLARY	MANDIBULAR
Central	15°	0°
Lateral	7°	0°
Canine	0°	0°
1st Premolar	-7°	11°
2nd Premolar	-7°	11-17°
1st Molar	10°	22°
2nd Molar	10°	25°

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ELAN AND ORTHOS SYSTEM

Elan and Orthos are two new appliance systems introduced by Craig Andreiko, that represent the first time modern CAD/CAM [computer-aided design/computer-aided manufacturing] technology has been applied to both human anatomy and appliance design in the orthodontic field[23].

ELAN:

I. APPLIANCE PHILOSOPHY: [23]

- Elan is a new dimension in treatment planning. Over the years, treatment planning and appliances have evolved to more completely address the individuality of the patient.
- Computers now aid in the cephalometric evaluation of the patient and in previewing the anticipated results. Appliances exist that are designed for extraction, nonextraction, expansion, etc.
- Elan is the first system to integrate the treatment plan and the appliance for a specific patient.

II. APPLIANCE DESIGN: [23]

- Elan begins with digitizing the skeletal and dental entity of the patient.
- The system then proceeds to design an occlusion, based on the practitioner's treatment plan and on algorithms developed to mate the three-dimensional positioning of the dentition to the skeletal framework.
- The system then designs and fabricates brackets, wires, and bracket-positioning devices that are essentially reverse-engineered from the desired final results for that individual patient.

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III. STEPS IN PLANNING INDIVIDUAL TREATMENT NEEDS: [23]

- The Elan system begins with an analysis to determine the medullary center of the mandibular bone. This is converted to a mathematical equation called the Mantrough, which is the keystone of the analysis.

Development of Mantrough, with grid overlay used for selection of lingual and labial limits.

- The mandibular teeth are then placed on the curve such that the crown long axes are at specified inclinations, as opposed to the facial inclinations that have been used to date.
- The centric stops (buccal cusps) of these teeth are aligned on another smooth equation derived from Mantrough, such that the roots of the teeth are centered in the bone.
- The maxillary teeth are then placed in occlusion with the already-set mandibular teeth.
- Maxillary posterior teeth are placed with respect to centric stops and calculations for molar rotation.

- The maxillary anterior teeth are placed from calculations to provide either group function or cuspid rise parameters. Other calculations regarding tooth-size discrepancies, depth of bite, etc., are also done at this time.
- Essentially, the system does an ideal setup for each case.

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III. ADVANTAGES: [23]

- It is an evolution of preadjusted appliances. Since the system can capture the "personality" of the practitioner and match this to the individual patient, it is essentially the same appliance he or she is now using, with much more of the guesswork eliminated.
- This system allows the practitioner to concentrate more on treatment planning and less on adjusting for the mismatch between the appliance and the patient.

IV. BRACKET: [23]

- TYPE: Currently, the system is available only in the twin configuration, but it has long-term plans to encompass all techniques, including ceramic and plastic appliances.
- SLOT SIZE: Both .018" and .022" slots are available currently.
- PLACEMENT: Mandibular brackets are placed as occlusally as possible for hygiene while assuring clearance from the buccal cusps of the maxillary teeth in the final occlusion. The maxillary brackets are placed fairly centrally, due to the absence of interferences.

VI. CROWN LONG AXIS: [23]

- The crown long axis, as used in the Elan system, is a line that passes through points of bisection of the incisal edge and the cervix of the tooth, as seen from a mesiodistal profile.
- The system works more off the body of the tooth, essentially, but also utilizes specific occlusal landmarks to more accurately control root positioning.

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ORTHOS: [23]

Orthos is a new average prescription and appliance design based on computer
analysis of more than 100 cases derived from the Elan technology. It is a coordinated system of brackets, buccal tubes, and wires.

It contains refinements and upgraded logic from the other currentlyavailable prescriptions. The computer logic written to solve functional and static occlusal puzzles and the appliance design software

developed for Elan are being used to design the Orthos average appliances.

FACTORS AFFECTING APPLIANCE DESIGN AND PERFORMANCE: [23]

- By utilizing new rotation-in-slot technology, the lower anterior brackets have been reduced in the faciolingual dimension while, at the same time, the 1st-order relationship between lower cuspids and anteriors has been corrected.
- Mandibular posterior segments have less negative torque than prior designs to keep these teeth from being inclined lingually.
- Orthos archwire forms are taken from skeletal studies and are also "coordinated" mathematically for the first time.
- Molar rotations are calculated from actual anatomy for the first time.
- The mandibular arch has more progressive tip to aid in root paralleling.
- Mandibular bicuspids have distal root tip to level marginal ridge contacts.
- Upper second bicuspids have distal tip to level marginal ridges between the second bicuspids and the first molars, and they are thicker than the first bicuspids to reduce the need for bayonet bends.
- Upper posterior segments have more buccal root torque to keep the dangling lingual cusps from causing balancing interferences with the prominence of today's expansion mechanics.

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Effect of progressive tip on root paralleling (top: typical prescription; bottom: Orthos values).

VIAZIS BIOEFFICIENT THERAPY

Bioefficient Therapy was given by Dr. Anthony Viazis. It is a patient-friendly and user-friendly system designed to shorten the time-consuming initial phase of treatment. By proceeding more quickly to an individualized finishing stage, it reduces burnout for both patient and clinician and produces noticeable results early in treatment, improving patient cooperation and the quality of care[24].

BRACKET DESIGN: [24]

Conventional single brackets have not been as popular as twin brackets because they have virtually no capability of controlling rotations or tipping. Dr. Viazis developed a multifunctional single bracket for Bioefficient Therapy that solves this design problem while providing optimal tooth movement. Its capabilities are:

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1. *CONFORMITY TO CROWN ANATOMY AND GINGIVAL OUTLINE*: [24]

- This is especially useful in the case of bicuspids, where the brackets can be placed as far gingivally as needed because of a narrow, rounded gingival end.
- A low profile allows the brackets to blend in well with the archwire, and the side elbows are hidden behind the elastomeric modules after ligation.
- *EASE OF USE*: [24]Variability in bracket positioning is usually attributable to improper mesiodistal or buccolingual placement of the

slots. With the new brackets, if the operator aims the ball indicator toward the center of the curvature of the gingiva, the vertical member automatically lines up along the long axis of the tooth.

- Vertical position can be easily verified with a periodontal probe. If brackets without ball indicators are used, the vertical member can be visually aligned along the long axis of the tooth and checked with the probe.
- The side elbows help with mesiodistal orientation. Assuming the tooth is a normal shape, the incisal edge of the tooth should be parallel to the horizontal member of the bracket.
- Improper ligation of elastomeric modules can result in added staff time and patient discomfort. This bracket design makes ligation easy and secure, since both the wings and the elbows are used.

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Both wings and elbows of new brackets (left) can be used for ligation. Larger interslot distance (x_1) compared to conventional twin brackets (x_2) allows much greater wire flexibility. Shorter interbracket distance increases wire stiffness for rotation control.

2. *MINIMUM FRICTION*: [24]

- The bracket slot is elevated from the horizontal member. This single-slot contact produces the least amount of wire-bracket contact and thus the lowest possible friction.

3. *TIP CONTROL*: [24]

- The main problem with conventional single brackets is loss of tip control. In the new bracket design, as soon as a tooth begins to tip (as

in space closure), the archwire contacts the side elbows, and the single slot momentarily becomes a wide twin slot that produces root movement before any further crown movement. Thus, the tooth "walks" back in a zigzag fashion.

- The interelbow distance is much shorter than the interslot distance, and therefore the wire is much stiffer between the elbows, resulting in better leveling and root parallelism.
- The tooth movement is continuous and controlled.

4. *ROTATION CONTROL:* [24]

- The narrow, elongated configuration of the brackets, with the wings moved toward the mesiodistal surfaces of the teeth, provides maximum rotation control.
- Depending on the amount of rotation control needed, either of two configurations of elastomeric modules can be used. For maximum control, the elastomer is slipped over one wing of the horizontal member; both sides of the module are then passed behind the vertical member and over the other wing.
- For a quicker rotation correction, the module is placed over the vertical member and then under the wing of the side that needs correction.With this method, the module partially covers the slot. As the archwire is placed, the module is displaced to the side, and the opposite side is tied with a steel ligature. Thus, the module acts like a Steiner wedge.

6. *VERTICAL SLOT:* [24]

- A vertical slot is a helpful bracket feature even for clinicians who do not use it consistently, because it can be used with the new nickel

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titanium uprighting springs to enhance and detail tooth movement during the finishing stage. The slot does not add significantly to bracket width.

7. *HIGH ANTERIOR TORQUE*: [24]

- It is more efficient and less time-consuming to have torque built into the brackets than to torque the archwires. Because most clinicians finish with undersize wires, extra torque is needed to counteract any tipping effect produced by active mechanotherapy, especially during space closure.
- The bracket prescription for the Bioefficient system was designed to overcorrect malocclusions and to make it possible to work with the largest possible wires from the start of treatment.
- It is a modification of the preadjusted systems developed by Roth, Andrews, Alexander, and Hilgers.
- The torque-in-base brackets are diagonal in shape, and the bases have anatomically contoured triangular shapes.
- The height of the upper central incisor bracket is designed so that the middle of the tooth (the FA point of Andrews) coincides with the bracket slot. Other bracket heights are decided according to the distance of the base from the incisal edge. [24]

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Bracket heights and prescriptions (x = distance from upper central incisor bracket base to incisal edge; y= distance from lower central incisor bracket base to incisal edge).

It should be emphasized that it is impossible to fit all patients into the same bracket prescription. Full-size or undersize wires should be

used as the case dictates, and individualized finishing is almost always required. [24]

BRANDT TORQUEONTROL SYSTEM

The new edgewise type bracket and arch wire selection permits tip control, sliding mechanics with straight arch wire and initial continuous programmed torque in the upper front region where it is needed most.[25]

APPLIANCE DESIGN: [25]

- The system has 0.020″ slot for the upper anterior teeth for active programmed control of bodily movement and torque of the anterior teeth.
- It uses 0.022″ slot for the buccal teeth for optimal sliding mechanics.

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PRINCIPLE OF THE TORQUEONTROL SYSTEM: [25]

- Upper anterior teeth: High effective torque
- Buccal segment: Maximal sliding mechanics

RACKET POSITION: [25]

	MAXILLARY	MANDIBULAR
Central	4.5 mm	4.5 mm
Lateral	4 mm	4.5 mm
Canine	5 mm	5 mm
1st Premolar	4.5 mm	4.5 mm
2nd Premolar	4.5 mm	4.5 mm
1st Molar	3.5 mm	3.5 mm
2nd Molar	3.5 mm	3.5 mm

PRESCRIPTION: [25]

Tooth	Angulation (tip)	Inclination (torque)
Maxillary		
Central incisor	5^0	11^0
Lateral incisor	8^0	7^0
Canine	11^0	0^0
First premolar	0^0	7^0
Second premolar	0^0	7^0
First molar	0^0	10^0
Second molar	0^0	10^0
Mandibular		
Central incisor	0^0	-5^0
Lateral incisor	0^0	-5^0
Canine	5^0	-11^0
First premolar	0^0	-17^0
Second premolar	0^0	-22^0
First molar	-5^0	-25^0
Second molar	0^0	-30^0

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DUAL ENVIRONMENT BRACKET

The Dual Environment bracket was introduced by George F Schudy in 1990.[26]

APPLIANCE PHILOSOPHY: [26]

- According to the author, the ideal edgewise bracket should offer a maximum range of action for wires, yet still permit precise control with small edgewise wires and require minimum change in technique.
- A new bracket was designed to capitalize on the computer modeling that demonstrated the advantages of small wires and greater intrabracket space, but without the disadvantages of the Bi-Metric appliance.

BRACKET CONFIGURATION: [26]

- The bracket has a large outer slot, for maximum archwire flexibility in the initial phase, and a small inner slot that accepts small rectangular wires for maximum control later in treatment.

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Dual Environment bracket with large outer slot (F) and small inner slot (P).

- The outer slot measures .040" for twin brackets and .030" for single brackets.
- The inner slot can be either .016" or .018".
- The flexibility of the outer slot in some cases allows the use of a full-size .016" x .022" initial archwire, even with a great deal of irregularity.
- The inner slot is used after rotations have been partially corrected and vertical alignment has been accomplished. The same full-size wire can then be seated in the smaller slot.
- This new bracket allows the teeth to adjust comfortably during the initial phase of treatment.

- Therefore, patients experience little discomfort when the wire is seated in the inner precision slot after two to four weeks.

ADVANTAGES: [26]

- Faster leveling of arches with fewer arch changes. The large posterior intrabracket space allows less friction with working arches, permitting the teeth to move more easily both vertically and horizontally.
- Easier torquing of teeth with less discomfort. Torquing efficiency is directly proportional to the length of the wire and inversely proportional to its stiffness. For a given span, an .016" x .022" wire has 38% more deflection than an .018"´x .025" wire and 68% more deflection than an .022"x .028" wire. Seating torque of even 30-45° is virtually painless for the patient. Lighter torquing forces are also associated with reduced root resorption.
- Fewer permanent sets in archwires due to mastication. The working arch is not closely held in the posterior brackets; it flexes within the slots and acts as a shock absorber to prevent strain on the wire from chewing.
- This two-slot bracket allows the clinician to move sequentially from an appliance that increases range of action by maximizing intrabracket space and minimizing control, to one that exerts anterior and terminal molar control, to one that finally engages all the teeth with precision control. In addition to its efficiency, the appliance greatly reduces patient discomfort.

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MCLAUGHLIN, BENNETT AND TREVISI SYSTEM

McLaughlin and Bennett worked with Trevisi to re-design the entire bracket system to complement their proven treatment philosophy and to overcome the perceived inadequacies of the original SWA.[27,28,29]

They re-examined Andrew's original findings, and took into account additional research input from Japanese Sources and brought about the MBT Bracket System which they called "Third generation of preadjusted appliance. "

According to various arch forms' research it was recommended to use 3 different arch forms according to different clinical situations. These were- tapered, square and ovoid. When superimposed, they vary mainly in inter-canine and inter pre-molar width, giving a range of approximately 6mm. However the inter-molar widths of the three shapes were similar.

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Also they further updated light force levels by the use of heat activated Nickel- titanium wires (HANT) re-stating the overall treatment philosophy.

Following changes were made in the standard SWA Brackets: - [27,28,29]

- Original dots and dashes system for brackets identification was changed to laser numbering of standard metal brackets.

- Brackets were available in standard size metal , mid-size metal, clear forms .
- Rectangular shape was replaced by rhomboidal form to reduce the bulk of each bracket.

- Torque in base-the Computer –aided design (CAD) factor --

  Torque-in-base was an important issue with the first and second generation preadjusted brackets. Technology was not available to set bracket slots in the correct position relative to the facial surfaces of the crown without torque-in-base.

  Since the advent of CAD-CAM bracket design, the brackets may be finished with all torque-in-base (full size and clear) or a combination of torque-in-base and torque-in-face with absolutely no difference in slot position.

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- Refinement of bracket base design

It is incorporated to increase the strength and help plaque control in difficult areas.

- Lower premolar bracket may be offset on specially designed base, to increase bond strength and reduce the risk of bond failure.
- Tapered bracket bases on lower incisors can help in plaque control in this difficult area.
- Change in Anterior bracket Tip Specification:

Thus, in original SWA Brackets, their was additional tip built into the anterior upper brackets by 10^{o} and lower anterior bracket by 12^{o} in total from the MBT Brackets.

Disadvantage of additional anterior tip: -

1) It creates significant drain on antero-posterior anchorage.
2) It increases the tendency for bite deepening during the alignment stage.
3) In some cases it brought the upper canine root apex too close to the first premolar root apex.

As the lighter forces were used in all stages of treatment by MBT philosophy, this additional anti-tip or second-order compensation was not necessary and so in MBT bracket system the tip of bracket was same as the original research value. This also dramatically reduced anchorage needs of each case, and put less demand on patient co-operation.

As the MBT values are based on Andrew's original research values, there is no compromise in ideal static occlusion.

And if the condyles are in centric relation, there is no compromise in ideal functional occlusion as described by Roth.

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tooth	SWA Tip		Recommended Tip	
	LOWER	UPPER	LOWER	UPPER
Central Incisor	2^0	5^0	0^0	4^0
Lateral Incisor	2^0	9^0	0^0	8^0
Canine	5^0	11^0	3^0	8^0
First premolar	2^0	2^0	2^0	0^0
Second premolar	2^0	2^0	2^0	0^0

- Change in upper posterior bracket tip specification:
- Upper bicuspid brackets are provided with 0^0 tip to keep these teeth in a slightly more upright position, more in the direction of Class I, and also reduces the anchorage needs in some cases.
- Upper molar brackets are provided with 0^0 tip, which when placed parallel to the occlusal plane, introduces 5^0 tip into the upper molars.

- Change in lower posterior bracket tip specification:
- Lower posterior tip in the first and second bicuspid brackets is maintained at 2^0, to slightly incline these teeth forward.
- For the lower first and second molars, 0^0 tipped brackets are provided, which when placed parallel to the occlusal plane, introduce 2^0 of tip to these teeth.

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- Torque specification:

In original standard SWA brackets the built-in torque was relatively inefficient in delivering torque. It was therefore necessary to build extra torque into the important incisor and molar region in order to meet clinical goals with minimum wire bending.

Torque is not efficiently expressed by the preadjusted appliance system owing to two reasons:

1. The area of torque application is small and depends on the twist effect of a relatively small wire compared to the size of the tooth.
2. In order to slide teeth it is normal practice to use .019/.025 steel wires in the .022 slot .These wires have a slop of about 10°

- Incisor torque specification:
- Upper incisor brackets are provided with additional palatal root torque, while lower incisor brackets are provided with additional labial root torque.
- This adjustment aids in the correction of the most common torque problems occurring in the incisor areas.

- Upper Cuspid, bicuspid and molar torque specification.
- Upper cuspid and bicuspid brackets are provided with the normal -7^0 of torque.
- Upper molar brackets are provided with an additional 5^0 of buccal root torque (-9^0 to -140) to reduce palatal cusp interferences with these teeth.
- Upper canine torque. Available in -7^0, 0^0, $+7^0$, torque.
- The 0^0 and $+7^0$ options are for cases with narrow maxillary bone form and\or prominent canine roots, and are often used with archwires in the tapered form.
- There was a tendency for upper first molar palatal cusps to extrude. Bracket with – 14^0 of buccal torque gives extra control.

In some cases it is necessary to add buccal root torque to the upper archwire, even when using a -14^0 torque bracket.

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- Lower cuspid, bicuspid and molar torque
- Progressive buccal crown torque is provided in the brackets of the lower posterior segments.
- This allows for buccal uprighting of these teeth, which is beneficial in most cases.
- Also, the original SWA first molar torque -30°, second molar torque -35° allowed rolling-in of lower molars.
- Therefore the lower premolar torque was changed by 5°,first molar torque by 10° and second molar torque by 25°.
- Lower canine torque available in -6^0, 0^0, $+6^0$.
- The 0^0 and $+6^0$ options are for cases with narrow mandibular bone form or prominent canine roots, or deep bites at start of treatment.

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- In-out specification

- It is 100% fully expressed because the archwire lies snugly in the slot.
- An upper second bicuspid bracket with an additional 0.5mm of in-out compensation is provided for the common situation in which upper second bicuspids are smaller than upper first bicuspids.
- This is helpful in obtaining good alignment of marginal ridges in cases with small upper second premolars.

➢ Factors, which govern the selection of canine brackets.

1. Arch form.
2. Canine prominence.
3. The extraction decision (tip control).
4. Overbite.
5. Rapid palatal expansion.
6. Agenesis of upper lateral incisors, where space is to be closed.

1. Arch form.

Well-developed arches -- -7^0 upper & -6^0 lower.

Ovoid / tapered arches -- 0^0 upper & lower.

Narrow tapered arches -- $+7^0$ upper & $+6^0$ lower.

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2. Canine prominence.

In cases with prominent canine / canine with gingival recession use 0^0 torque or $+7^0$ upper & $+6^0$ lower torque.

3. The extraction decision (tip control).

In cases of premolar extraction, canine bracket having 0^0 torque are used. This is because 0^0 brackets tend to maintain the canine roots in cancellous bone, Thereby making tip control of the canine roots easier.

4. Overbite.

In many deep bite situations like for eg. In class II div. 2 case, there is often a requirement to move the canine crowns labially, but to maintain the roots centered in the bone. This is more readily achieved if 0° or +6° lower canine brackets are used.

5. Rapid palatal expansion

As rapid palatal expansion creates secondary widening in the lower arch , use of 0^0 or $+6^0$ torque brackets on lower canine tooth helps in uprighting the lower teeth to assist the favorable change.

6. Agenesis of upper lateral incisors, where space is to be closed.

If one or both the upper lateral incisors are missing, a decision may be made to close the spaces, and bring the canines in contact with the central incisors.

A +7° torque bracket may be used by inverting the -7° bracket which also maintains the tip at 8°.

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- Some other modifications
- Lower Second premolar tubes:

ADVANTAGES:

- Decreased occlusal interference of the opposing teeth, mainly in overbite and class II cases.
- Comfortable to the patient.
- Decreased friction during the sliding mechanics.
- Decreased chairside time as the tubes are self-ligating.

- Lower second molar mini tubes:

Helpful in cases where the inter-occlusal space and the gingival tissue do not allow the placement of regular banded molar tubes or bondable molar tubes.

- Lower first molar non-convertible tubes

Advantages:

1. Comfortable, cleaner and stronger than Convertible tubes
2. Fewer interferences and hence accurate vertical positioning

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BEGG LIGHT WIRE APPLIANCE

The Begg technique was introduced by percival Dr. Raymond Begg. Begg studied and worked with Angle from 1924-25. During that time, although Angle was still teaching the ribbon arch appliance, he was working simultaneously on a new mechanism in which he turned the ribbon arch bracket by 90^0 and inserted it "edgewise" into "tie brackets" with slots in their faces.[30]

Dr. Begg and Fred Ishii, were the first to treat patients with this new appliance. According to Begg, Angle stated openly that he changed the orientation of the bracket slots to make it easier for the "not so clever orthodontist". According to Angle, upper and lower edgewise wires can be preformed to ideal shapes prior to placement and the dental arches expanded by drawing teeth towards the archwires with ligature ties. Because Angle advocated nonextraction treatment, there were few spaces to close. He also developed the edgewise mechanism to achieve better control of the mesiodistal axial inclinations of teeth. [30]

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After returning to Australia in 1925, Begg practiced the edgewise mechanism for 2 yrs and followed the nonextraction philosophy. He soon became dissatisfied with many of his post-treatment profiles and was often faced with serious relapses. [30]

Accordingly in 1928, he began, when indicated, to remove teeth and/or reduce tooth substance by stripping and recognized the role of attrition in human dentition. He realized that edgewise mechanism was not designed to rapidly close extraction spaces and reduce deep over bites. He also observed that edgewise brackets, even when used in conjunction with round archwires, could cause undesired root movements. The unavoidable uprighting of mesiodistally tipped teeth

caused by the placement of archwires in edgewise brackets created an unnecessary strain on intraoral anchorage and often resulted in anterior teeth being being bodily repositioned across the midline. To avoid these problems, Begg discarded wide-channel brackets and began using ribbon arch brackets, facing the slots gingivally rather than occlusally. A ribbon arch bracket, used in conjunction with a round archwire, permits free tipping in all directions. In 1956 he introduced the concept of differential force system. [30]

BRACKET CONFIGURATION: [30]

The Begg technique employs modified ribbon arch brackets whose flanges accept a direct bonding pad or can be spot welded to a band. The archwire slot is 0.020 x 0.045 inches to accept both a 0.020 inch arch wire and, when required, a 0.016 inch torquing auxiliary. Two vertical slots, one on either side of the archwire, accept lock pins and/or auxiliaries.

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BRACKET PLACEMENT :[31]

- Brackets are centered mesiodistally on the labial or buccal surface of the teeth with the base of the arch wire slot 4 mm from the incisal edges or cusp tips.
- The only exception to this vertical placement is the maxillary lateral incisor, brackets on these teeth are set closer to the incisal edges at 3.5 mm, to automatically provide the desired esthetic shortening of these teeth in relation to their neighbours.

BASIC TENETS OF BEGG MECHANOTHERAPY:[32]

- Use of light orthodontic forces.

- Splitting of bodily movement into the crown tipping movement followed by root movement, for an efficient bodily translation with the least taxation of the anchorage.
- Use of brackets permitting free tipping movement in the initial stages due to minimum friction between the wire and bracket.
- Use of differential forces for the movements of different groups of teeth.
- A definite sequence of stages as also treatment steps.
- Use of light intra-oral elastic forces.
- En-Masse movements of anterior and posterior teeth for attaining the objectives like overjet reduction and correction of posterior occlusion.
- Separation of root moving forces from arch wire forces.
- Over correction of all the displacements.
- Use of high tensile strength round wires.

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ADVANTAGES:[5]

- Light optimum force levels are used throughout the treatment, which are physiologically more acceptable and are comfortable to the patient.
- Relatively continuous force application.
- Minimal friction of wires in brackets and tubes.
- Rapid alignment, leveling and rotation of anterior teeth.
- Rapid and efficient overbite correction chiefly by means of molar extrusion and incisor intrusion.
- Simultaneous crown tipping and retraction of all anterior teeth.
- Relatively continuous paralleling of roots at extraction sites by auxiliary springs.

- Relatively continuous torquing of upper, or occasionally, lower incisors.
- Extra-oral force not necessary except with extreme anchorage problems.

DISADVANTAGES: [5]

- Difficulty in coordinating maxillary and mandibular arch form and width.
- Difficulty in obtaining bilateral symmetry.
- Difficulty in obtaining control of premolar and molar torque without the use of auxiliaries.
- Difficulty in stabilizing teeth during final artistic positioning.

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MODIFICATION OF BEGG TECHNIQUE

This was introduced by Dr Akira Kameda. He modified the Begg technique to comply with the demands of time and progress of technology .

This was based on 25 yrs of clinical experience. The basic idea was to solve unfinished and/or unstable parts of pure Begg technique. He thought that the drawbacks of the technique were:[33]

- Emperical diagnosis.
- Unnecessary and over tipping teeth in mesio-distal and labio-lingual planes which includes anchor molars.
- Collapse of the arch form.
- Rotations and mesial tipping of second premolars.
- Stage III was mechanically taxing with several unfavourable side effects.
- Gummy smile with canting of the occlusal plane.

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Since 1972 he has sought to rectify these deficiencies of Begg technique and this has resulted in the development of the Kamedenized Begg technique.

APPLIANCE PHILOSOPHY: [33]

- Dr. Kameda states that most malocclusions are comprised of labio-lingual alignment problems, with mesio-distal axial inclination problems consisting only a minor part.
- It is therefore, irrational to correct these problems by tipping teeth mesiodistally as is done in pure Begg technique.

- These malocclusions for correction resolution need tooth movement in the labio-lingual plane.
- The fundamental difference in the tooth movement of Kamedanized Begg technique when compared with pure Begg technique is in the direction and the magnitude of the tip.

BRACKET CONFIGURATION: [33]

- In 1983 , he introduced torquing and reverse torquing brackets.
- The classical Begg bracket configuration was retained but it had torque built into the base of the bracket.
- Built in torque adjustments is obtained by raising the incisal or gingival edge of the bracket base away from the tooth surface by using metal wedges between the base of the bracket and the bonding mesh pad.
- The amount of torque built-in was 20° for the upper incisors and -10° for the lower incisors.
- These brackets are to be used according to the specific clinical problem.
- The usual pattern of usage is as follows:

	Upper incisors	Lower incisors
1. Class II malocclusion	20°	-10°
2. Class III malocclusion	-10°	20°

- Individual teeth needing torque/reverse torque may receive appropriate brackets.

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THE BEDDTIOT APPLAINCE

The appliance system known as the Begg-edgewise diagnosis-determined totally individualized orthodontic technique (BEDDTIOT) offers the capacity to employ selected principles and features of Begg and edgewise mechanisms in specific situations in which they are most advantageous.[34]

APPLIANCE PHILOSOPHY: [34]

- The appliance was developed to meet specific criteria, characteristics deemed to be most desirable in an orthodontic appliance
- . The primary goal was the facility to treat each patient's needs in the manner most efficient for that individual.
- The intent was toincorporate the important advantages, features, and capabilities of many fixed appliances and minimize deficiencies, making the most of current understanding of orthodontic biomechanics and technology.
- The control and precision of edgewise appliances (having full torque and angulation built in) is combined with the capabilities for anchorage conservation and rapid tooth movement (of the "light-wire differential force" approach to biomechanics) by means of attachments that are versatile, simple, economical, and small.
- Treatment is *individualized.*
- Begg principles are employed in some cases; various edgewise techniques in others. A wide variety of combinations may be employed easily.

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BRACKET CONFIGURATION: [34]

- The brackets are narrow, single-width (0.050 inch or 1.3 mm) edgewise brackets with 0.022 inch (height) and 0.028 inch (faciolingual depth) horizontal arch wire slots.
- On the lingual side of the bracket (that is, against the band or bonding pad) is a 0.020 x 0.020 inch vertical slot.

BEDDTIOT bracket on universal bonding pad

- The arch wire slots are "torqued" (cut at such angles to the brackets that they will be oriented parallel to the plane of the arch when the teeth are positioned properly.

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Cross section of the bracket with 20° lingual crown torque on Mandibular second premolar

- In average cases the appropriate brackets to assign to the various teeth will be determined by the slopes of the facial surfaces of the teeth.
- Since the slope of the surface of any particular tooth varies among patients, the operator should exercise judgment in the selection of appropriate brackets.
- Except for torque, the brackets are all identical. Therefore, they are interchangeable; any bracket may be used on any tooth.
- Placed with its torque-indicator groove gingival, a bracket provides lingual root torque; with the groove occlusal, it provides lingual crown torque.
- The standard torques make up a set with a smooth progression—0°, 5°, 10°, 15°, and 20°. Thus, an appropriate bracket is available for most situations.

TORQUE: [34]

	MAXILLARY	MANDIBULAR
Central	-10°	0°
Lateral	-5°	0°
Canine	0°	10°
1st Premolar	5°	15°
2nd Premolar	5°	20°
1st Molar	10°	25°

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- Each of the five brackets prewelded on both flat and curved universal bonding pads provides maximum versatility. The pads are of minimal size, and their shape facilitates the placement of the brackets with either end toward the gingiva. In this way each may be used for either lingual crown or root torque.
- The brackets are milled from solid bars of stainless steel.
- They have arch wire slots that open on the facial surface; thus, malpositioned teeth are usually moved directly toward engagement with the arch wire because full advantage can be taken of the resilience of both the arch wires and elastomeric ligatures.
- Alignment can be achieved with the use of long-range, low-magnitude forces.
- The brackets are small in all dimensions to ensure optimal appearance and minimal lip and cheek irritation. This also lessens occlusal interference, enamel surface involved in bonding, and problems with gingival proximity and oral hygiene.

- Narrow brackets have long, resilient spans of arch wire between them— a great advantage over twin bracket edgewise. A wire in narrow single brackets has approximately twice the elastic range of the same wire in twin brackets and is only about one half as stiff, that is, produces only one half as much force in a given deflection.
- The fact that a wire is distorted less in the engagement of narrow brackets magnifies their advantage; less elastic range is required and less force is produced.
- The dimensions of the arch wire slot allow considerable (but limited) mesiodistal tipping on undersized wires (10° distal crown tip on 0.016 inch, the usual working wire), as well as limited uprighting (5° mesial crown tip on 0.018-inch arch wire).
- Uprighting springs may be inserted in the 0.020 x 0.020 inch vertical slot. Uprighting springs are not needed for "braking" (to prevent overtipping) and need not be removed before treatment is truly completed (they cannot go too far).
- The vertical slot has many potential uses. It can accommodate ligatures, elastic hooks, rotation devices, and various other auxiliaries. Turned 90° (so it is horizontal), it can serve as a miniature buccal tube. An example of its function as a buccal tube would be to gain control of partially erupted or impacted second molars that require uprighting or crossbite correction.

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TIPEDGE

In the past, the ribbon arch bracket used by Dr. P.R. Begg in the Begg technique provided the freedom required for rapid tooth movement from relatively light forces. But however, Begg died in 1983 still searching for a way to achieve final, positive, three-dimensional control from a ribbon arch-type bracket. But he never looked at the edgewise bracket as the solution, since he always considered it the problem.[44]

The edgewise mechanism with conventional, static archwire slots was the most popular appliance during that period. But even this appliance had deficiencies like there are no provisions in the edgewise archwire slot to facilitate anteroposterior interarch corrections, for anterior bite opening and for opening or closing spaces. Subsequent changes had also been made in the edgewise appliance, since its invention by Angle such as wider, twin brackets and preadjusted arch wire slots, which have increased and refined the level of tooth control. Yet, these modifications made it more difficult to accomplish the major repositioning of both teeth and the jaws that is often required. [44]

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In 1986, a change in the design of the arch wire slot made by Dr. P.C. Kesling, corrected all these problems. The modification was the removal of diagonally opposed corners from the conventional edgewise slot to permit either mesial or distal crown tipping. [44]

Such modification of the slot could not have been considered by Angle, because at that time there were no mesiodistal uprighting springs. They were created by Begg in 1960, to upright teeth in conjunction with ribbon arch type brackets. Without such springs the tip-edge bracket itself would not be practical. Therefore, a simple,

graphic equation can be formulated to relate the main contributions that led to the evolution of the bracket: [44]

DEVELOPMENT OF THE TIP-EDGE BRACKET: [44]

- Personal clinical experience and results of a study done in 1968 led Dr. P.C. Kesling to conclude that differential tooth movement (crown tipping followed by controlled root uprighting) requires that each tooth tip freely either mesially *or* distally— not in both directions.
- The use of round arch wires permits labial or lingual tipping of all teeth.
- During the early stages of treatment, the crowns of all teeth tip distally with the exception of those distal to extraction sites (and mesial to the anchor molars), which tip mesially.
- When teeth are free to move in this manner, it is possible to correct deep anterior overbites and retract dental arches with light (2oz), intraoral elastic and arch wire forces that leave the anchor molars upright and relatively undisturbed.
- By chamfering diagonally opposed corners of the conventional edgewise arch wire slot, it is possible to create an edgewise-type bracket that is programmed to permit either mesial or distal crown tipping and yet still control final crown inclination.
- Because the archwire slot permits initial crown tipping mesially or distally and faces horizontally, the slot and bracket are termed "Tip-Edge" and the technique that takes full advantage of this slot and differential tooth movement with straight archwires, is termed "The Differential Straight-Arch Technique".

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APPLIANCE CONFIGURATION:

TIP-EDGE BRACKETS: [44,36]

- By removing predetermined, diagonally opposed corners from the conventional edgewise archwire slot, the Tip-Edge bracket is created.
- This permits the desired distal crown tipping required for differential tooth movement.
- Pre-adjusted in three dimensions, the Tip-Edge slot permits the use of straight archwires in the majority of cases: both extraction and non-extraction.
- The bracket was further modified by the addition of rotation wings and a vertical slot of 0.020″ x 0.020″ to enhance rotational, tip and torque control.
- Various components of the Tip-Edge bracket are:[35]
    1. Uprighting and torque control surfaces (pre-adjusted).
    2. Central ridges for vertical control.
    3. Wings for rotational control.
    4. Notches or vertical slot to accept Side-Winder springs.

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A- Crown tipping control surfaces

B- Root uprighting control surfaces

C- Vertical and torque control central ridges or pivots

D- Rotational control surfaces or wings

- Tip-Edge brackets are available in single, twin or ceramic versions to meet the preferences of all orthodontists.[44]

- The slots not only permit initial crown tipping but they are also preadjusted to provide the desired final degrees of crown tip and torque.
- The bracket slot is 0.022″ wide between the central ridges which facilitates full yet passive, engagement of the intial 0.018 round arch wire in brackets on teeth that are originally tipped mesio-distally.

II. AUXILIARIES:[44]

- The generous sized vertical slots make possible the use of many auxiliaries throughout the treatment.
    - These may include power pins to accept elastomerics or rotation springs for rapid, physiologic rotation.
    - The most important auxiliaries for use with this system are the mesio-distal uprighting springs or Side-Winders.
    - A unique elastomeric ligature has been developed for the Tip-edge bracket that can provide mesiodistal angular control referred to as a Tip-edge ring. [35]

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CONCEPT AND FUNCTION:[44]

The Tip-Edge concept is to provide an edgewise type bracket that is familiar to all orthodontists and can be used to treat all malocclusions through differential tooth movement. This is accomplished by maintaining everything that is positive associated with an edgewise bracket, especially the labially facing archwire slot and tie wings, while removing that one thing that prevents mesiodistal crown tipping- diagonally opposed corners of the slot itself. This modification of the edgewise slot facilitates the following functions:

1. BITE OPENING:[44]

- Most malocclusions require anterior bite opening, which involves the intrusion of incisor teeth.
- If each tooth is free to intrude along its own path of least resistance, desired bite opening can be accomplished relatively rapidly and with the lightest of forces – approximately 5 gm per tooth.
- Conventional edgewise slots prevent this free root movement and when teeth are tipped mesially or distally, can even cause lateral movements of the roots which further complicates intrusion because of the action of undesired couples and moments created.
- Tip-edge arch wire slots with their one-point contacts with the archwire prevent the creation of such lateral pressures on root surfaces and permit the roots to intrude in an unhindered fashion and it is possible to open the deepest of the anterior bites without the need for extraoral forces.

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2. RETRACTION AND SPACE CLOSURE WITHOUT LOSS OF VERTICAL CONTROL:[44]

- Tip-edge archwire slot permits retraction of anterior teeth without deflection of the arch wire.
- All teeth, even central incisors, tend to tip distally as they are retracted.
- With conventional arch wire slots, this causes binding, first between the slot and the arch wire and secondly, especially in the canine area – it causes the incisal deflection of the wire itself. The central and lateral

incisors are therefore extruded, which may deepen the bite or increase gingival display which is not desirable.

- In the Tip-Edge brackets due to the removal of appropriate corners of the slot, the slot size increases as the tooth tips, with no binding and no deflection.

3. VARIABLE ARCHWIRE SLOT: [44]

- The slot of the Tip-Edge bracket are not only designed to permit crown tipping in one direction but they also become larger as the teeth tip.
- This is due to the inbuilt interior geometry of the slot which is designed such that, relative to the plane of a straight archwire, the vertical dimension within the slot continuously increases with each degree of distal crown tipping.
- The clinical advantages of this feature can be appreciated by comparing what happens to effective slot sizes when Tip-Edge and conventional edgewise brackets are tipped similar amounts.

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The advantages gained are :

a) No binding or arch wire deflection during retraction.
b) Ease of stepping up in archwire size.
c) No inadvertent mesial or distal root movements.
d) Ease of placing rectangular archwires when third order discrepancies exist between the slots and the wires.
e) No need to use nickel titanium or memory wires to avoid discomfort and/or accidental debonding.

4. ANCHORAGE CONSIDERATIONS: [44]

- Extra oral anchorage is absolutely not needed when practicing the differential straight arch technique (DSAT) with Tip-Edge brackets. The forces are so light (2 ounce) that adequate anchorage can be easily found within the mouth.
- Binding, which normally occurs between conventional edgewise slots and archwires during space closure, is eliminated in the Tip-Edge bracket by atleast 90% due to the in-built interior geometry of the bracket itself, wherein the corners of the slots that usually press against the upper and lower surfaces of the archwires as the teeth tip and cause the friction are eliminated.
- In non-extraction cases the design of the Tip-Edge archwire slots automatically sets up anchorage in one arch while permitting free distal tipping in the other arch.

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5. FAIL-SAFE MECHANISM: [44]

- Of great importance and advantage when using Tip-Edge archwire slots is the fact that lack of patient co-operation (not wearing elastics) does not result in negative/undesired tooth movements. The tooth movements merely stop and progress is put on "hold".

6. INTERBRACKET DISTANCE: [44]

- The force delivered to teeth from archwires is inversely proportional to the distance between the brackets- interbracket distance.
- If the teeth are tipped mesially or distally or when the labiolingual inclinations of adjacent teeth vary, relatively short interbracket distances result in the creation and delivery of very high force values during slot engagement with either round or rectangular wires.

- To overcome these problems, orthodontists have elected to use nickel titanium and/or undersized arch wires when second or third order discrepancies exist.
- The tip-edge archwire slot completely eliminates problems caused by interbracket distances. Initially, when using round archwires, the cut-out corners of the slot prevent binding from tipped teeth - torque discrepancies are no concern because of the round wire.
- As treatment progresses and crowns are tipped toward their final positions in the dental arches, slot sizes have increased. This permits passive engagement of full size, rectangular stainless steel wires with zero flexing.
- Each tooth will have either one point or no contact with the archwire. Therefore, "interbracket" distance is, in effect, from molar tube to molar tube.

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AXIAL INCLINATION CONTROL: SELECTIVE, LIMITED AND PHYSIOLOGIC.

One of the most unique and advantageous features of the Tip-Edge archwire slot is its ability to permit controlled root movement that is selective- as to time and location, physiologic and predetermined. [44]

SELECTIVITY: [44]

- Axial tooth control is selective and always under the control of the operator. This refers to both time and location.

- The mere engagement of arch wires, either round or rectangular in cross section, into Tip-Edge archwire slots has no effect on the inclinations of teeth in any directions.
- When axial control, tip, or torque is desired, it is achieved by the addition of Side-Winder springs to those teeth requiring such correction while the other teeth are left undisturbed.
- The application of force is, therefore, selective and adjacent teeth are not "round tripped" by arch wire flexing, promoting both stability and patient comfort.

LIMITATION: [44]

- The design of the Tip-Edge slot automatically limits the degree of mesiodistal uprighting.
- The second order power from the Side-Winder spring causes the tooth to upright mesiodistally.
- As this occurs, the bracket and its slot rotate relative to the stiff, passive archwire. Uprighting continues until the control surfaces within the slot strike the upper and lower surfaces of the archwire. At that point, uprighting ceases.

PHYSIOLOGIC: [44]

- The forces transmitted to the teeth by Side-Winder springs and other auxiliaries are relatively light and continuous.
- They are, therefore, far more physiologic than the heavier, intermittent jolts of force created by second and third order flexing of steel archwires- even though undersized.
- The design of the Tip-Edge archwire slot also makes it impossible to inadvertently deliver high third order torque forces from flexed rectangular archwires.

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- If a torque discrepancy exists between the archwire slot and the arch wire itself, the central ridges will be moved apart vertically causing the bracket to rotate and the tooth to tip mesially or distally within the confines of the periodontal membrane spaces until the force drops to zero. This is referred to as " Bracket escape" and is beneficial, because it allows a zero torqued rectangular archwire to fit into a severely lingually inclined bracket with little binding or discomfort.

REFINED BEGG TECHNIQUE

This technique was introduced by Dr. V. P. Jayade. According to him, no treatment modality is ever perfect. With the passage of time its drawbacks become apparent. Unless the treatment evolves to overcome those drawbacks, it is likely to become stagnant and then die slowly. Refinements become necessary to incorporate new concepts and technological progress. The present day Refined Begg technique evolved from the original teachings of Dr. Begg to overcome the shortcomings of the conventional Begg technique and to assimilate the contemporary thinking and material advances.[32]

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APPLIANCE CONFIGURATION: [32]

A. BRACKETS: [32]

- The brackets used are TP-256-000, or any other having a similar design and dimensions.
- The depth of the slot is 0.020″and its height is 0.045″.
- The dimensions of the bracket base are 3mm x 3mm.

- They must be made of good quality stainless steel sheets of minimum thickness 0.015″ so that the slot does not open during treatment.

BUILT-IN ADJUSTMENTS: [32]

I. INCISOR BRACKETS:

1. Anti-rotational adjustments: [32]

- The rotational control in Begg bracket during the first stage is poor due to the excessive play when an undersize 0.014″ or 0.016″ wire is used in the 0.020″ slot.
- This has been corrected by building an anti-rotational adjustment in the bracket.
- The mesial or distal edge of the bracket is raised away from the tooth surface for the mesio-lingual or disto-lingual correction respectively (i.e for the incisors which are rotated mesio-labially or disto-labially respectively, to start with). Brackets having such adjustments are available ready made.
- They can also be prepared, as suggested by Mollenhauer, by welding a piece of 0.010″ ligature wire on the mesial or distal edge of the bracket base mesh.
- This is an extremely useful modification that greatly increases rotational control of the Begg brackets. It eliminates the need for archwire offsets, which are otherwise required for holding the corrected rotations throughout the treatment.

2. Built-in torque: [32]

- This technique uses Begg brackets with built-in torque adjustment in the brackets, as was recommended by Kameda, which is obtained by raising the incisal or gingival edge of the bracket base away from the tooth surface.

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- The brackets commercially available have a thin metal wedge interposed between the bracket base and the mesh for this purpose.
- When a rectangular ribbon wire is used in conjunction with these brackets, labial or lingual root torque is produced.
- It is not possible to build such an adjustment in a bracket by welding a piece of wire at the incisal or gingival edge because relatively bigger size wires need to be welded since the deflection range required for achieving adequate torque is quite large.
- Such wires lift the bracket base edge too far away from the tooth surface, and therefore reduce the bonding strength.

II. PALATAL BRACKETS: [32]

- These brackets are placed on the palatal surface of upper incisors when palatal elastics from TPA are used for the upper incisor intrusion.

B. MOLAR TUBES: [32]

- Round molar tubes with 0.036″ inner diameter and 6mm in length are routinely used. Oval tubes with 0.072″ x 0.024″ lumen size and 5m length are used on the second molars in the first molar extraction cases.

C. COMBINATION TUBES: [32]

- These consist of a round gingival 0.036″ diameter tube, 6.2 mm in length, and a rectangular (ribbon) occlusal 0.025″ x 0.018″ tube, 5.5 mm in length. These are used when finishing is done with the rectangular wires.

BUILT-IN ADJUSTMENTS IN THE MOLAR TUBES: [32]

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1. UPPER MOLAR TUBES:

- As suggested by Swain, these are fixed perpendicular to the mesial aspect of the upper molar bands, which results in approximately 10° disto-lingual rotational offset.

2. LOWER MOLAR TUBES:

- These are given a lesser offset of approximately 5° disto-lingual rotation.

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EVOLUTION OF COMBINATION BRACKETS

BEGG/CHUN-HOON COMBINATION BRACKET TECHNIQUE

This technique was introduced in the early 1960's. It incorporates all the essential features of both the light wire and edgewise techniques. This versatile combination bracket can be used interchangeably with both techniques. Available in regular and curved bases.[37]

ADVANTAGE: [37]

- In case of transferred patients, the treatment can be continued with either of the technique according to the preference of the orthodontist.
- Ample room provided for edgewise ligature wire.

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MODIFIED FULL-FLANGED COMBINATION BRACKETS

- Modified version offers gingivally extended welding flanges to provide more area for welding.
- It allows the archwire to rest completely within the bracket.

MODULAR SELF LOCKING APPLIANCE SYSTEM

- A VARIATION IN THE COMBINATION TECHNIQUE
-

This technique was introduced by Maxwell S. Fogel and Jack M. Magill in 1976. The key objective was to treat greater numbers, better, faster, and easier, at lower cost; to utilize highly trained paraprofessionals wherever possible; and to use appliances which can

achieve the optimum biologic response. The philosophy of simplicity, economy and flexibility was the motivation behind the introduction of the Modular Self-Locking Appliance System.[38]

The Modular Self-Locking Appliance System is a light wire system using a single pivotal bracket or twin self-locking low frictional attachments. It has clinically demonstrated simplified and securely controlled mechanics for individual and collective tooth movements to attain optimum end results. Development of an adaptable appliance receptacle makes possible the utilization of the best features of the original Combination Technique with the new and improved clinical procedures.

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The components of the system are as follows:

1. INSERT BRACKET: [38]

- The principal module is the Insert Bracket which is made of a special soft stainless steel and appears able to withstand the various demands made upon it.
- The stainless steel insert bracket does not undergo electrolytic changes, although it possesses the desired quality of softness, which brass has. Steel is stronger, generally lasting throughout treatment, and can be opened and closed as many times as necessary.

The elements of the insert bracket are:

- *Archwire chamber (*. 025"):

For maximum performance in light wire therapy, the round archwires float freely in the .025 chamber. The chamber is strategically placed in

relation to bracket wings, permitting adequate tipping of the archwire, setting in motion less restricted
tooth movements.

- *Beaks:*

They are flared, forming a funnel-shaped entrance for the wire. Beaks can be opened and closed for containment and release of the wire.

- *Insert slot* (.020"):

Entrance formed by shape of beaks, facilitates easy access for archwire.

- *Slot apex (*.012")

Constricted portion of funnel, permits snapping in and retention of wire prior to closure of beaks.

- *Seat:*

Base of insert bracket which rests in the grooved wing of the receptacle for stability.

- *Stem:*

Extension of insert bracket fits into the vertical slot and holds insert bracket in position when bent at right angle.

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- *General thickness (.018").*

- *Bracket head (.070"*x .070").

- *Overall length* (.235").

PLACEMENT OF THE INSERT BRACKET: [38]

- The stainless steel insert bracket is easily fitted into the vertical slot of the receptacle. The stem is cinched and bent laterally with a light wire

plier or a dull ligature cutter, pressed snugly under the wing and against the side wall of the receptacle.

- Removal of the insert bracket is also a quick and easy procedure. The stem is staightened and cut; the head is grasped with the flat end of a dull ligature cutting plier; the insert bracket is removed, using the receptacle wing as a fulcrum.

2. RECEPTACLE : [38]

- The receptacle is made in three sizes — Small (.150"), Medium (.180"), Wide (.200")— and is contoured for specific teeth in the anterior and posterior segments.
- The three vertical slots accommodate insert brackets and auxiliaries.
- A single slot is used in the early stages and both mesial and distal slots are used in the finishing stages.
- Because the vertical slots accommodate the insert brackets and auxiliary springs, the receptacles must not be contoured, lest the slots will be narrowed or distorted causing difficulty of component insertion.
- Blockage of vertical slots must be scrupulously avoided during cementation or bonding. This may be avoided by use of wax in slot openings, use of elastic rings around wings of receptacle, and placement of insert bracket prior to cementation.
- The horizontal slot is an elective feature to satisfy those operators who may still be unsure of handling the modular self-locking concept in its totality.

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- It is suggested that the receptacle be placed toward the incisal edge of the band in order to provide sufficient metal backing for the insert bracket.
- The receptacles are routinely spot welded to the bands in two strategic locations, namely the tabs and the body of the attachment.

- Receptacles are also available in either clear or tooth-colored plastic.

3. MOLAR TUBE ATTACHMENT: [38]

- The oval or slightly flat molar tube with mesial hook is an important component of the Modified Combination Technique.
- Molar control and anchorage are definitely more favorable with the oval buccal tube. The oval tube has a vertical slot to assist in molar uprighting or increased molar resistance, when necessary.

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INSERTION OF LIGHT WIRE INTO INSERT BRACKET: [38]

- The .014, .016 or .018 round archwire is snapped into the insert racket with mild finger pressure.
- In special situations involving major malpositions of certain teeth, a wire director may be used to guide the archwire into the insert slot, where it is quickly and easily snap-locked into the circular insert chamber.
- Finally, closure of the insert bracket beaks is accomplished by gently using How pliers. Usually, the cuspid insert brackets are closed first,

followed by the four incisor teeth, a remarkably simple and rapid procedure.

- There is adequate tipping movements and free flowing movement of the attachment along the archwire.

REMOVAL OF ARCHWIRE FROM INSERT BRACKET: [38]

- If the archwire is not to be re-used, it is practical to cut the wire interproximally and slip each segment out of the light wire insert bracket. It is strongly recommended that the used archwire be cut, removed and discarded, because of the simplicity of light wire fabrication and the ease and rapidity of its insertion with the snap-in insert bracket.
- Re-using the old archwire is a waste of time, since most of the vital qualities of the wire have already been dissipated.
- If it is necessary to preserve the existing archwire, removal is accomplished by opening the insert bracket with an insert spreader.
- The insert spreader, an .012 flat-bladed instrument, is carefully fitted into the insert slot and simply pushed forward, opening the slot to its original dimension and preparing the release of the wire.
- The archwire is snapped out of the slot, using a scaler which acts as a miniature crowbar, effectively and gently disengaging the archwire without distorting it.

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MODERN BEGG: A COMBINATION OF BEGG AND STRAIGHT WIRE APPLIANCES AND TECHNIQUES

Begg appliances and appliances of the straight wire type have been known to produce fine orthodontic results. An analysis of these appliances, however, shows that each has unique characteristics which can be advantages or disadvantages in a total treatment program. In order to increase the total effectiveness of a treatment program, it is suggested that the favorable mechanical capabilities of one or more appliance systems be combined into a synergistic type of mechanics. One such treatment approach might involve light, rapid tipping forces to correct gross changes in tooth position at one stage in treatment, while more rigid and precise appliances are used later in treatment to produce maximum tooth detailing and occlusal intercuspation. Such a combination of treatment capabilities enables the practitioner to achieve selectively or collectively, in an optimum way, the various goals for the denture, patient, and doctor.[39]

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The combination of light wire and edgewise techniques has undergone a significant evolution in orthodontics. The *FOUR STAGE LIGHT WIRE APPLIANCE* introduced by Dr. William J. Thompson in 1981 represents the successful collaboration between Begg practitioners and a manufacturer to produce a mechanism with beneficial design features that uses the advantages while avoiding the disadvantages of both the Begg and the Straight wire appliance. The system permits the use of pure Begg mechanics in that part of treatment and in those cases in which it is most effective. It also permits the use of a straight wire appliance in the same cases or in any cases in which a rigid, preangular-

pretorqued finishing procedure is desired. The treatment mechanism is divided into four stages incorporating the usual stages I, II and III of the Begg technique and stage IV includes finishing with the straight wire appliance.[5]

FOUR-STAGE LIGHT WIRE BRACKET CONFIGURATION:[5,39]

- The four-stage light wire bracket fulfills all the requirements of a true combination bracket.
- The bracket incorporates all the advantages of the true Begg light wire technique like the archwire slot permits maximum free tipping movements, little friction, and no binding, with a vertical slot to facilitate uprighting and torquing of the roots.
- The bracket is also designed to translate teeth, has adequate mesial and distal width for control of rotations, provides optimal torquing power, and is preangulated and pretorqued as in a true straight wire system.
- The dual capability of the appliance system is due to a combination bracket design in which the lower third of the bracket is a Type 256 Begg bracket and the upper two-thirds of the bracket is a 0.018 by 0.025 inch straight wire slot with in-and-out positioning, preangulated and pretorqued.
- The gingival or ribbon arch slot is designed to permit maximum crown and root tipping movements and the edge wise slot is designed for precise fine detailing.
- The bracket differs from other combination attachments in that the gingival slot permits unrestricted tipping and the edge wise slot incorporates preangulation, pretorque and in-out correction.

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- Three bracket types provide adequate mesiodistal width for optimal rotations, tipping and torque.

	BODY WIDTH	BEGG SLOT	STRAIGHT WIRE SLOT
Maxillary centrals	3.30	0.020″	0.018″ or 0.022″
Canines,premolars, Maxillary laterals	2.54	0.020″	0.018″ or 0.022″
Mandibular incisors	1.78	0.020″	0.018″ or 0.022″

- The base of the four stage bracket is beveled to reduce the possibility of friction or binding with the arch wire.

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BRACKET PLACEMENT:[5]

- The appliance is set up in the standard manner with the 0.036 inch Begg

tube placed gingivally on the first molars. All Begg slot heights, other than the molars, are dictated by the edgewise slot and, as such, are 1 to 1.5 mm. more gingival than in a routine Begg banding. It is absolutely essential to set up the straight wire slot so that on the straight wire series the wire is level from the molar tube to all other brackets.

- Positioning of the molar tubes is done first. Slight variations in the dimension from molar tube to cusp tip will exist because of anatomic differences, but a cusp-tip-to-tube distance of 3.5 mm. is a desirable starting point.
- If 3.5 mm. is acceptable, then all other edgewise slots must also be at 3.5 mm. except those on the canines and lateral incisors.

- Upper and lower canine brackets are placed gingivally 0.5 to 1 mm. more, depending on tooth size and shape. Such a position promotes canine-protected occlusion.
- The upper lateral incisors are placed 0.5 mm. more incisally to free them from interferences on the working occlusal movements.
- Each tooth must receive the specific brackets designed for it so that angulation, torque, and the in/out compensation are correct.
- The 1 to 1.5 mm. increased gingival positioning of the Begg slot does not seem to affect the bite-opening or tipping characteristics of Begg treatment. Free tipping is made very effective by means of a specially tapered bracket slot.

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BRACKET PRESCRIPTION:[5]

Tooth	Angulation (tip)	Inclination (torque)
Maxillary		
Central incisor	5^0	7^0
Lateral incisor	9^0	3^0
Canine	11^0	-7^0
First premolar	2^0	-7^0
Second premolar	2^0	-7^0
First molar	0^0	-10^0
Second molar	0^0	-10^0
Mandibular		
Central incisor	2^0	0^0

Lateral incisor		2^0	0^0
Canine		5^0	-11^0
First premolar		2^0	-17^0
Second premolar		2^0	-22^0
First molar		0^0	-25^0
Second molar		0^0	-30^0

ADVANTAGE:

- An advantage of the combination system bracket is the potential in transfer of cases under treatment with either of the technique.

COMBINATION ANCHORAGE TECHNIQUE

Experience and advances in design and technique have greatly enhanced combination orthodontic techniques. Improvements have made the delivery of treatment more effective and reduced the problems with appliance adjustment and esthetics. Some of these improvements are in the bracket itself, which has been modified for efficiency and esthetics. A technique of orthodontic mechanics called Combination Anchorage Technique (CAT) introduced by Dr. William J. Thompson in 1988, with his experience with the Four-Stage Light Wire appliance represents an advancement in the combination orthodontic techniques. The technique was designed to broaden the treatment effectiveness of the orthodontist by providing a combination of orthodontic technical capabilities. Use of the two different bracket slots provides a simple and efficient means to vary (1) anchorage (dynamic or static), (2) movement (tipping or bodily), (3) technique (light wire or straight wire), (4) resistance (one tooth or multiple teeth), and (5) treatment compensation (skeletal or dental).[40]

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Clinical experience with combination brackets since 1978 provided with extensive knowledge regarding the expanded capabilities of the technique. What was originally believed to be a modernized Begg system evolved into a true combination anchorage technique.

APPLIANCE PHILOSOPHY: [40]

- With combination treatment it is possible to use light wire mechanics at their optimum for rapid anterior alignment, maximum retraction of incisors, and superb bite opening.
- At the desired point in treatment, the anchorage resistance can be altered by changing slots, wire size, and friction to produce maximum edgewise control and resistance in a specific area of the appliance.
- The variable anchorage capability is extensive. It can be structured to permit tipping of all teeth in one or both arches to correct midline discrepancies.
- It also can be designed to move posterior teeth mesially or distally and to retract or limit retraction of anterior teeth.
- The control of movement is made possible by use of different types of tooth movement and by establishing variable magnitudes of resistance in the different bracket slots at a specific location in the appliance.

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IDEAL REQUIREMENTS OF A COMBINATION BRACKET: [40]

- To optimize the capability of the combination treatment, it is essential that the combination anchorage brackets be designed to produce optimum light wire and/or optimum straight wire movements.

- The gingival slot provides the most efficient light-force tipping movement because it closely resembles a true Begg ribbon arch-type bracket. It produces maximum speed, maximum tipping, minimum pain, the least amount of friction, and maximum effectiveness for auxiliary uprighting and torquing springs.
- The design of the edgewise part of the bracket must facilitate optimum three-dimensional edgewise treatment. It must have three-dimensional movement capabilities built into the slot for torque, tip, and compensation of anatomic width.
- The bracket must be wide enough for adequate rotation and torque control, and the contour must be esthetic and nonirritating to the tissue.

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SHORTCOMINGS OF THE ORIGINAL COMBINATION BRACKET: [40]

- The original combination brackets proved to be bulky, weak, and esthetically unattractive.
- Although capable of Begg and straight wire mechanics, design deficiencies made them less effective than typical Begg or edgewise brackets.
- There were problems with pinning, rotations, slot closure, and occlusal interference.

COMBINATION ANCHORAGE TECHNIQUE (CAT) BRACKET DESIGN: [40]

- The CAT bracket design has proved to be clinically excellent for both light wire and straight wire treatments. It is comfortable and esthetically pleasing to the patient.
- It has a 0.022 x 0.035-inch gingival or ribbon arch slot and either a 0.018 x 0.025-inch or 0.022 x 0.028-inch straight wire edgewise slot.
- An enclosed vertical slot also is incorporated into the bracket for use with uprighting or rotating springs, elastic or surgical fixation hooks, and for attachment of the tandem or double arch wires.
- All brackets are identified by color coding dots at the distogingival aspect. Maxillary brackets are red and mandibular brackets are blue.
- Bracket size and contour have been reduced. Comparison with other brackets indicates that the profile of the new bracket is less bulky occlusally, buccolingually, and on the peripheral edges.
- These changes have reduced lip irritation caused by bracket bulk, reduced irritation caused by sharp corners, and practically eliminated distortion of lower premolar tie wings caused by occlusal interference.
- Gingival extension of all pads and brackets has been reduced to make placement more accurate and occlusal interference less likely.
- A redesigned pin slot and bracket pad have simplified placement and retention of pins. Phase I and II treatments are now completed with the same type of pins.
- Special pins are available to reduce friction during tipping movements of an arch wire in the gingival slot.
- New auxiliary extension pins have been contoured for lip comfort and modified to hold an elastomeric ring or an elastic.

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- Use of these extension pins with elastomeric rings permits fixation of tandem arch wires and are also used as surgical ligation hooks.

BRACKET PLACEMENT: [40]

- The technique for placement of the combination brackets is similar to that used for all straight wire appliances. The edgewise slot should be parallel and at the same level as the interproximal contact points of the teeth in normal occlusion.
- For molars it is normally recommended that the rectangular tube be 3.5 mm from the molar cusp tip.
- All other teeth should be at the same level as the molars except canines and upper lateral incisors. These are altered to provide clearance during mandibular excursions. The edgewise slot should be located 4 mm from the cusp tip on canines and 3 mm on the maxillary lateral incisors.
- When the edgewise slots are leveled with a continuous straight wire, it is important that the canines be slightly extruded and maxillary lateral incisors slightly intruded. These positions will establish optimum canine rise and protect the smaller lateral incisors during lateral and protrusive excursions.

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BRACKET PRESCRIPTION: [40]

- The CAT bracket retains the three-dimensional edgewise capability of the earlier combination brackets.
- However, maxillary incisor brackets now can be obtained with varying degrees of torque.
- Maxillary canine torque has been reduced to 0°. This change produces less prominence of the canine roots on the labial plate and it positions

the lingual surface for a gentle rise in lateral excursions as desired with mutually protective occlusion.

- Torque on the lower premolar has been changed from 17° on the first premolar and 20° on the second premolar to a standard of 19° for both. This change reduces both inventory requirements, identification problems, and does not adversely affect positioning or intercuspation.

Tooth	Angulation (tip)	Inclination (torque)
Maxillary		
Central incisor	5^0	7^0
Lateral incisor	9^0	3^0
Canine	11^0	0^0
First premolar	2^0	-7^0
Second premolar	2^0	-7^0
First molar	0^0	-10^0
Second molar	0^0	-10^0
Mandibular		
Central incisor	2^0	0^0
Lateral incisor	2^0	0^0
Canine	5^0	-11^0
First premolar	2^0	-19^0
Second premolar	2^0	-19^0
First molar	0^0	-25^0
Second molar	0^0	-30^0

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LINGUAL ORTHODONTIC APPLIANCES

With the advent of bonding of attachments directly to the teeth, the elimination of the band material kindled a desire for even more cosmetic appliances, which first resulted in clear plastic brackets and tooth-colored ceramic brackets. A current approach has been bonding brackets directly on the lingual surfaces of the teeth.

In 1975, Dr. Craven Kurz of Beverly Hills, California, became convinced that a lingual bonded edgewise appliance was feasible and would make a significant contribution to adult orthodontics. He created his own lingual appliances by modifying labial appliances, and utilized them on a limited basis in his practice. His initial results encouraged him to continue his work in lingual orthodontics. In 1976, research and development on a nonedgewise lingual appliance was initiated by Ormco in close cooperation with Dr. Alexander (Jim) Wildman in Eugene, Oregon. This program pointed out many of the difficulties involved with a totally lingual fixed appliance. Later in 1976, Dr. Kurz submitted specific designs and concepts to the U.S. Patent Office for the patent rights to his unique edgewise lingual appliance. Shortly thereafter, Dr. Kurz and Ormco began an intensive program to develop the appliance and bring it from a dream to reality.[41]

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In 1978 detailed studies were conducted, measuring the morphology of the lingual surfaces of the teeth in order to reduce the size of the bracket bases and facilitate lingual bonding. The lingual arch form was studied topographically, to establish lingual torque and tip angulations in reference to accepted labial measurements. From this accumulated data and using a design concept to assure proper function and patient comfort, the initial lingual edgewise prototype

was manufactured in 1979. [41]

In December 1979, Dr. Kinya Fujita, of Kanagawa Dental University,Japan, published an article describing appliances with a lingual bracket design and mushroom shaped archwires. His work confirmed the experiences of Dr. Kurz and Ormco that, certainly with refinements, lingual appliances were a viable adjunct to the orthodontist's armamentarium. [41]

KURZ LINGUAL APPLIANCE

This was introduced by Dr. Craven Kurz in association with Ormco in 1982. [41]

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BRACKET CONFIGURATION: [41]

- The brackets are composed of a hardened stainless steel with a single design, varying in width with each tooth in the arch.
- The brackets are brazed to a diffusion bonded foil/mesh base. The bonding base is contoured to approximate the lingual morphology of each individual tooth.
- Since there is such a wide variety of lingual anatomy, additional adaptation is achieved in the laboratory on a custom tooth-by-tooth basis at the time of the indirect bonding setup.
- Brackets have an .018" archwire slot which parallels the occlusal plane.
- Elastomeric ligatures are more commonly used due to their ease of application while wire ligatures are indicated in specific instances.
- Brackets are provided with various degrees of torque, angulation, and bracket thickness. These characteristics were determined after

extensive study of lingual morphology, and by comparing this anatomy and tooth position to accepted standards for labial appliances.

- Maxillary anterior brackets incorporate a bite plane designed into the incisal edge of the bracket. The bite plane is parallel to the archwire and the occlusal plane. [41]
- All brackets have a gingival ball hook which greatly facilitates elastic ligature placement, rotation control, and placement of intra- and intermaxillary elastics.
- Patient selection is of the utmost importance, and patients with short clinical crowns on the maxillary anteriors present definite limitations. Maxillary incisor lingual crown heights of less than 6mm will not permit sufficient space for bonding the brackets to avoid gingival impingement and still finish with 1 to 2mm of overbite. [41]
- Mandibular bicuspids also present a limitation to lingual bonding. Frequently, the lingual cusps, even on fully erupted teeth, have less than the 4mm of crown length necessary to place the bracket. Since these lower bicuspids are not visible on most patients, they can usually be banded without losing the "invisible" aspect of the appliance.
- Banding of the Mandibular posterior teeth, with the use of buccal segmental wires and lingual attachments, has become a common and preferred option.
- The preferred mechanotherapy approach has evolved into a combination using both buccal and lingual posterior segments, with the lingual brackets alone being confined to the incisors, canines, and maxillary bicuspids.

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- This arrangement— termed the "crossover technique" or "buccolingual segmental technique"— appears to offer the best features for both esthetics and anchorage control. [41]
- In this technique, first and second molars are banded with a terminal lingual tube welded to the first molar band. Buccal tubes are also placed on the molar bands.
- Bonded or banded buccal brackets are occasionally placed on maxillary second bicuspids, if the patient's smile permits.
- In the mandible, buccal attachments on the bicuspids add considerably to the options of the buccal segmental approach and do not usually compromise esthetics.
- Thus, the mandibular buccal segment consists of bonded buccal brackets on the bicuspids and a banded first molar with both buccal and lingual attachments, thus providing the option of bypassing the bicuspids on the lingual, with the lingual archwire terminating in the first molar lingual tube.

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MODIFICATION OF LINGUAL TECHNIQUE

This technique was introduced by Dr. Stephen F. Paige in 1982.[42]

BRACKET DESIGN CRITERIA: [42]

- The first important factor to be considered in designing lingual attachments is that interbracket distance is reduced on the lingual. Therefore, the bracket must be designed to be as narrow as possible mesiodistally.
- Keeping the buccolingual distance minimal would also have advantages, since a small buccolingual dimension will increase interbracket distance. In crowded situations, more brackets could be placed at the initial appointment if the bracket profile is small.
- Secondly, as a consequence of decreased bracket width, mesiodistal root control becomes more difficult. Cuspid and bicuspid uprighting after closure of extraction spaces requires efficient mechanisms for uprighting. A possible solution to this problem is the use of vertical slots for arch auxiliaries.
- The third factor to consider is the topography of the lingual surfaces of the maxillary and mandibular anterior teeth. The lingual contours of the anterior teeth seem to vary a great deal.
- Because of the concave and convex surfaces, the amount of torque supplied to the tooth by the bracket will be very sensitive to its occlusal-gingival placement. A very small change in the occlusal-gingival placement can produce a large change in root torque.

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Amount of torque will relate to occlusal gingival placement of lingual bracket.

- It has been argued that this problem could be solved by indirect bonding procedures by the bracket manufacturer. If a bracket comes off during treatment, or if the orthodontist is unable to indirect bond all of the teeth at the initial appointment, he is still required to bond the attachment directly.
- Indirect bonding by the bracket manufacturer for an edgewise "straight-wire" technique must take into account many factors normally in the control of the clinician. Many patients need dental compensation and appropriate torque values for skeletal patterns other than Class I. Overcorrection of tooth angulation and inclination also would be difficult for proper finishing, if bracket placement is determined by the manufacturer. Thus, until future advances make precision direct bonded placement of the lingual bracket possible by the orthodontist in clinical situations, a preangulated, pretorqued "straight-wire" edgewise approach to bracket design appears to be impractical at this time.
- A fourth factor for consideration would be ease of insertion, ligation, and removal of the archwires. A very satisfactory solution in the technique is the incisal/occlusal placement of the archwire. The use of vertical slots could permit the use of pins to increase ease of ligation.

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BRACKET CONFIGURATION: [42]

- According to the author, the bracket that satisfies these design criteria nicely is a Begg bracket and is available from many manufacturers.

- It is as narrow as possible and has a vertical slot for use of auxiliaries.
- Lingual tooth contours on the maxillary and mandibular teeth are much less of a factor because torque control can be achieved by properly shaped torquing auxiliaries, much like conventional Begg mechanotherapy.
- Ligation can be achieved with steel ligatures, elastic modules, or pins.
- The slot can be oriented in an occlusal-incisal direction to ease archwire placement and removal.
- Placement of the bracket is sensitive only to the incisal-gingival placement because angulation and inclination can be achieved with the use of auxiliaries.
- The TP 256-500 Begg bracket with the slot oriented in a gingival direction was used initially.
- The bracket currently in use is the Unipoint combination bracket (Unitek), with the slot oriented in the occlusal-incisal direction. The horizontal slot is not routinely used during treatment and is used only to aid in unraveling of crowded anteriors.
- The Unipoint combination bracket was used because of the need to have a gingival "wing" to place elastic modules on continuous elastic chains.

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CREEKMORE LINGUAL APPLIANCE

This technique was introduced by Dr. Thomas Creekmore in 1989. According to the Dr. Creekmore, an acceptable lingual orthodontic appliance system must include the following key elements:[43]

(1) A mechanical appliance that aligns teeth from the lingual aspect as efficiently as a labial appliance.

(2) A means of positioning brackets precisely to create a "near" straight-wire appliance on the lingual aspect.

(3) A consistent and accurate indirect bonding technique.

(4) A selection of preformed arch wires complete with canine-premolar offsets.

(5) Specially designed pliers with longer handles and offset beaks.

(6) Lingual bracket-removing pliers.

(7) Offset torquing keys.

(8) Training for the orthodontist and staff to develop their lingual treatment technique so that it becomes as routine as their labial treatment.

To satisfy these requisites, a lingual mechanical appliance (Conceal) was developed by Dr. Creekmore. [43]

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APPLIANCE CONFIGURATION: [43]

- The foundation of the design is the opening of the arch wire slots to the occlusal aspect rather than to the lingual aspect.The occlusal approach makes arch wire insertion, seating, and removal easier than arch wire insertion with lingually opening slots.

- An additional benefit of an occlusal slot is that the arch wire will not pull out of the slot with space-closing mechanics. This eliminates the special time-consuming ligation techniques (double-over ties) necessary for lingually opening slots.
- A critical breakthrough for this technique was the design of premolar and molar brackets, with occlusal tie wings projecting mesially and distally instead of labiolingually. These tie wings change the direction

of the ligature pull 90°, effectively seating the arch wire in the bottom of the slot.

- Anterior brackets use this same design feature to enhance the quality of their ligation. The occlusal tie wings have mesial and distal undercuts that parallel the bottom of the slot They also change the direction of the pull of the ligature to seat the arch wire into the bottom of the slot.
- Conceal brackets are designed around the Unitwin bracket "centered slot" concept. The Unitwin bracket is, in effect, a single bracket without tie wings in the center of a 0.045 inch twin bracket.
- It uses the advantages of both single and twin brackets by allowing maximum interbracket distance for optimal tip and torque functions, while providing twin tie wings for rotation control. The mesiodistal bracket side does not necessarily dictate the arch wire slot dimensions.

Each Conceal bracket has three different slot widths for the three different functions of tip, torque and rotation.

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- Tip control in an occlusally inserting system is analogous to rotation control in a labial system. Both depend on the length of the lever arm and the quality of the ligature tie to seat the arch wire in the bottom of the slot. For twin brackets, the length of the lever arm is the width of the bracket. For brackets with rotation wings, the lever arm is the width of the bracket plus the length of one rotation wing.
- From labial experience, it is known that adequate rotation control requires a minimum lever arm of about 0.100 inch in length. Therefore, adequate tip control in an occlusally inserting system requires a slot width of 0.100 inch. The floor of the slot for all of the

Conceal brackets is about 0.100 inch, which provides excellent control in the tipping plane.

- The width of the slot for rotation is about 0.070 inch. Rotation control in an occlusal-slot system results from the engagement of the arch wire in the slot and does not depend on the ligature tie. It is analogous to tip control in a labial system.
- Torque control is the same for both systems. The width of the slot for torque is about 0.035 inch. The arch wire can twist as it exits the slot E-F. Torquing play is a function of the size of the rectangular or square arch wire relative to the size of the rectangular arch wire slot. Width of the slot is not a factor in torquing play. The ligature tie does not influence torquing play.
- For anterior teeth at the level of the arch wire slot, space available for brackets on the lingual surfaces is about two thirds of that available on the labial surfaces. The resulting decrease in interbracket distance means that smaller arch wires must be used to develop proper forces.
- The Conceal system slot is therefore 0.016 inch horizontally and 0.022 inch vertically, a size determined by computer models to produce forces comparable to those of traditional labial designs. Reduction of the slot size to more closely match the desired smaller arch wire size provides more precise rotation and torque control.
- In addition to the occlusal opening and optimum slot design, Conceal meets the difficult challenge of small working space. Since the lingual anterior tooth surfaces are inclined about 45° to the occlusal plane, the space available for brackets is smaller gingivally than occlusally.
- Anterior brackets have a Y configuration, with a single tie wing projecting gingivally and twin tie wings projecting occlusally. This

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design provides the same selectivity of ligation as a regular twin bracket, but it is easier to ligate. Canine and lateral incisor brackets have built-in T hooks for intramaxillary and intermaxillary elastics.

ADVANTAGES OF LINGUAL BRACKETS OVER LABIAL BRACKETS[43]

- Facial surfaces of the teeth are not damaged from bonding, debonding, adhesive removal, or decalcification from plaque retained around labial appliances.
- Facial gingival tissues are not adversely affected.
- The position of the teeth can be more precisely seen when their surfaces are not obstructed by brackets and arch wires.
- Facial contours are truly visualized since the contour and drape of the lips are not distorted by protruding labial appliances.
- Most adult and many young patients would prefer "invisible" lingual appliances if costs, treatment times, and results were comparable to those of labial appliance treatment.

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EVOLUTION OF SELF-LIGATING BRACKETS

A *self-ligating bracket* is defined as "A bracket, which utilizes a permanently installed, moveable component to entrap the arch wire." Self-ligating brackets may be classified onto two categories: passive and active.[45]

1. PASSIVE BRACKETS:[45]

- They use a rigid, moveable component to entrap the arch wire.
- Tooth control with passive brackets is determined solely by the fit between bracket slot and arch wire.
- As a result, tooth control frequently is compromised with undersized arch wires housed in what is essentially an arch wire tube.

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2. ACTIVE BRACKETS:[45]

- They use a flexible component to entrap the arch wire.
- This flexible component constrains the arch wire in the arch wire slot and has the ability to store and subsequently release energy through elastic deflection.
- This gentle action imparts a light but continuous level of force on the tooth and its supporting structures, resulting in precise and controlled movement.
- The homing action of the flexible component may be described as the ability of the bracket to reorient itself and its accompanying tooth in three dimensions until the arch wire is seated fully in the arch wire slot: the "home" position.

- Any subsequent rotation, tipping, or torquing during tooth movement of any kind results in the labial deflection of the flexible component and reactivates this homing behavior.

HISTORICAL PERSPECTIVE OF SELF-LIGATING BRACKETS: [45]

The concept of a self-ligating orthodontic attachment is not new.The first patent for a self-ligating attachment, the Boyd band bracket, was filed by Charles. E. Boyd in 1933. Shortly thereafter James W. Ford filed a patent for the Ford Lock design, which was manufactured briefly by the Dee Gold Company of Chicago, Illinois. Production was abandoned because the design was too bulky and expensive to be commercially viable. The bracket was reintroduced in 1951 by his son William F. Ford, but it was marketed primarily for the Johnson twin wire technique. An overview of the evolution of Self-ligating brackets is given in the following table:

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Patent File Date	Bracket	Mode Of Action	Moving Component
1933	Boyd band bracket	Passive	Rigid sliding bar
1933	Ford Lock	Passive	Rigid rotational lock
1935	Russell appliance	Passive	Rigid sliding lock
1953	Schurter device	Passive	Rigid locking pin
1957	Rubin device	Passive	Rigid hinged plate
1966	Branson	Passive	Rigid rotational screw
1972	SPEED system	Active	Highly flexible spring clip

1972	Edgelok bracket	Passive	Rigid sliding cap
1979	Mobil-Lock bracket	Passive	Rigid rotational disk
1986	Activa bracket	Passive	Rigid rotational arm
1995	Time bracket	Passive	Rigid rotational arm
1996	Damon bracket	Passive	Solid indented slide
1998	TwinLock bracket	Passive	Solid labial slider
2000	In-Ovation	Active	Flexible spring clip
2004	Damon 3	Passive	Rigid solid slide

I. RUSSELL LOCK EDGEWISE BRACKET: [45]

- The first self-ligating bracket, the Russell lock edgewise attachment, was developed by New York Orthodontic pioneer, Dr Jacob Stolzenberg, in 1935.
- This bracket had a flat head screw seated snugly in a circular, threaded opening in the face of the bracket.
- For the orthodontist arch wire changes were quick and simple. The horizontal screw could be loosened or tightened with a small watch repair screw driver to obtain the desired tooth movement.
- Loosening allowed bodily translation on round wire, while tightening facilitated root torquing with a rectangular or square wire.
- The mechanism of this revolutionary bracket was in stark contrast to the traditional approach of tying steel ligatures tightly around each bracket.

II. EDGELOK BRACKET :[45,46]

- In 1972, Dr. Alexander J. Wildman of Eugene, Oregon, developed the Edgelok Bracket.

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- The bracket had a round body with a rigid labial sliding cap. A special opening tool was used to move the slide occlusally for arch wire insertion.
- When the cap was closed over the arch wire with finger pressure, the arch wire slot was converted to arch wire tube by closing off the labial portion of the slot, thereby entrapping the arch wire.
- The rigidty of this outer fourth wall rendered the bracket passive in its interplay with the arch wire.

ADVANTAGES OF THE EDGELOK BRACKET: [46]

1. *Strength.* The basic shape of Edgelok is a slot surrounded on four sides by contoured metal surfaces. The material is cast chrome alloy, a much harder material than machinable 300-series stainless steel. Because of this hardness and the large welding flange, it is all but impossible to shear Edgelok from a band .

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2. *Smooth to tissue.* One of the benefits of the button shape is that it is a smooth, round surface which is exposed to the tissue. The absence of ties is an obvious additional benefit.

3. *Low profile.* Edgelok's button shape allows it to be large where needed for strength, but small in the critical areas. The occlusal boss can be reduced as much as necessary to accommodate the occlusion. It is even possible to use Edgelok as a bite block.

4. *Automatic locking and unlocking*. Elimination of the tedium of tying was one of the basic advantage of Edgelok.

5. *Reliable action*. Because of Edgelok's strength and design characteristics, the locking action is extremely reliable. It clicks open and it clicks shut. There is no intermediary position.

6. *Complete control in all planes of space* . Practicing orthodontics with Edgelok was like practicing with an eighth-inch buccal tube on each tooth. One is forced into complete bracket engagement at all times. The bearing or rotating surface was similar to the bearing surface of the traditional siamese bracket.

LIMITATIONS OF EDGELOK BRACKET: [46]

- Passive brackets like the Edgelok bracket have limitations in their ability to control tooth movements because of their total reliance on the fit between the arch wire and the bracket slot.
- This means that tooth control is compromised when undersize wires are used.

The Edge-lock was the first passive self-ligating bracket design to enjoy any sort of commercial success.

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III. THE MOBILE-LOCK BRACKET :[45]

- About 2 years later, Dr. Franz Sander introduced the Mobil-Lock bracket.
- The bracket had a semi-circular locking mechanism .
- The Mobil-Lock bracket required a special tool to rotate the semi-circular labial disk into the slot open or closed position.
- As with the Edgelok, the passive outer wall transformed the arch wire slot into a tube that loosely contains the arch wire.

IV. SPEED BRACKET SYSTEM:[47]

The SPEED appliance system was developed by Dr. Herbert .G. Hanson in 1975 and introduced in 1980. Hanson in 1975 ,

combined Angle's edgewise appliance with his own concept of developing both a dynamic and self-ligating appliance. This resulted in a spring-loaded, self-adjusting ligatureless design that possessed the unique quality of retaining and actively influencing control of the arch wire within the arch wire slot. The acronym SPEED has been chosen to identify the appliance and the system of treatment which is continuing to evolve with its use. The name is derived from the descriptive terms *SPRING-LOADED, PRECISION, EDGEWISE, ENERGY, AND DELIVERY,* all of which describe features of the design. In the ongoing quest for perfection, the SPEED appliance has undergone numerous refinements since its introduction in 1980.

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DESCRIPTION OF THE SPEED APPLIANCE: [47]

The main components of the appliance are a multislotted bracket body, a spring clip, and specially shaped foil-mesh bonding bases.

THE BRACKET BODY: [47]

- The bracket body has:
  1. Four slots
  2. A shallow triangular groove
  3. Short welding flanges
  4. No gingival tie wing.
- The four slots are:
  1. An 0.018 by 0.025 inch horizontal arch wire slot opens to the labial and has an 0.75 inch lingually centered radius to its lingual wall.

2. An 0.017 by 0.017 inch horizontal slot opens to the lingual, with its gingival wall continuous with the occlusal surface of the welding flanges.
3. A vertical spring slot of uniform and appropriate depth for each of five different base curvatures opens to the lingual.
4. A shorter and narrower angled instrument-access slot communicates with the spring slot from the labiogingival aspect.

- The bracket body has a shallow transverse groove on its labial surface a short distance occlusal to the arch wire slot.

THE SPRING CLIP: [47]

- The highly resilient spring clips are formed from a high tensile 17-7 precipitation-hardening 0.005 by 0.060 or 0.005 by 0.072 inch stainless steel strip.
- Each has a short labial arm joined to a somewhat longer lingual arm by an 0.025 inch (radius) curved occlusal portion which has an angle of wrap of 217 degrees 30 minutes when free from external stresses.
- In this "resting" condition prior to assembly, the spring arms converge at an angle of 37 degrees 30 minutes.
- The lingual arm of the spring has an 0.030 inch wide indent centered near its gingival edge which projects labially approximately 0.005 inch.
- After forming and prior to assembly, the springs are precipitation hardened for 1 hour at 900° F. (480° C.).

THE BONDING BASES: [47]

- The bonding pads are just wide enough for a secure laser seam weld to

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each bracket flange.

- As viewed from the labial, the mesial and distal edges of each pad are parallel to one another and angulated relative to the occlusal edge in accordance with the amount of crown tip usually required by the type of tooth to which it has been assigned.
- While these three edges are straight, the gingival edge is curved gingivally in the form of a semi-ellipse.
- The occlusal edge of each bonding pad is cut "level" so that it will be parallel to the long axis of the arch wire slot after pre-angulated welding.
- All pads requiring mesiodistal curvature are bent about a central axis parallel to their mesial and distal edges. Typical bend radii are 0.10, 0.15, and 0.20 inch.
- Premolar pads are given an additional occlusogingival curvature appropriately asymmetrical for conformity to the usual anatomic contours of these teeth.

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BRACKET-SPRING ASSEMBLY: [47]

- After stress relieving and heat hardening, the spring clip is mounted on the bracket body by a special procedure designed to prevent any plastic deformation.
- When the spring is in the slot-closed position, its arms are held apart so as to reduce their angle of convergence by at least 2 degrees. This is, of course, elastic deformation, which means that the mounted spring embraces the bracket body and creates a gingival component of force where its inclined inner surface bears against the occlusolabial corner of the arch wire slot.

- The spring may thus be regarded as attempting to propel itself even beyond the fully closed position which, in fact, it would do if the bracket body surfaces preventing such movement were reduced.
- Mounting the spring on the bracket body in the slot-closed position converts the arch wire slot into a trapezoidal tube having three rigid walls and an elastic inclined labial wall.
- The 0.017 inch lingual horizontal slot also becomes a tube, but the area of the spring forming its fourth wall is next to the restrained lingual arm and is therefore much more rigid. This makes it well suited for receiving square-wire hooks for elastics, ligatures, or even auxiliaries for various types of tooth movement.
- Welding the bracket-spring assembly to its bonding base transforms the vertical lingual slot into a conduit housing the lingual arm of the clip in a close-tolerance (but not frictional) fit.

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THE SPEED APPLIANCE FUNCTION: [47]

The wingless SPEED appliance is unique in its manner of operation due to the presence of the flexible spring clip. This highly resilient spring clip is primarily responsible for controlling tooth movement in all three planes of space through rotation, tip, and torque. Its unique method of delivery ensures a more continuous delivery of force, as well as a reduced level of frictional drag. The SPEED appliance has been designed for precise rotational control about three axes:

1. The occlusogingival axis (rotations)
2. The labiolingual axis (tipping)
3. The mesiodistal axis (torque)

These mutually perpendicular axes intersect at the arch-wire-slot centroid, so that any change in a bracket's attitude (and consequently that

of the tooth to which it is attached) can be described in terms of rotation about one or more of these axes.

V. ACTIVA BRACKET :[48]

- The Activa bracket was introduced by Dr. Erwin Pletcher in 1986.
- The Activa brackets are fully programmed preadjusted brackets with a horizontal slot of .022″ x .022″ and a vertical slot of .020″ x .020″.
- The bracket has an inflexible, curved arm that rotates occluso-gingivally around the cylindrical bracket body.
- The arch wire is retained by a resilient clip that rotates into a retaining groove gingival to the arch wire, positioning two straps labial to the wire and creating a bracket that is very similar mechanically to a molar tube with twin channel caps.
- The clips can be opened and shut with a wide range of commonly used hand instruments including ligature tuckers, flat plastics, and Mitchell's trimmers.
- All brackets have permanent, as well as painted, identification marks.
- Brackets for the anterior teeth have gingival and occlusal tabs to assist orientation relative to the facial axis of the clinical crown.

ADVANTAGES OF ACTIVA BRACKET: [48]

- Low friction between bracket and arch wire.
- More certain full arch wire engagement.
- A vertical slot for hooks, rotational and uprighting springs.
- The brackets are smaller than the twin or mini twin brackets and inturn more esthetic.
- Being true straight wire, can integrate with any of the straight wire bracket within same arch.

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- Arch wire changes are faster and easier because of simple opening and closing of the caps and requires less chair-side assistance.
- Reduced friction causes teeth to move dramatically faster with less force.
- Will accept elastic chains.
- Sliding mechanics work well with this appliance.
- Excellent patient comfort and acceptance.
- It is possible to immobilize a tooth or a group of teeth so that they will not move, by placing an elastic over the arch wire in the slot of any bracket and then closing the cap over the elastic, this makes anchorage control easy.
- Easier oral hygiene and less cross-infection risk because of no ligatures.

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DISADVANTAGES OF ACTIVA BRACKET: [48]

- Higher bond failure rate
- Less convenient with elastomeric chain
- Unfamiliarity
- Harder to hold and seat when bonding
- Partial slot engagement not possible
- Breakage of arch wire retaining clips
- Low friction increases wire displacement

VI. TIME BRACKET :[45,49]

- The Time bracket was introduced by Dr. Wolfgang Heiser, Austria in 1995

- About the size of the conventional bracket, the Time bracket features a curved, rigid arm that wraps occlusogingivally around the labial of the bracket body.
- A sharp instrument is used to pivot the arm gingivally into a slot-open position and occlusally into the slot-closed position.
- The stiffness of this bracket arm prevents any substantial interaction with the arch wire, thereby rendering the Time bracket a passive bracket.

VII. TWINLOCK BRACKET :[45]

- The TwinLock bracket was Dr. A .J. Wildman's second endeavor, after the Edgelok bracket and was introduced in 1998.
- The bracket featured a flat rectangular slide housed between the tie wings of an edgewise twin bracket.
- It is moved occlusally into the slot-open position with a universal scaler. It then slides gingivally with finger pressure to entrap the archwire in a passive configuration.

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VIII. DAMON SL BRACKET : [50,51]

- The Damon SL bracket was introduced by Dr. Dwight H. Damon in 1996.
- Design Criteria for the Damon SL Bracket[50]

The Damon SL bracket was designed to satisfy the following major criteria:

_ Andrews Straight-Wire Appliance concept

_ Twin configuration

_ Slide forming a complete tube

_ Passive slide on outside face of bracket

_ Brackets opening inferiorly in both arches

- They had a slide, which moved vertically on the labial surface of an otherwise fairly conventional twin tie-wing bracket. [51]
- The slide clicked into a positive open or shut position and opened in a downwards direction in both jaws to give a full view of the slot. [51]
- A tiny U-shaped wire spring lay under the slide and clicked into the two labial 'bulges' on the slide to provide positive open and shut positions. [51]
- These brackets were a major step forward, but suffered two irritating problems—the slides sometimes opened inadvertently and they were prone to breakage. [51]

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IX. DAMON 2 BRACKET:[51]

- The imperfections in the Damon SL bracket led to the development of Damon 2 brackets, which retain the same vertical slide action and U-shaped spring to control opening and closing, but place the slide within the shelter of the tiewings.
- Combined with the metal injection moulding manufacture, which permits closer tolerances, these developments have almost completely eliminated inadvertent slide opening or slide breakage.
- A side effect of this design change has been to reduce the overall size of the bracket to very compact dimensions. This reduced size is an advantage. The larger inter-bracket span produces lower forces, but the secure full engagement retains much better control than for a conventional bracket of the same width.

- There remains scope for further improvement. Also, whilst the slide closure is very secure, the close fit causes the force required for closure to vary.
- One unique and useful feature of the slides on Damon brackets is that they open inferiorly in both arches in order to give an unobstructed view of the slot.

X. GAC In-Ovation bracket:[51]

- These are very similar to the SPEED bracket in conception and design, but are of a twin configuration .
- They are a good, robust design, and no breakage of the clips has been personally experienced or reported. Some relatively minor disadvantages in bracket handling are apparent.
- First, some brackets are hard to open. This is unpredictable, but more common in the lower arch where the gingival end of the spring clip is difficult to visualize. Excess composite to the gingival of lower brackets can be hard to see and may hinder opening.
- Secondly, these brackets are extremely easy to close inadvertently before the archwire is in position and the downwards direction of closure makes this more likely in the lower arch.
- Thirdly, the security of closure of the flexible clip can be overcome by some rectangular nickel-titanium wires, which can cause spontaneous opening of the clip.
- Lastly, it is possible—as with the Damon2 bracket slides—to incompletely open the clip and discover the need for the final fraction of opening through difficulty with removing a thicker archwire.

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EVOLUTION OF BRACKETS BASED ON MATERIALS

Brackets can be classified depending on materials used for manufacturing them as:

1. Metallic
    a. Gold alloys
    b. Stainless steel
    c. Cobalt Chromium
    d. Titanium
    e. Magnetic
2. Plastic
    a. Fibre Glass reinforced
    b. With metal slot
3. Ceramic
    a. Monocrystalline alumina
    b. Polycrystalline alumina
    c. Zirconium

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METALLIC BRACKETS:[44]

Before Angle began his search for new materials, orthodontists made attachments from noble metals and their alloys. The metals used were:

- Gold (atleast 75%, to avoid discoloration)
- Platinum
- Iridium
- Silver alloys

ADVANTAGES:

- Esthetically pleasing
- Corrosion resistant
-

DISADVANTAGES:

- Lack flexibility and tensile strength.
- Inappropriate for complex machining and joining when used in the traction bars.

In 1887 Angle tried replacing noble metals with German silver, a brass. An accomplished metallurgist, Angle knew that he had to prepare the German silver "according to the use for which it was intended." To obtain the desired properties he varied the proportions of Cu, Ni, Zn around the average composition of the Neusilber brass as well as by applying cold working operations at various degrees of plastic deformation. As a result, Angle made it rigid enough for jack and traction screws, elastic enough for expansion arches, or malleable enough for bands.

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DISADVANTAGES OF GERMAN SILVER:

- Unsightliness
- Lack of reproducibility
- Mechanical and chemical properties of German silver were below modern demands.

The material that was to truly displace noble metals was stainless steel.

I. STAINLESS STEEL: [44]

The family of steels that contain more than 12% chromium owes its success in the manufacture of instruments and attachments to combined high mechanical strength, acceptable appearance, and chemical resistance. Stainless steel entered dentistry in 1919, being introduced at Krupp's Dental Polyclinic in Germany by the company's dentist, F. Hauptmeyer. Angle used it in his last year (1930) as ligature wire. By 1937 the value of stainless steel as an orthodontic material had been confirmed.

STRUCTURE AND COMPOSITION: [44]

There are several classes of stainless steels, each characterized by a specific crystal structure determined by composition. The composition of stainless steel used for orthodontic attachments is as follows:

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METAL	PERCENTAGE	FUNCTION
Chromium	16-26%	Protects the steel from corrosion with an impermeable, corrosion-resistant layer of chromium oxide.
Nickel	3-14%	Stabilizes at lower temperatures into a homogenous and corrosion-resistant austenitic phase.
Manganese	2-18%	Replacement for nickel to stabilize austenite phase in nickel free alloys.
Molybdenum	0.6-4%	Substitutional metal.
Carbon	0.02-0.15%	Added for strength in powder metallurgy.

Phosphorus	0.03-0.2%	Allows the use of a lower temperature for sintering.
Sulphur	0.01-0.15%	Allows easy machining of wrought parts.
Silicon	0.35-1%	Improves resistance to oxidation and carburization at higher temperatures and to corrosion in some media.

CLASSIFICATION:

Steels are classified according to the American Iron And Steel Institute (AISI) system. The steels, which have AISI numbers beginning with the numeral 3, are all austenitic; the higher the number, the less nonferrous the alloy. The letter L signifies a lower carbon content.

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1. AUSTENITIC STEELS (300 series): [44]

- It is called austenitic because the metal has an austenite structure at room temperature.
- Structurally these steels are solid solutions, which offer better corrosion resistance of all the stainless steel alloys.
- It has a face-centered cubic structure that renders these steels nonferromagnetic.
- Most of the stainless steel metal brackets are made form the austenitic steel. AISI series 303, 304, 316 and 317 are the major classes of Stainless steel being used by manufacturers.

- The emerging trends in Stainless steel usage, is the increasing use of 304L and 316L (Low Carbon content) steel in bracket manufacturing.

2. MARTENSITIC STEELS (400 series): [44]

- In addition to carbon, other elements were added to stainless steels to stress their microstructure and thereby increase tensile strength.
- Stronger but less corrosion-resistant alloys were the result and thus should be used only for short contacts with the oral environment.
- These steels are used primarily for instruments that require sharp or wear-resistant edges.

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3. FERRITIC STEELS: [44]

- The name *ferritic steel* derives from the fact that the microstructure of these steels is the same as that of iron at room temperature (BCC).
- The difference is that in ferritic steel, chromium is substituted for some of the iron atoms in the unit cells.
- The modern "super ferritics" which belong to this category, contain 19-30% chromium and are used in several nickel-free brackets.

4. DUPLEX STEELS: [44]

- Duplex steels consist of an assembly of both austenite and ferrite grains.
- Besides iron these steels contain molybdenum and chromium, and they have a lower nickel content.

- Their duplex structure results in improved toughness and ductility as compared to ferritic steels, while their yield strength is more than twice that of austenitic stainless steel and are highly stress-corrosion resistant.
- Duplex steels have been used for the manufacture of one-piece brackets e.g Bioline "low nickel" by CEOSA, Madrid.

5. PRECIPITATION-HARDENABLE(PH) STEELS: [44]

- The PH steels can be hardened by heat treatment, unlike most stainless steels.
- The process actually is an aging treatment, which promotes the precipitation of some elements purposely added.
- Because of its high tensile strength, 17-4 PH stainless steel is widely used for "mini" brackets.
- The manufacturer Ormco has used the 17-7 PH stainless steel for the Edgelok brackets.

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6. COBALT-CONTAINING ALLOYS: [44]

- Several cobalt-containing alloys are commonly used in orthodontics, both for wire and brackets.
- Alloys such as Elgiloy and Flexiloy contain a large proportion of nickel while, others are almost nickel free, having been developed to replace their allergenic counterparts.
- These nickel-free steels are used primarily to manufacture attachments, such as Prestige (Pyramid Orthodontics), Nu-Edge LN (TP Orthodontics), and Elite- Opti-MIM (Ortho- Organizers).
- These alloys generally are corrosion resistant.

II. TITANIUM:[52]

The problems of nickel sensitivity, corrosion, and inadequate retention were solved with the introduction of a new, pure titanium bracket (Rematitan) that was competitive in cost to stainless steel brackets.

PROPERTIES:

- Its one-piece construction requires no brazing layer, and thus it is solder and nickel-free.
- A computer-aided laser (CAL) cutting process generates a myriad of micro- and macro-undercuts, making it possible to design an "ideal" adhesive pattern for each tooth.
- Such patterns can allow for the differing occlusal and torsional forces that occur on specific teeth (e.g., anterior teeth vs. second bicuspids).
- The laser undercuts eliminate the need for additional chemical treatment of the base, such as silanization, which can increase bond strength to an undesirable level.
- Titanium and titanium-based alloys have the greatest corrosion resistance of any known metals (except pure gold and platinum, which are too soft and expensive for orthodontic use).
- Rematitan brackets are made from a pure, medical-grade titanium that has advantages in miniaturization over stainless steel because of its greater strength (made possible by special cold-working processes) and its lower elastic modulus.
- In addition, lower anterior brackets can be chamfered to avoid occlusal interference in deep-bite cases.

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- Single-piece construction allows the lowest possible bracket height, since clinical in-and-out depths remain the same. This makes the miniaturized appliance even less conspicuous.
- A low bracket profile can be helpful in assessing lip balance during treatment, especially in cases of lip insufficiency and protrusion. Bulkier labial appliances, including ceramic brackets, can produce a false assessment of lip posture.
- Many patients prefer the appearance of the silver-gray titanium brackets over shiny, reflective stainless steel. The matte finish on the Rematitan bracket, when wet, absorbs light and takes on a subtle luster that blends better with the shade of the tooth.
- Titanium also has low thermal conductivity, and thus alleviates the sensitivity to extreme temperature changes often experienced by patients wearing metal appliances.
- It imparts none of the metallic taste of stainless steel brackets.
- Some clinicians have found titanium brackets to be superior even to stainless steel brackets in sliding mechanics.
- An oxidation treatment of the titanium bracket, in addition to creating chemical and mechanical passivity, hardens the bracket slot. Surface hardness of the slot is one of several factors that can reduce the coefficient of friction.
- The smooth, Teflon-like surface of titanium is due to a thin layer of titanium oxide, which prevents direct contact between the metallic atoms on the surfaces of the wire and the bracket, thus reducing interatomic adhesion and friction.

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III. MAGNETIC BRACKETS:[53]

These were introduced by Terushige Kawata in 1987.

PROPERTIES: [53]

- The magnetic material that was first employed clinically was a cast alloy consisting of 25% to 30% chromium, 15% to 25% cobalt, and 45% to 60% iron. The size of the magnet originally used was 6 x8 x 2 mm.
- Although the CoCr alloy was easy to process and had sufficient magnetic force to facilitate tooth movement, it was believed that its size was too great to be used intraorally.
- Recently, a new material has been developed that contains a rare earth metal (samarium) and cobalt. By using this new material, the appliance can be made smaller in size while enhancing the force level.
- This new magnet is a powdered metallurgically processed intermetallic compound of cobalt and rare earth metals.
- The magnet has at the present time the highest available coercivity and maximum energy product. It is further suited to flat circuits and resistant to outer demagnetizing fields.
- The new material has recently been further improved so that a magnetic force of 50 g has been increased to 250 g while at the same time the volume of the material has decreased.
- This force magnitude is sufficient to move canines and other teeth.
- The samarium-cobalt magnets were prepared by attaching an edgewise bracket with an 0.018″ slot to the surface of the magnet and plating it with chromium to prevent corrosion of the magnet and with nickel to solder the bracket to the surface.

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- The layer of nickel allowed the edgewise bracket to be soldered to the surface below 500° C.
- Finally, a mesh base was soldered onto the rear of the magnetic bracket, allowing the bracket and magnet combination to be bonded to the surface of the teeth by means of a direct bonding system.
- The magnetic brackets were designed to form an ideal arch in both the maxilla and mandible on the completion of treatment.
- The size of the magnetic bracket varies as follows:

(1) The mesial distal length of the mandibular incisor bracket is 4 mm, the vertical width is 3.5 mm, and the labiolingual thickness is 3 mm

(2) The mesial distal length of the maxillary incisor bracket is 7 mm, the vertical width is 3.5 mm, and the labiolingual thickness is 3 mm.

- Because of the tooth size, the mesial-distal length is the variable.
- With this arrangement, each bonded bracket can be used for mesiodistal magnetic force.
- However, if the distance between the malpositioned teeth is over 3 mm and the magnetic force is thus not sufficient to retract these teeth, a power chain can be added to assist the magnetic force in the initial stage.
- When these teeth come closer together, that is, within 3 mm, the power chain is removed and the additional retraction can be done through the available magnetic force. This procedure has reduced treatment time as compared with traditional methods.

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PLASTIC BRACKETS:[44,54]

Plastic brackets were first marketed in the early 1970's. Initially constructed from acrylic and later polycarbonate, their

acceptance by orthodontists as an aesthetic alternative to metal brackets was short lived because of the inherent
problems.

DRAWBACKS OF PLASTIC BRACKETS:[54]

- Staining and odours.
- Lack of strength and stiffness resulting in bonding problems.
- Tie wing fractures.
- Permanent deformation or creep. This occurs when a material is subjected to a constant load over an extended period of time and is particularly important for thermoplastic materials such as polycarbonate resins.
- Polycarbonate bracket slots distorted with time under a constant physiologic stress (2000gm.-mm) rendering them insufficiently strong to withstand longer treatment times or transmit torque.
- In a simulated intra-oral situation Harzer et al. reported significantly higher torque losses and lower torquing moments with polycarbonate brackets compared to metal brackets. They recommended that manufacturers should provide data on the distortion to be expected in polycarbonate brackets, which must be offset by additional torque, or that the bracket torque should be omitted from the technical specification.

MODIFICATIONS OF PLASTIC BRACKETS: [54]

- To compensate for the lack of strength and rigidity of the original polycarbonate brackets, high-grade medical polyurethane brackets and polycarbonate brackets reinforced with ceramic or fibreglass fillers

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and/or metal slots have been recently introduced and are becoming increasingly popular.

- Polycarbonate brackets with metal reinforced slots demonstrate significantly less creep than conventional polycarbonate brackets although torque problems still exist.
- Approximately 15% loss in torque over 24 hours has been observed with both ceramic reinforced and metal lined polycarbonate brackets. However, the performance of these brackets is significantly better than polycarbonate brackets and they probably have the potential to challenge ceramic brackets with future development.
- When comparing torque deformation characteristics of seven commercially available plastic brackets against stainless steel brackets, Sadat-Khonsari et al. showed that metal slot reinforced brackets were subjected to the lowest degree of deformation, followed by pure polyurethane, pure polycarbonate and fibreglass reinforced polycarbonate brackets.
- Ceramic reinforced polycarbonate brackets showed the highest deformation under torque stresses. The addition of ceramic and fibreglass in the plastic brackets also failed to improve the torque stability of the polycarbonate brackets and pure polyurethane brackets showed no significant difference from pure polycarbonate at optimal torque.
- A comparison with stainless steel brackets illustrated that plastic brackets are only suited for clinical application if they have a metal slot.
- Self-ligating aesthetic brackets are a further recent development. Polycarbonate self-ligating brackets have been shown in vitro to

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generate significantly greater static and kinetic frictional forces than stainless steel self-ligating brackets but are comparable to conventional stainless steel brackets.

CERAMIC BRACKETS:[54,55,56]

Ceramic brackets were introduced in the 1986, offering many advantages over the traditional aesthetic appliances. Ceramic brackets provide higher strength, more resistance to wear and deformation, better colour stability and, most important to the patient superior aesthetics. Ceramic brackets are available in a
variety of morphologies including true Siamese, semi-Siamese, solid and Lewis/Lang designs and also various appliance systems including Begg and variable force
ligation brackets.

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PROPERTIES OF CERAMIC BRACKETS:[55]

- Ceramics are renowned for their hardness and for their resistance to high temperatures and to chemical degradation. The atomic structure that imparts these advantages also accounts for the most glaring fault of ceramics— their brittleness.
- Metals can be deformed considerably without fracturing, even in the presence of significant impurities and at sharp intersections. This ductility is a function of their non-oxidized atomic structure. When metals are stressed, a shifting at grain boundaries causes a redistribution and relief of the stress.

- In contrast, ceramics used in orthodontic brackets have highly localized, directional atomic bonds. This oxidized atomic lattice does not permit shifting of bonds and redistribution of stress. When stresses reach critical levels, the interatomic bonds break and material failure occurs. This is called "brittle failure".
- Ceramic compounds, unlike metals, are also susceptible to crack propagation caused by minute imperfections or material impurities. High-strength ceramics can fail relatively easily when cracks or imperfections allow for local concentrations of stresses.
- Although sharp intersections can be tolerated by stainless steel alloys, the geometry of ceramic brackets is critical in preventing stress build-up and brittle failure. Rounded intersections minimize the likelihood of brittle failure occurring at force levels substantially below the material's maximum strength.

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COMPOSITION OF CERAMIC BRACKETS:

All the currently available ceramic brackets are composed of aluminum oxide. One type is polycrystalline, made of sintered or fused aluminum oxide particles, and the other contains a single crystal of aluminum oxide.

Polycrystalline ceramic brackets:[55]

- Polycrystalline brackets are manufactured by blending aluminum oxide particles with a binder so that the mixture can be molded into a shape from which a bracket can be cut.
- The molded mixture is heated to temperatures in excess of 1800°C to burn out the binder and fuse the particles together. This fused part is

then machined with diamond cutting tools to provide the slot dimensions and other critical tolerances.

- The machined bracket must be heat-treated to remove surface imperfections and relieve stresses created by the cutting operations.
- Optical properties and strength are incompatible for polycrystalline ceramics. The larger the ceramic grains, the greater the clarity or translucency. However, the material tends to become weaker when the grains reach a size of about 30 microns.
- Polycrystalline brackets begin as aluminum oxide particles of about .3 microns, which are fused to produce ceramic grains of 20-30 microns. Heat treatments after machining must be carefully controlled to prevent further grain fusion, which could detract from physical properties.
- The main advantage of the polycrystalline manufacturing process is its ability to mold brackets— a relatively inexpensive operation that yields large quantities.
- The disadvantages of this molding process are the presence of structural imperfections at grain boundaries or of trace amounts of impurities. Impurities in quantities as minute as .001 percent or slight imperfections can serve as foci for crack propagation under stress.
- The molding process and heat treatment produce fused aluminum oxide with grain boundaries that refract light, resulting in a degree of opacity.
- Production of polycrystalline brackets is less difficult, and hence these brackets are more readily available at present.
- The most apparent difference between polycrystalline and single-crystal brackets is in their optical clarity.

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Single crystal ceramic brackets:[55]

- Single-crystal ceramic brackets are manufactured by an entirely different process. Single crystals of man-made sapphire are produced by making a molten mass of aluminum oxide at temperatures in excess of 2100°C.
- This mass is slowly cooled to allow a carefully controlled crystallization. The resultant crystal is purer than its natural counterpart.
- Orthodontic manufacturers purchase these large single crystals and mill them into the shapes and dimensions of various brackets, using ultrasonic cutting techniques, diamond cutting, or a combination of the two.
- After milling, the sapphire crystals are heat-treated to remove surface imperfections and to relieve stresses induced by the milling operations.
- The primary advantage of single-crystal manufacturing is the elimination of possible stress-inducing impurities or imperfections.
- The disadvantage is the difficulty and added expense of milling the third-hardest known material. This involves the development of new technology— with its inherent new problems.
- Single-crystal brackets have noticeably more optical clarity than polycrystalline brackets.

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Polycrystalline zirconia brackets:[54]

- Polycrystalline zirconia brackets (ZrO2), which have the greatest toughness amongst all ceramics, have been offered as an alternative to alumina ceramic brackets.

- They are cheaper than the monocrystalline ceramic brackets but they are very opaque and can exhibit intrinsic colours making them less aesthetic.
- Good sliding properties have been reported with both stainless steel and nickel-titanium archwires along with reduced plaque adhesion, clinically acceptable bond strengths and bond failure loci at the bracket/adhesive interface.
- However, Keith et al. found no significant advantage of zirconia brackets over polycrystalline alumina brackets with regard to their frictional characteristics.

DISADVANTAGES OF CERAMIC BRACKETS:[54]

- Difficulty in bonding and bond strength
- Increased frictional resistance
- Bracket breakage and fracture resistance
- Iatrogenic enamel damage
- Debonding

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EVOLUTION OF BRACKETS BASED ON BIOMECHANICAL CONSIDERATIONS

1. EFFECT OF BRACKET SLOT SIZE IN THE EDGE WISE SYSTEM: [57]

- The use of rectangular arch wires in rectangular bracket slots was introduced by Edward Angle in the late 1920's with his edgewise arch mechanism.
- The original appliance was designed for use with gold arch wires, and the 22 x 28mil bracket slot size was designed to accommodate rectangular arch wires of approximately the same dimension.
- In Angle's concept of treatment, sliding teeth along archwires to close extraction sites was unnecessary, because extractions for orthodontic purposes were not done.
- Torquing movements were important and a major goal of appliance design was efficient torque.
- The appliance was engineered to produce appropriate force and a reasonable range of action in torsion when gold archwires of 22 x 28 dimension were used with narrow brackets
- When gold arch wires were replaced by stainless steel arch wires, Angle's original engineering calculations were no longer valid because steel wires of the same dimension were more stiffer.
- An alternative was to redesign the edgewise appliance, optimizing the bracket slot size for steel.
- A reduction in slot size from 22 to 18 mil was advocated for this purpose.

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- Even with this smaller slot size, full dimension steel wires still produced slightly greater forces than the original edge wise system, but the properties of this appliance system were close to the original.
- Good torque is possible with steel wires and 18mil edgewise brackets.
- The next important consideration with the introduction of steel wires was the use of undersized arch wires in edgewise brackets to reduce friction if teeth are suppose to slide along the arch wire.
- As a practical matter, sliding teeth along an arch wire requires at least 2 mil of clearance, and even more clearance may be desirable.
- The 18 mil wire offers excellent clearance in a 22-slot bracket, but fits tightly in a 18-slot bracket.
- The original 22-slot bracket therefore would have some advantage during space closure but would be a definite disadvantage when torque is needed later.
- Hence, slot size plays an important role in determining arch wire changes and sequence at each stage of treatment.

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I. EFFECT OF BRACKET WIDTH: [57]

- Control of root position with an orthodontic appliance is needed in two circumstances: when the root of a tooth needs to be torqued faciolingually, and when mesiodistal root movement is needed for proper paralleling of teeth when spaces are closed, as at extraction sites.
- In the former instance, the necessary moment is generated within the bracket, and the key dimension are those of the arch wire; in

the latter circumstance, the moment is generated across the bracket, and bracket width determines the length of the moment arm.

- The wider the bracket, all other things being equal, the easier it will be to generate the moments needed to bring roots together at extraction sites or to control mesiodistal position of the roots in general.
- The bracket width assumes even greater practical significance when the extraction site is to be closed by sliding teeth along an arch wire, and friction between the wire and bracket is encountered. Frictional resistance to sliding is affected by the force with which the bracket contacts the arch wire and the contact angle between the wire and the bracket.
- The wider bracket reduces both the force needed to generate the moment and the contact angle and is thus advantageous for space closure by sliding.
- Wider brackets have a partially offsetting disadvantage in that the wider the bracket on a tooth, the smaller the interbracket span between adjacent teeth, and therefore the shorter the effective length of the arch wire segments between supports.
- Reducing the span of the wire segments in this way greatly decreases both the springiness of the arch wire and its range of action.
- For this reason, the use of extremely wide brackets is contraindicated. The maximum practical width of a wide bracket is about half the width of a tooth, and even narrower brackets have an advantage when teeth are malaligned, because the greater interbracket span gives more springiness.

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II. SURFACE QUALITIES OF BRACKETS: [57]

- Bracket surfaces are important in friction.
- Most modern orthodontic brackets are either cast or milled from stainless steel, and if properly polished have relatively smooth surfaces comparable with steel wires and sliding with these brackets is reasonably good.
- Titanium brackets were introduced primarily because they eliminate the chance of an allergenic response to the nickel in stainless steel brackets. They have surface properties like those of titanium wires and sliding with titanium brackets is problematic due to the increased surface reactivity, particularly if titanium arch wires are also used.
- Ceramic brackets also show frictional resistance to sliding. The polycrystalline ceramics have considerably rougher surfaces than steel brackets. This rough but hard ceramic material is likely to penetrate the surface of even a steel wire during sliding, creating considerable frictional resistance. Even the single crystal brackets have increased frictional resistance to sliding. To solve this problem of friction, ceramic brackets with metal slots have been introduced

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CONCLUSION

As we know that treatment principles are mainly based on science but art is also a part of it. Through the years, the advent of new system of brackets have been pounded into the field of orthodontics, which has guided and at the same time misguided the clinician in his planned mechanotherapy. This can't be attributed only to the in built properties of the material but also to the extent of basic knowledge a clinician owes regarding that particular system.

As such there is no known universal bracket system to treat all types of malalgined teeth, yet there are varieties of system available in which the clinician should judge and make judicious use of it. Providing a "*Right Treatment for a Right Patient using a Right Appliance at a Right Time"*.

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Speech is a very sophisticated autonomous and unconscious activity. Speech in matured man is a learned habitual neuromuscular pattern, which makes use of anatomical structures, designed primarily for respiration and deglutition. Because oro-dental morphological features also may influence an individual speech, the dentist should therefore recognize the possible role of prosthetic treatment on speech activity.
Corrections of faulty speech is the primary task of the speech specialist, but the complexity of the voice producing mechanism implores the services of the allied health sciences successful treatment of defective speech usually requires close co-operation between the speech therapist and the practitioner in some branch of the medical or dental professions.

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Vasanthi Swami
Vinit Swami

Phonetic Considerations in Prosthodontics

Rehabilitation of Speech

I Dr Vasanthi Swami, (Assistant Professor) MDS Prosthodontics. I am Passionate about my work and teaching and this passion led me to challenge myself daily and learn new skills.

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INTRODUCTION

"**Speech is the use of systematized vocalization to express verbal symbols or words**." (Sheridan)

Speech is a very sophisticated autonomous and unconscious activity. Speech in matured man is a learned habitual neuromuscular pattern, which makes use of anatomical structures, designed primarily for respiration and deglutition. Because oro-dental morphological features also may influence an individual speech, the dentist should therefore recognize the possible role of prosthetic treatment on speech activity.

The loss of teeth and supporting structures alters the main articulatory cavity and produces a marked effect on the speech pattern proportionate to the location and magnitude of alterations. An empiric approach to the phonetic factor in denture construction frequently places the burden for compensating for speech changes for the adaptability of the tongue. Additionally significant is the fact that the speech mechanism is highly susceptible to degenerative diseases. If dentures are to contribute effectively to the functions of speech, dentists should utilize studies in the speech science field to augment their clinical knowledge of the phonetic factor in denture construction.

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Corrections of faulty speech is the primary task of the speech specialist, but the complexity of the voice producing mechanism implores the services of the allied health sciences successful treatment of defective speech usually requires close co-operation between the speech therapist and the practitioner in some branch of the medical or dental professions.

A missing bicuspid will permit a lateral emission, which is intolerable to the precise speaker or singer. A missing anterior tooth will permit an anterior emission, which impairs speaking until an accommodating articulations pattern in learned. Gross removal of gingival tissues denies the tongue its usual soft tissue contact and because a potential escape of the air stream between the interspaces of the exposed root portions of the teeth. Mechanical movement of the tooth or teeth in the maxillary arch, will increase or decrease the area for speech articulations. Speech rehabilitations following dental treatment is an obligations of the profession, and failure to include phonetics in the dental curriculum is not coincident with the high standards established by dental educators to provide maximum health service.

The poorly contoured replacement for a single tooth can cause speech impediment, and larger prosthetic restorations fabricated without regard for speech articulations will impair speech articulations will impair speech until an accommodating articulations pattern is learned. A very high percentage of the English speaking sounds are produced by contact of the tongue with some portions of the palate and teeth. Since these contact areas are either replaced or covered by the complete denture, speech rehabilitation for the edentulous patient becomes the serious task of the prosthodontic. Failure to contour the palate to accommodate normal tongue contact usually results in poor speech for a period of several days or several weeks, depending upon the amplitude of the patient and the discrepancy in the palatal contour. This inarticulate period, generally accepted as "getting used to denture", could be markedly reduced or completely eliminated if proper attention were given to palatal contour at the time of the waxed trial denture try in. Faculty speech is never desirable, even for a short period of time. It is unpleasant for the listener, embarrassing to the patient, and adds to the burden of adaptation is dentures. Contour of the palate for proper tongue. Contact is not difficult, time consuming, or expensive, however it does require some knowledge of the fundamentals of phonetics and a precise knowledge of the normal tongue contact areas for speech articulation.

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NEUROPHYSIOLOGICAL BACKGROUND

A very complex neuro-physiological mechanism governs the production of speech. A large number of oral mechanosensitive receptors (tactile and kinesthetic) are involved in its motor control. Therefore, all prosthodontic treatment will, more or less, have an influence on speech performance because a great number of these structures will be involved.

Speech production includes large number and sequences of innate and learned motor acts produced in sequences of 12-16 sounds/sec in a rhythmic behavior. It has been hypothesized that less cortex area is required for processing of skills as they become automatic. Once automatized, speech control becomes localized in certain areas such as the pre-motor and motor cortex. For the precise movements executed in speech production the pyramidal motor system has the primary role.

Feed back plays a dynamic and flexible role in the control of most motor events, including sequencing and timing of speech movements, there seems to be a subconscious but learned type of pattern recognitions, or feedback, of afferent information is used is guide central pattern generator (CPG's) and a central program. Other neural networks are also very active in the rapid transformations of the shape of the oral cavity from one fixed configurations to another. Proprioceptive mechano-sensitive afferents will establish the timing of certain aspects of the very fast motor pattern and will, in synergy with cortical information, generate the final motor output and rhythm. A precise co-ordination between different articulators is essential for the final sound production.

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A prerequisite for the satisfactory speech sounds and adaptation in an intact general feed back system, with auditory feedback is regarded as a very important mechanism. When impaired hearing is present, speech production will deteriorate. Adaptation after an oral rehabilitation also may create problems in the formation of new neuromuscular pathways.

It appears that adaptation to complete dentures may be explained by feedback mechanism related to speech motor programming. Initially, a complete denture wearer attempts to over come problems related to the new prosthesis by the help of auditory and oro-sensory feed back during function. After a while only, the patient will be aware of remaining articulating difficulties, which often are related to certain

specific sounds. The listener (dentist) is, however, not able to detect any speech production disturbances. At this stage, there are still sensory stimulations from orofacial afferents to central areas. Finally, if the process of adaptation proceeds, the patient will not be aware of any articulatory difficulties or distortional sounds due to the prosthesis. New speech production central engrams have been established, and adaptation and / or habituation to the complete dentures occur.

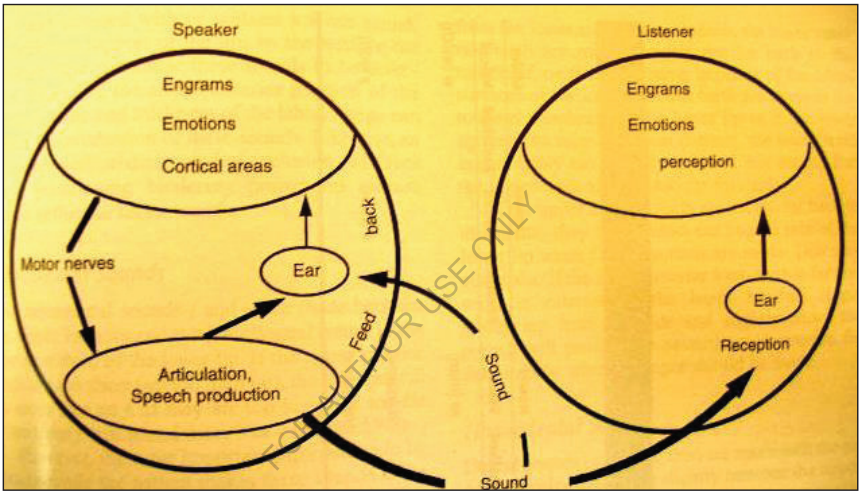

Fig 1: Speech production and communication

INNERVATION OF SPEECH

The principal motor nerves for the muscles of speech are the trigeminal (V^{th} cranial), facial (VII^{th} cranial), glossopharygeal (IX^{th} cranial), Vagus (X^{th} cranial), and hypoglossal (XII^{th} cranial). These innervate the laryngeal muscles (vagus), muscles of the soft palate (mandibular division of the trigeminal and vagus), pharyngeal muscles (Glossopharyngeal and Vagus), muscles of the tongue (hypoglossal), and muscles of the periphery of the mouth (facial) in order to obtain motility, to control tonus, and, in turn, to generate and withstand pressure.

The speech mechanism is characterized by motility, by the capacity to exert pressure, by the capacity to resist pressure, and by the ability of the talker to identify through habitual pressures against familiar structures the conditions for a particular sound. The motor innervations involved derives from three pathways; the cortico-bulbar pathway, extra pyramidal paths, and cerebellar paths. The first of these, the corticobulbar-corticospinal, or pyramidal tract permits the conscious control of precise movements required, e.g., in the articulation of speech sounds. This tract becomes important in the relearning of speech habits to accommodate new intra oral structures. The extra pyramidal tract also conveys some voluntary impulses as well as the control of muscle tonus, the regulation and inhibition of opposing sets of muscles, and the coordination of depth of breathing, tension of vocal folds, the lips, the cheeks, the tongue, and the pharyngeal walls. The third pathway, from the cortex to the speech muscles, is the cerebellar one, the route of the automatic coordination. This one takes over much of speech after childhood until violent changes in the speech mechanism or the functioning of the mechanism are introduced.

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COMPONENTS OF SPEECH

Kantner and West divided speech into 5 components:-

Respiration, phonation, resonations, articulations and neurologic integrations, Chierici and Lawson added audition, or the ability to hear sounds, to this list. The successful performance of these functions is necessary for the production of acceptable speech.

1. RESPIRATION:-

During respiration, inhalations and expirations are approx. equal in duration and the airflow is regular and repetitive. During speech, however, the inhalation phase is shortened and the exhalation phase in prolonged and not repetitive. In normal discourse, the volume and pressure of the expelled air is comparable to the vegetative breathing. Upward movement of the diaphragm with contraction of the costal cartilage and contiguous musculature creates an intrapulmonary pressure which is greater than atmospheric pressure, thus permitting air to be expelled from the lungs. Prolongation of exhalation is achieved by the valve mechanism along the laryngeal, pharyngeal, oral and nasal components of the respiratory tract these valves impede the expired air and help to create speech signals. Subglottic pressure is maintained by the balanced elasticity between the inspiratory intercostals musculature and the expiratory abdominal musculature. If the vital capacity of lungs is compromised, as in emphysema, speech will be perceived as "breathy". The poor projections of the voice, in such cases are due to the reduced volume and pressure of the expired air.

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2. PHONATION:-

The larynx provided the first level of constrictions for controlling the respiration air stream. The primary function of vocal cords is to protect the lungs and the lower respiratory tract from inhalation of particulate matter. This mechanism requires a simple, forceful approximation of the vocal folds. Speech, conversely, requires a multitude of positions, varying tensions and vibratory cycles, and an intricate co-ordination of the vocal folds with other structures. If the vocal folds are partially or completely adducted or closed, they impede the expired air. With the proper degree of tension and sufficient sub-glottal pressure, the vocal cords may set in vibration and thus impart phonation to air stream. Where as phonation is essential

for certain speech sounds, other speech signals do not require phonation, hence, the vocal folds are abducted or open. The tension and position of vocal folds will, in part, determine the pitch of the phonated sound. In the production of low pitched sounds, the vocal folds are relatively thick and flaccid. In high-pitched sounds, the margins of the approximated folds are thin and tense.

3. RESONATION:-

The sounds produced at the level of vocal folds, is not the final acoustic signal which is perceived as speech. This sound is augmented and modified by the chambers and structures above the level of glottis. The pharynx, the oral cavity and the nasal cavity act as resonating chambers above the level of glottis. The pharynx, the oral cavity and the nasal cavity act as the resonating chambers by amplifying some frequencies and muting others, thus refining tonal quality. The pharynx being a muscular tube, services as a excellent resonating chamber. This tube is formed by 3 closely associated muscles namely: - inferior, middle and superior constrictor. These muscles are unique in that they share common insertions, the medial pharyngeal raphe, but have a different anterior origin. Also, it appears that each muscle constrictor, as well as portions of each muscle can contact selectively. The dimensional changes imparted by this muscular action influence the resonant characteristics of the pulsating air stream as it emerges from the larynx. The velopharngeal mechanism proportions the sound and / or air stream between the oral and nasal cavities and influences voice quality (or the basic sound) that is perceived by the listener. If velopharangeal closure is compromised, or if the structural integrity or relative size of the oral, pharyngeal or nasal cavities has been altered, voice quality can be compromised.

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4. ARTICULATION:-

Amplified, resonated sound is formulated into meaningful speech by the articulators, namely, the lips, tongue, cheek, teeth and palate, by changing the relative spatial relationship of these structures. The tongue is considered to be the single most important articulator of speech because of its ability to affect rapid changes in movement and shape. The tongue may impede, selectively restrict, and channel the air stream with precise contact against the teeth and palatal areas, thus articulating the basic laryngeal sound, or the non-phonated air stream, into recognizable speech. If oral structures such as the tongue, adjacent soft tissues, jaws or lips, are altered surgically and / or neurologically, articulation may be compromised.

5. NEURAL INTEGRATION:-

Speech is integrated by the central nervous system both at the peripheral and central level. The sequential and simultaneous movements required throughout the speech complex demand precise co-ordination.

Neurologic impairments may compromise, a specific component of the speech such as the vocal folds, soft palate or tongue, or it may indirectly effect the entire speech system. A cerebro-vascular accident may compromise the ability of the patient to comprehend and or formulate meaningful speech, even though all structures used to produce speech are anatomically with in normal limits**.** In addition, a neurologic impairment may produce a specific type of speech deformity. Example: The loss of motor innervations to the soft palate may compromise elevation and velopharangeal closure.

6. AUDITION:-

Audition, or the ability to receive acoustic signals, is vital for normal speech. Hearing permits receptions and interpretation of acoustic signals and allows the speaker to monitor and control speech output. Compromised hearing can preclude accurate feedback and hence, affect speech. Speech development and subsequent speech therapy is hampered in-patient with hearing impairments.

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PHYSIOLOGIC VALVES IN SPEECH PRODUCTION

The primary functions of the respiratory and digestive tract in relation to their secondary function of producing and modifying sounds may be understood by recognizing that the speech mechanism that includes three principal physiologic valves.

1. Valve I , the glottis
2. Valve II, the palatopharangeal region
3. Valve III, the orifice of the mouth.

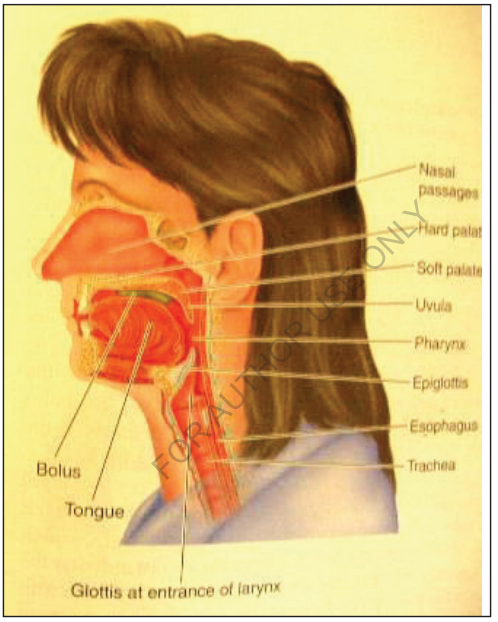

Fig. 2

1. PHYSIOLOGIC VALVE I:-

True vocal folds of larynx :- The vibrating mechanism produces vocal tones, and the true vocal folds serve as a valve only in connection with speech sounds that have tone i.e., the voiced sounds other wise, the outgoing stream of air passes through the region of the vocal folds without interference as in normal breathing. The valve mechanically serves to modulate the outgoing breath stream in instance of voiced

sounds only. It is a generator of sound waves which enables man to communicate at a distance as contrasted to the short distance through which one might communicate by whispering.

The larynx, containing the vocal folds that serve intermittently as value I during speech, is composed of three single cartilages and three pairs of cartilages. They are connected by ligaments and moved by muscles, the larynx has a mucous membrane lining that is continued superiorly with the pharynx and inferiorly with the trachea. The cartilages and muscles offer the means for adducting (approximating) and abducting (separating) the true vocal folds and for tensing them (shortening antero-posteriorly) and relaxing them (elongating antero-posteriorly) as shown in figure 3.

The true vocal folds are casually related to voice as apposed to whisper. The folds are attached anteriorly to the thyroid cartilage and posteriorly to the arytenoid muscles. When in a position of rest, as in quiet breathing, the free edges of the folds form an angular opening which has its apex located anteriorly and its base posteriorly the opening or aperture between them when they are not approximated is called rima glottidic. When voice is desired, the folds are approximated, and air is pushed against them from below with sufficient force to blow the edges of these elastic folds apart. The overload of air pressure is momentarily spent. Tension restores the folds to a closed position. This cycle is repeated and becomes quesivibratory. The acoustic output is called voice.

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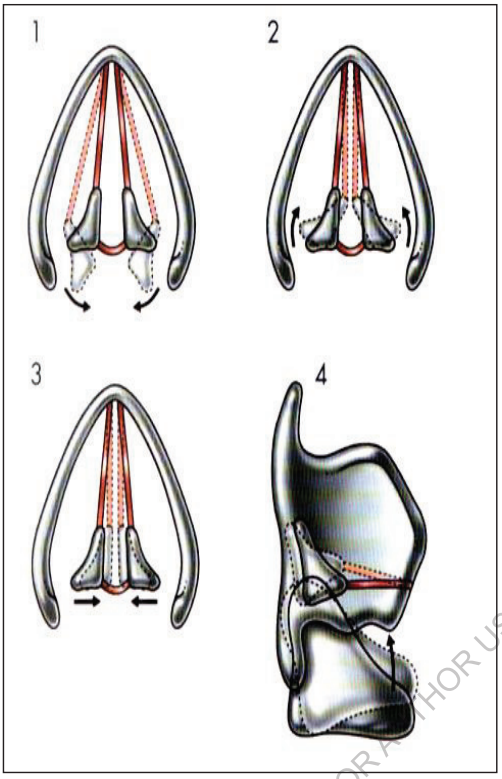

1 Opening of the rima glottidis by rotation of the arytenoids
2 Closure of the rima glottidis by rotation of the arytenoids
3 Closure of the rima glottidis by approximation of the arytenoids without rotation
4 Tensing of the vocal folds by tilting of the anterior part of the cricoid cartilage

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Fig . 3: Moments of vocal cords. The broken outline shows the new position of the vocal folds following muscle contraction.

The muscles that control the vocal folds are divided into two classes:-

a. Those with in the organ itself (intrinsic) and
b. Those that act upon it from out (extrinsic).

The intrinsic muscles have two main functions:-

1. To adduct and abduct the folds
2. To regulate the degree of their tension and length.

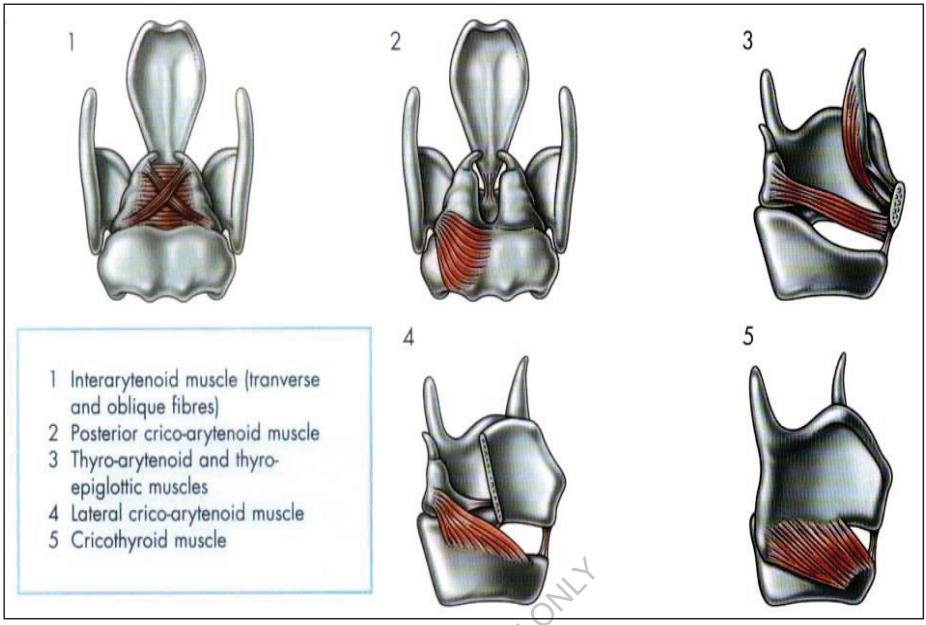

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Fig 4: Intrinsic muscles of larynx

The muscle that open the rima glottidis are posterior Crico-arytenoids. They are attached to the posterior surfaces of the arytenoid and cricoid cartilages. Thus, they may rotate the arytenoid cartilages laterally and separate the true vocal cords.

Closure of rima glottides is affected by the arytenoid and lateral crico-arytenoid muscle. They rotate the arytenoid muscle is medially and causes the true vocal folds to be approximated. The arytenoids muscle extends from the posterior and lateral surfaces of one arytenoid cartilage to the corresponding surface of the other. These bring the arytenoids cartilage together, consequently narrowing the rima glottidis. The most important muscle used in lengthening and tensing the true vocal folds is the cricothyroid.

The vocal folds are relaned and shortened by the thyroaryteniod muscle.

The **extrinsic (accessory) muscles** act upon the larynx as a whole, connecting the larynx with the hyoid bone, the sternum, the tongue and the pharynx. By means of these muscles, the larynx may be elevated, depressed and tilted.

2. PHYSIOLOGIC VALVE II:-

Palatopharangeal region:-The pharynx is made up primarily of a constrictor band of broad, flat muscles inserting into a median raphe along its posterior wall. The pharynx may be divided arbitrarily into three parts (as shown in Fig. 5):-

1. **The nasal pharynx** is a continuation of nasal cavity posteriorly; it is bounded inferiorly by the soft palate and terminates along the posterior pharyngeal wall near the atlas (1st cervical vertebra). It's only function is respiratory.
2. **The oral pharynx** is a continuation, inferiorly, of the nasal pharynx to the laryngeal pharynx, i.e. about the level of hyoid bone. It's function are respiratory and digestive.
3. **The laryngeal pharynx** is the inferior portions of the pharynx. It extends inferiorly from the oral pharynx and terminates in the esophagus at about the level of the VIth cervical vertebra. Its function is strictly digestive. The palato-pharangeal value is located in the region in which the respiratory and digestive tracts cross each other (pharyngeal Isthmus). Both in the act of swallowing and in speech, this value divide the pharynx into naso-pharyngeal and oro-pharyngeal cavities. The principal closure is affected by movement of the soft palate into contact with the posterior wall of the pharynx.

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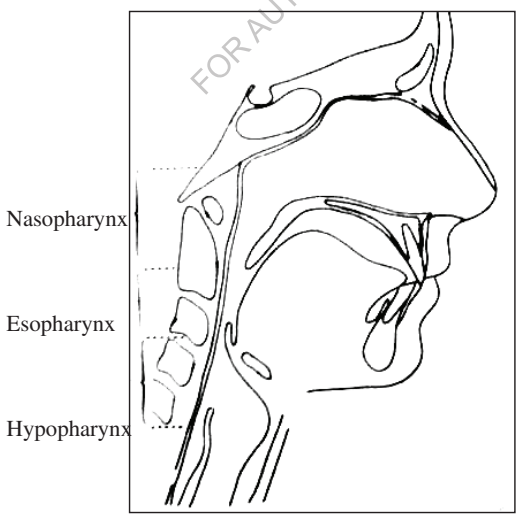

Fig. 5: Schematic picture of the different vales and articulators

3. PHYSIOLOGIC VALVE III:-

The Mouth:-The mouth is a complicated valve, capable of making many changes, both in capacity and in size of the orifices. It is modified by many articulators, the chief one being the tongue.

The three physiologic valves serve to form a number of more specific articulatory valves, such as:-

1. Mandibular lip against the maxillary lip.
2. Mandibular lip against the maxillary teeth.
3. Tip of the tongue against the alveolar ridge etc.

These valves are formed by momentary intrusions of some segment of the physiologic valves into the path of the outgoing stream.

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ENGLISH CONSONANTS: THEIR POSITION AND MODE OF PRODUCTION

The production of English consonants and involve six valves below:-

1. Bilabial
2. labiodental
3. Linguodental
4. Lingeoalveolar
5. Linguopalatal
6. Linguovelar

Out of the above six valves five valves are affected by teeth position:-

I. **Bilabial Sounds: -** The sounds b, p and m are made by contact of the lips (as shown in Fig. 6). Insufficient support of lips by teeth and / or denture base can cause these sounds to be defective. Therefore, the anterior-posterior position of the anterior teeth and the thickness of the labial flange can affect the production of these sounds like wise an incorrect vertical dimension of occlusion (VDO) or teeth positioning hindering proper lip closure, might influence these sounds.

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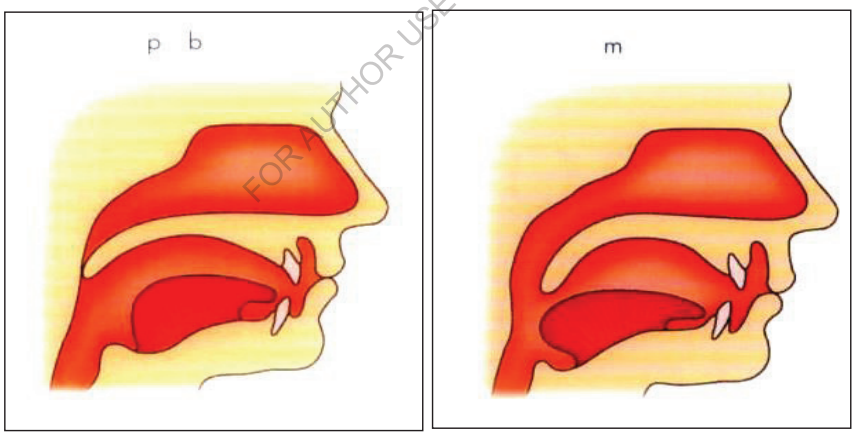

Fig. 6: Bilabial sounds

II. **Labio-dental Sounds: -** The labio-dental sounds f and v are made between the upper incisors and the labio-lingual center to the posterior third of the lower lip (as shown in Fig.7). If the upper anterior teeth are too short (set too high up), the V sound will be more like an 'f'. If they are too long (set too far down), the f

will sound more like a v. If upper teeth touch the labial side of the lower lip while these sounds are made, the upper teeth are too far back in the mouth. In this situation, the relationship of the inside of the lower lip to the labial surfaces of the teeth should be observed while the patient is speaking. If the lower lip drops away from the lower teeth during speech, the lower anterior teeth are most probably too far back in the mouth. If, on the other hand, imprints of the labial surfaces of the lower anterior teeth are made in the mucous membrane of the lower lip, or if the lower lip tends to raise the lower denture, the lower teeth are probably too far forward, and this means that the upper teeth are also too far forward.

If the upper anterior teeth are set too far back in the mouth, they will contact the lingual side of the lower lip when f and v sounds are made. This may also occur if the lower anterior teeth are too for forward in relation to the lower residual ridge.

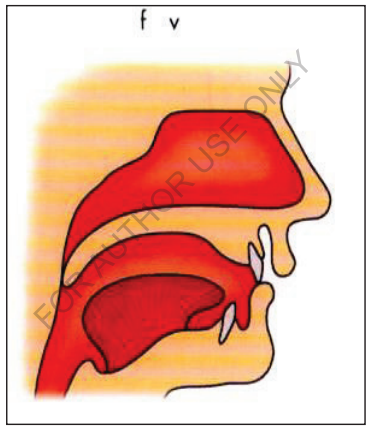

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Fig. 7: Labio-Dental sounds

III. Linguodental Sounds:-

Dental sounds (eg. Th) are made with the tip of the tongue extending slightly between the upper and lower anterior teeth (as shown in Fig. 8). This sound is actually made closer to the alveolus (the ridge) than to the tip of the teeth. Careful observation of the amount of tongue that can be seen with the words – this, that, these and those will provide information as to the labio-lingual position of te anterior teeth. If about 3mm of the tip of the tongue is not visible, the anterior teeth are probably too far forward, or there may be an excessive vertical overlap that does not allow sufficient space for the tongue to protrude between the anterior teeth. If more than

6mm of the tongue extends out between the teeth when such sounds are made, the teeth are probably too lingual.

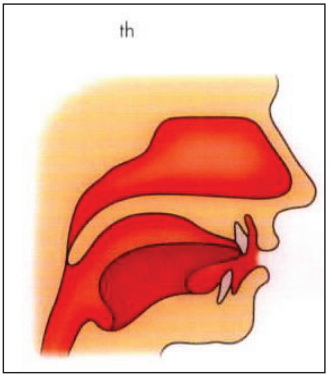

Fig. 8: Linguodental sounds

IV. Linguoalveolar Sounds:-

Alveolar sounds (eg. t, d, s, z, v & l) are made with the valve formed by contact of the tip of the tongue with the most anterior part of the palate (the alveolus) or the lingual sides of the anterior teeth (as shown in Fig. 9). The sibilants (sharp sounds) s, z, sh, ch & j (with ch & j being affricatives) are alveolar sounds, because the tongue and alveolus forms the controlling valve. The important observations when these sounds are produced are the relationship of the anterior teeth to each other. The upper and lower incisors should approach end to end but not touch. A phrase such as "I went to church to see the judge" will cause the patient to use these critical sounds, and the relative position of the incisal edges will provide a check on the total length of the upper and lower teeth (including their vertical overlap).

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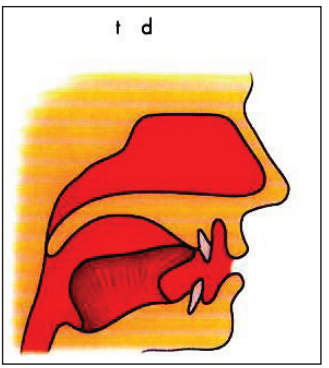

Fig. 9: Linguoalveolar sounds

THE 'S' SOUND

From a dental point of view, the S sound is the most interesting one. This is the case because its articulation is mainly influenced by the teeth and palatal part of the maxillary prosthesis (as shown in Fig. 10). Clinical experience suggests that s and t can cause most problems suggests that s and t can cause most problems in a prosthodontic context. In nearly all languages of the world, S is a common speech sound. The inter individual variation in articulatory details may be great due to individual variation in teeth, palate, lower jaw and tongue shape and size. However, the following phonetic properties are common to all s sounds.

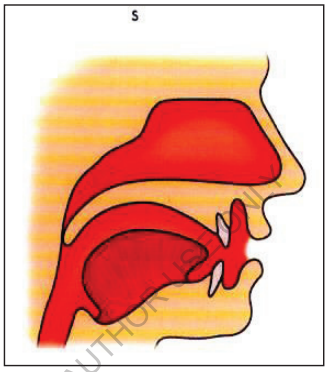

Fig. 10: 'S' sound

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Linguopalatal and Articulatory characteristics :-

1. The tip of the tongue is placed far forward, coming but never touching the upper front incisors.
2. The sagittal groove is made in the upper front part of the tongue, with a small cross sectional area.
3. The tongue dorsum is flat.
4. Normally, the mandible will move forward and upward, with the teeth almost in contact.

Auditory characteristics

1. The sound is fairly loud, with a light, sibilant (sharp) quality.
   The S sound can be considered dental and alveolar speech sounds because they are produced equally well with too different tongue positions, but there can be some variations even behind the alveolus. Most people make the S sound with the tip of the tongue against the alveolus in the area of the rugae, but with a small space for air to escape between the tongue and alveolus. The tongue's anterior dorsum forms a narrow groove near the midline, with a cross section of about $10mm^2$. The size and shape of this small space will determine the quality of the sound. Part of the sibilant sound is generated when the teeth are being hit by a concentrated air jet. If the opening is too small, a whistle will result. If the space is too broad and thin, the S sound will be developed as sh, somewhat like a lisp. The frequent cause of undesired whistles with dentures is a posterior arch form that is too narrow.

Creation of a sharp s requires accuracy of the neuromuscular control system, for the creation of the groove and directioning of the air jet. Even small deviations of only 1mm will influence the quality. For example, if the tip of the tongue touches the upper front teeth, the result will a lisped sound.

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V. Linguovelar sounds:-

The truly palatal sounds (example: year, she, insion and onion) present less of a problem for dentures. The velar sounds (k, g and ng) have no effect on dentures, except when the posterior palatal seal extension encroaches on the soft palate.

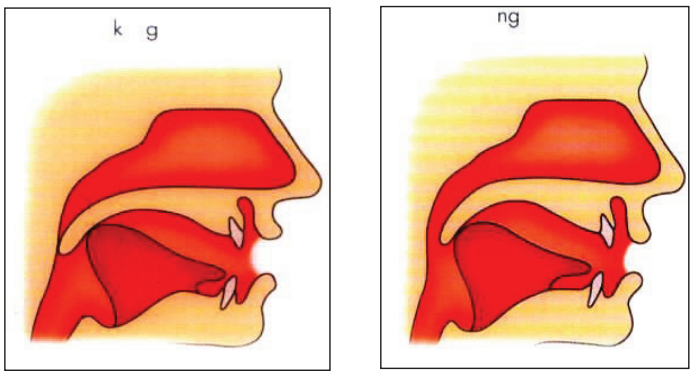

Fig. 11: Linguoalveolar sounds

VELOPHARYNGEAL FUNCTION

Hyper nasality and decreased intelligibility of speech may result from congenital or acquired defects of the velopharyngeal mechanism. Velopharyngeal deficits may result from congenital malformations (Such as cleft palate), developmental aberrations (Such as a short hard or soft palate, or deep nasopharynx), acquired neurological deficits, or the surgical resection of neoplastic disease.

CLASSIFICATION AND ETIOLOGY

Velopharyngeal deficiencies may be classified on the basis of physiology and/or structural integrity. Palatal insufficiency and palatal incompetence. Palatal insufficiency refers to patients with inadequate length of the hard and / or soft palate to affect velopharygeal closure, but with movement of the remaining tissues within normal physiological limits. The defect is secondary to a structural limitation. Patients with congenital and developmental aberrations and acquired soft palate defects would fall into this classification. Palatal incompetence refers to patients with essentially normal velopharyngeal structures, but the intact mechanism is unable to affect velopharyngeal closure. Patients with neurological diseases, such as bulbar poliomyelitis or myasthenia gravis, or neurologic deficits secondary to cerebrovascular accidents or closed head injuries are included in this category.

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General Considerations

The velopharyngal mechanism is a precisely coordinated valve formed by several muscle groups. At rest, the soft palate drapes downward so that the oral pharynx and nasopharynx are open and coupled, allowing for normal breathing through the nasal passages. Classically, when velopharyngeal closure is required, the middle one third of the soft arcs upward and back ward to contact the posterior pharyngeal wall at or above the level of the palatal plane. The lateral pharyngeal walls move medially to contact the margins of the soft palate at or slightly below the level of the torus tubarius, and the posterior pharyngeal wall may move anteriorly to facilitate contact with the elevated soft palate. Complete, or nearly complete, velopharngeal closure is required for normal deglutition and the production of some speech sounds, such as plosives. For other phonemes, such as vowels and nasal consonants, the velopharyngeal port will be open in varying degrees.

Previous Methods of Evaluation

Aerodynamic and air flow studies, lateral and frontal plane radiographic analysis, spectrographic and coordination analyses, direct observation through large facial defects instrumentation for direct oral observation, video fluoroscopic and nasoendoscopic studies, more anatomical dissections, electromyographic analysis, and neurological innervation.

Current Methods of Evaluation

Many current studies have employed the use of multi view video fluoroscopy, nasal endoscopy and oral nasal airflow recording techniques to study the physiology of the velopharyngeal complex during speech and non speech functions. Several studies have combined more than one of these evaluation methods. These methodologies are unique in that the evaluation can be conducted with little or no impact upon the physiology of the region.

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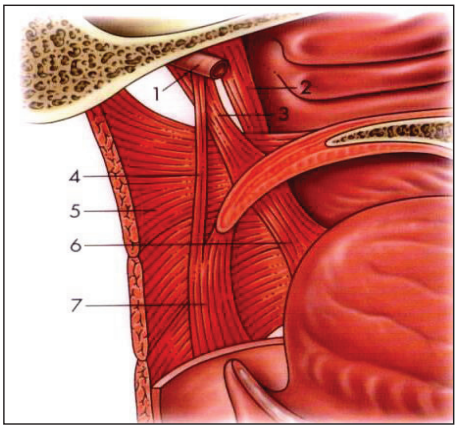
ANATOMY AND PHYSIOLOGY OF VELOPHARYNGEAL MECHANISM

The anatomy and physiology of the velopharyngeal mechanism will be described by dividing the description into the following anatomic components; namely, the soft palate, the posterior pharyngeal wall, and the lateral pharyngeal walls.



1 Auditory tube
2 Tensor veli palatini muscle
3 Levator veli palatini muscle
4 Salpingopharyngeus muscle
5 Superior constrictor muscle
6 Palatoglossus muscle
7 Palatopharyngeus muscle

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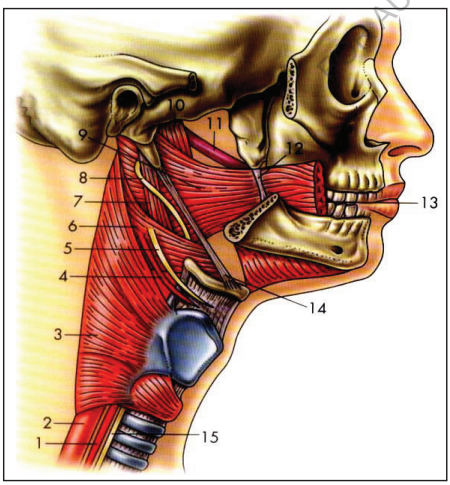
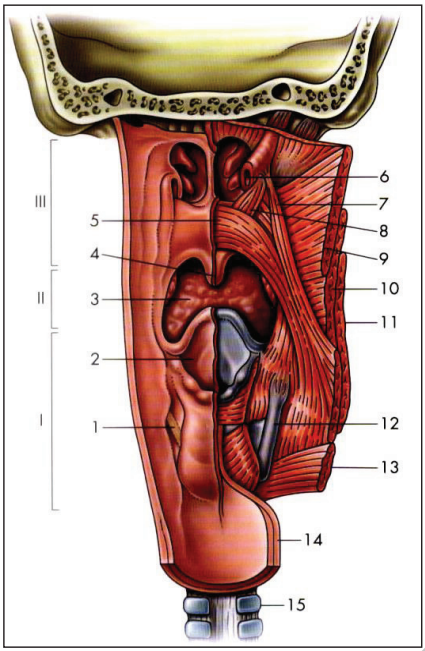
Fig. 12: Showing muscles of soft palate



1 Inferior laryngeal artery
2 Oesophagus
3 Inferior constrictor muscle
4 Superior laryngeal artery
5 Internal laryngeal nerve
6 Middle constrictor muscle
7 Stylopharyngeus muscle
8 Glossopharyngeal nerve
9 Superior constrictor muscle
10 Levator veli palatini muscle
11 Auditory tube
12 Pterygomandibular raphe
13 Buccinator muscle
14 Stylohyoid ligament
15 Recurrent laryngeal nerve

Fig. 13: Showing Pharynx lateral view



I Laryngopharynx
II Oropharynx
III Nasopharynx

1 Piriform fossa with internal laryngeal nerve beneath mucosa
2 Inlet of larynx
3 Tongue
4 Uvula
5 Palatopharyngeus muscle
6 Auditory tube
7 Salpingopharyngeus muscle
8 Levator veli palatini muscle
9 Superior constrictor muscle
10 Middle constrictor muscle
11 Thyropharyngeal part of inferior constrictor muscle
12 Thyroid lamina (posterior border)
13 Cricopharyngeal part of inferior constrictor muscle
14 Oesophagus
15 Trachea

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Fig. 14: Internal view of Pharynx

SOFT PALATE

Position and Movement

The position and movement of the soft palate, in relation to the pharynx, changes with age. At birth and shortly thereafter, the soft palate at rest is roughly parallel to the roof of the pharynx so that the upper nasopharynx is only a narrow slot. Closure of the velopharyngeal mechanism is accomplished by essentially a superior inferior movement of the soft palate. As growth occurs in the pharyngeal area, and as the adenoidal tissues regress, the movement of the soft palate takes on the characteristic anterior posterior elevation displayed by most adults.

Velopharyngeal closure is slightly below the level of the palatal plane up to 8 years of age, and is consistently above the level of the palatal plane thereafter.

The extent of the closure of the soft palate with the posterior pharyngeal wall varies with head position. An extended head position results in a deeper nasopharynx

than when the head is held in the Frankfort plane. **McWilliams(1969)**, in a radiographic study of 101 children with repaired cleft palates, found with the posterior pharyngeal wall was reduced significantly when the head was in an extended position.

The pattern of soft palate movement varies between men or women. This study disclosed that the soft palate was longer, the elevation was greater, the amount of contact with the posterior pharyngeal was less, and the inferior point of contact with the posterior pharyngeal wall was consistently higher in men than in women.

Velar Eminence and Musculus Uvulae

While the entire soft palate increases in length during closure, the posterior two thirds demonstrates a greater degree of lengthening and significant thickening. Several investigators noted a central longitudinal thickening or elevation of the nasal surface of the soft palate that was termed the velar eminence.

The musculus uvulas are responsible for the velar eminence, which contribute to velar stretch, and is essential for normal velo-pharyngeal closure. This paired muscle is the only intrinsic muscle of the soft palate.

Each of the 2 bundles of the musculus uvulae has its origin from the tendinous palatal aponeurosis, which is posterior to the hard palate and anterior to the insertion of the levator veli palatini muscle. The bundles converge above and at right angles to the sling of the levator veli palatini, and redivide and insert into the basement membrane and connective tissue of the uvula. The bulk of uvula consists of glandular tissue interspersed with muscle fibers.

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The levator supplies the force with contraction and elevates the soft palate. At the same time, the musculus uvulae contrast to fill the central gap between the soft palate, the lateral pharyngeal walls, and the posterior pharyngeal wall along the central one third of the nasal surface of the soft palate. The contraction of the musculus uvulae is considered essential for those individuals having any circular pattern of closure.

While the entire soft palate increases in length during closure, the central and posterior portions demonstrate a proportionally greater degree of lengthening along with thickening. This lengthening during closure has been termed velar stretch. The amount of velar stretch seems related to the task and/or anatomical or functional variables associated with the structures involved in closure.

Levator Veli Palatini and Other Muscles

Levator Veli Palatini muscles is responsible for palatal elevation. While the levator veli palatini muscles supply the force for palatal elevation, the finite positioning of the soft palate may be under the control of several other muscles acting in a reciprocal manner with the levator.

A consistent interaction was observed between the levator, the palatoglossus, and the palatopharyngeus. If the levator contracted forcefully, the palatoglossus and the palatopharyngeus also contracted forcefully. The reverse scenario was also true. The palatoglossus and the palatopharyngeus create a downward pull to the soft palate and oppose the upward contraction of the levator. Therefore, the levator must contract of the levator. Therefore, the levator must contract more forcefully if the palatoglossus and / or palatopharyngeus contact forcefully. The important function of the palatoglossus and palatopharyngeus in speech is to aid in positioning the tongue and pharynx. If the palatoglossus contracts to aid in tongue elevation and / or the palatopharyngeus contracts to restrict the pharynx, the levator veli palatini must increase its contraction force proportionally to achieve the desired velar elevation. Thus, there is a reciprocal relationship between the 3 muscles in positioning the soft palate and the tongue.

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Since the most superior constrictor needs further investigation. Since the most superior fibers of the superior constrictor insert into the soft palate, Kuehn speculated that these muscle fibers may assist the muscular uvulae to draw or stretch the velum posteriorly.

These reciprocal muscular relationships help to explain the inter relationship between tongue position (or velopharyngeal closure) and speech. Tongue posture and movement may differ with velopharyngeal incompetence or insufficiency. These patients often have a more posterior and superior tongue position during speech. Warren felt that a high tongue carriage would increase vocal tract resistance for patients with a velopharyngeal deficiency. These investigators felt that this compensatory tongue posture assisted with soft palate elevation, but also contributed to the faulty articulation reported for these patients.

Posterior Pharyngeal Wall

In 1863 and 1869, Gustof Passavant described a horizontal “cross roll” on the posterior pharyngeal wall which occurred during speech and swallowing in cleft

palate patients. This forward bulging, corresponding to the level of the atlas, has been termed Passavant's ridge or pad. This cross roll may vary from a slight forward bulging of the posterior pharyngeal wall to a very distinct roll extending horizontally across the posterior pharyngeal wall to blend with the mediolateral movement of the lateral pharyngeal walls. In its prominent form, Passavant's pad may extend forward and superiorly as much as 5mm in both directions. Passavant's ridge serves as a guide for proper placement of the soft palate obturator prosthesis.

To what extent does Passavant's ridge contribute to velopharyngeal closure?. This point is debatable. Calnan reported that Passavant's ridge varied in location, tended to be located below the level of palatal closure, contracted slowly and in an uncoordinated manner, and tended to fatigue easily. He concluded that it contributed little to velopharyngeal closure.

What muscules are responsible for posterior pharyngeal wall movement? This point, also, is debatable. The lateral and posterior walls of the oropharynx and nasopharynx are composed of muscle fibers of the fan-shaped superior constrictor muscle. The superior constrictor muscle has its origin along the pterygomandibular raphae and the tuberosity of the maxilla, and its fibers course posteriorly and horizontally to insert and anastomose with its counterpart into the aponeurosis in the midline of the posterior pharyngeal wall of both the oropharynx and nasopharynx. The anatomical components of Passavant's ridge have been debated, since fibers of the pharyngopalatinus muscle were found to intermingle with those of the superior constrictor. Calnan speculated that it was the pharyngopalatinus that comprised Passavant's ridge. Others believe that fibers of the superior constrictor form this unusual configuration, and they are responsible for the anterior movement displayed by the posterior pharyngeal wall.

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The lateral Pharyngeal walls

Lateral pharyngeal wall movement is essential if normal speech is to be achieved with either prosthetic obturation or surgical reconstruction. Lateral pharyngeal wall motion is difficult to assess because the drape of the soft palate precludes direct oral observation, and lateral radiographic projections will not disclose lateral pharyngeal wall motion unless the head is extended posteriorly with the patients in a supine position.

Lateral pharyngeal wall motion requires different methods of evaluation. Beumer observed and photographed the velo-pharngeal mechanism of 2 patients through large facial defects. He traced lateral wall movements during speech and

swallowing from motion picture films and concluded that lateral wall movements were an essential component of closure.

Following placement of an obturator, or a pharyngeal flap procedure, the adjacent pharyngeal tissues demonstrate increased motion. The physiologic basis for this phenomenon has not been explained completely.

Other forms of stimulation of the velo-pharngeal mechanism, such as muscle exercises, speech therapy and electrical stimulation, have not been effective in demonstrating a sustained increase in pharyngeal movements leading to improved speech.

The muscles contributing to the movement of the lateral pharyngeal walls, the direction of lateral wall movement, and the level laterally of velo-pharyngeal closure remain points of contention. The levator veli palatini muscle has its origin lateral to the torus tubarius, without attachment to the Eustachian tube. The levator courses downward, forward, and medially, and inserts into the central one third of the soft palate.

It appears that the palato-pharyngeus contributes little to the medial and posterior movement of the lateral pharyngeal walls. Its primary function is to mobilize the larynx and narrow the pharynx in speech and swallowing. Dickson felt that, in the adult, the fibers of the palato-pharyngeus are so intertwined with the superior constrictor that analysis of the function and boundaries of the palato-pharyngeus are difficult to delineate.

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THE TONGUE

The tongue is the principle articulator for speech, and learning its position for a given sound is the key to speech learning. To divide its role in speech the dorsum of the tongue is divided into a back portion, which approximates the soft palate, and a front portion, which approximates the hard palate, and the sides are referred its as the tongue blade and the apex is called the tongue tip, or apex.

To pronounce ‘a’ the dorsum of the tongue is arched and the blade contacting the alveolar ridge and the tip resting behind the lower incisors. The position for ‘e’ is essentially the same, except the dorsum is arched a little higher, with the blade in heavier contact with the alveolar ridge and the tip raised slightly. To pronounce ‘i’, the tongue is pulled back with the dorsum flattened at the beginning of the sound, but raises to the ‘e’ position for the completion. To pronounce ‘U’ the tongue first assumes the ‘e’ position then fills back with the dorsum flattened for the second part of the sound. For the ‘o’ tongue is in its flattest and lowest position with no palatal contact.

Functional Tongue Classification

The working range of the mobile tongue varies with the individual. Therefore, classification and knowledge of the conditions that cause variations are indicated.

The degree of activity and the variation in functional type suggest the following classification:-

1. The occupational tongue.
2. The still tongue
3. The normal tongue
4. The habitual tongue.

The term "*occupational tongue*" was selected to apply to those people whose activities require increased tongue action. This includes jurists, teachers, lecturers and preachers.
The developed increased muscular positioning force will herein after be designated "tongue power movements".

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The "*still tongue*" is at the opposite end of the classification. In these patients, as a result of limited activity, due to injury, deformity, or undue timidity, a passive tongue exists. A example is ankyloglossia.

The "*normal tongue*" exists between these two extreme ranges and refers to the type of tongue function in people exhibiting a normal or average development. These cases are welcomed by the prosthodontist, as they give a range within limits in effecting desirable rehabilitation.

Tooth alignment should be effected without encroachment upon the tongue functioning space. The base of the tongue is frequently "hooked" by the lower second molars. This factor is a cause of unstable lower dentures which warrants recognition. Positioning lower second molars in complete dentures should be arranged without tongue impingement. In some cases, the insertion of a fixed appliance or removable partial denture will cause immediate tongue laceration of varying degrees. The traumatic problem in occupational tongues has a favorable prognosis with early recognition and adequate adjustment to the problem. Observation confirms the fact that tongue laceration rarely results from functional tongue interference in complete dentures, for the power movement of the tongue is capable of dislodging the interfering dentures, and thereby escaping injury. The value in straddling interference of flange margins upon the tongue is in effecting better

denture stability in function. The reaction of the tongue to interference with power thrusts by removable partial dentures or fixed bridges presents a different picture. The inability of the tongue to escape or dislodge the appliances results in repeated irritation or trauma. The degree of injury is commensurable with the duration of time and the intensity of the interference.

The "*habitual tongue*" is the term chosen to describe those disturbing power movements developed by habit, exclusive of the arching of the tongue to help retain dentures as described by Rowe". The base of the tongue is thick and powerful, and the dislodging force is most offending to prosthetic dentures. It is suggested that the lower second molar in prosthesis may be reduced bucco-lingually, and may be set buccal to the ridge crest to negate the objectionable effects of classic accepted tooth position that frequently tend to defeat lower denture stability. When narrowing of the last lower molars in complete dentures fails to give sufficient functional tongue space, it is advisable to set to combined opposing last molars in buccal version, reducing the lingual surface linguo-buccally, in distal progression. It is also possible to increase tongue space for better function by placing the last molars in a cross bite relation. The employment of a cross bite to effect greater tongue space is a new use for this method. In extreme cases, the second molars can be eliminated completely.

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THE MANDIBULAR MOVEMENT OF SPEECH AND THEIR SEVEN RELATED VALUES

Dentist's worries about where to position the six lower anterior teeth can be greatly minimized because patients, when speaking, tell this in a symphony of mandibular movement rather than in vocal words.

By recording and interpreting certain mandibular movements of speech, the patient reveals seven informative facts that are directly related to restoring the original mandibular tooth position, phonetic sharpness, and occlusal harmony.

These are:-

1. The vertical overlap.
2. Horizontal overlap,
3. Former lower anterior tooth display,
4. Former class of occlusion.
5. Maximum usable vertical dimension.
6. An accurate index for incisal guidance and
7. The maximum serviceable cusp height.

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Which mandibular movement to record?

The degrees of movement and the intimacy of teeth to one another during speech vary considerably, and this variation is dependent upon the speed and volume of the desired speech effects. However, two conditions always exist during speech. The first is that the lower teeth must move downward out of their centric occlusal position. This movement must be sufficient to prevent any tooth contacts during speech. Second, when repeatedly pronouncing the letter "S", the mandible assumes its most forward speaking position, and the anterior teeth are in their most intimate relation with one another. At this time, the incisal edges of the lower teeth, with a space of about 1.0 mm, between them. In a fair percentage of patients, however, there is practically no forward movement of the mandible and this fact is just as important and informative as any measurable movement.

To record any directional movement, there must be at least two control points. The centric occlusal relation is one control and the "S" position is used for the other. By setting the incisal edges of the lower teeth to this functional "S" relationship, a recording is automatically made of the extent of the downward and

forward movements from centric occlusal position. With some, these movements are great , with others they are surprisingly small. It is the extent of these movements, indicated by the difference between the "S" position and their position in centric occlusion that is the key to these seven values.

Improved phonetics in denture construction:-

The literature in dental prosthetics was reviewed and previous methods for improving phonetics were evaluated.

1. **Snow,** after observing many casts of natural dentitions, pointed out that a tracing which started t the vault and passed over the lingual alveolar area to the incisal edge of the maxillary incisor always formed a reverse curve. He recommend thickening and contouring the area lingual to the collars of the maxillary incisors of the denture in order to reproduce this reverse curve, and he maintained that this reproduction facilitated the pronunciation of S and SH.
2. **Landa** uses the labio dental sounds (F and V) as an adjunct to the arrangement of the maxillay anterior teeth. He believes the teeth should be arranged so that these fricatives can be pronounced easily and naturally. Landa also maintains that proper vertical dimension is the key to proper pronunciation of S and SH.
3. **Sears** reports that clearer S pronunciation will result from fashioning the area of the anterior median ridge according to the type of tongue. He recommends making a groove in this area for the broad tongue with a slight median sulcus and the building of a ridge in this area for the tongue with a deep median sulcus. Sears also advocates making a palatogram on patients whose median sulcus of the tongue does not coincide with the midline.
4. **Pound** believes that the entire lingual aspect of the maxillary denture should be contoured to simulate the normal palate, if proper phonetics is to be attained. The tongue plays a major role in speech. It changes position and shape for the pronunciation of each of the vowels, and it is the principal articulator for the consonants. In pronouncing the consonants, the tongue contacts various portions of the teeth, the alveolar ridge, and the hard palate. Since these structures are either replaced or covered by the denture, it was basic to the study to know exactly which portions of these structures are normally contacted by the tongue in pronouncing a given consonant. To accomplish this, palatograms were made to incorporate a maximum variety of tooth arrangement, tooth occlusion, arch form arch size, vault form, and vault depth.

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5. The area most sensitive to thickness is the anterior alveolar area from cuspid to cuspid. An addition of 1 mm, thickness in this area made speech awkward and indistinct, and an additional 1 mm thickness in the posterior alveolar area made speech awkward but not indistinct. The entire vault area could be thickened up to the tongue palatal tracing line without interfering with speech.

The speaking method in measuring vertical dimension:-

The exact measurement of the natural vertical dimension is most essential in the successful practice of many phases of dentistry. It has been found that the greatest cause of full denture difficulties is the failure to duplicate the normal vertical dimension. In occlusal reconstruction, many fine dentists have found, through experience that increasing the vertical dimension for patients with supposedly shortened vertical dimension ended in failure.

6. Also it is proved scientifically by the speaking method that vertical dimensional must not be increased. Those dentists who reconstruct the occlusion of patients will generally find that failures can be avoided by completing the treatment without the increase of vertical dimension. If this dimension should be increased, this treatment must be based on scientific proof and not on the opinion of the operator.

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The Speaking Method

The patient is seated in an upright position without the use of the headrest, with the eyes forward, and the occlusal surface of the upper posterior teeth parallel to the floor. The measurement is taken under identical conditions of posture and vigor of speech. The head must not tilt forward or backward and the patient should speak rapidly in a calm and relaxed manner. A particular observation must be made that the patient does not consciously control the movement of the mandible, as any variation from normal might affect the measurements.

Direct the patient to close into centric occlusion, with the upper and lower teeth together in maximum occlusal contact. Draw the centric occlusion line with sharp pencil on a lower anterior tooth at the horizontal level of the incisal edge of the opposing upper anterior tooth.

Have the patient say “yes” and while the phonetic sound s is being pronounced, draw the closest speaking line on the same lower anterior tooth at the horizontal level of the upper incisal edge. The distance between the centric occlusion line (lower line)

and the closest speaking line (upper line) is called the closest speaking space. This closest speaking space is the measurement for vertical dimension.

In some patients, the mandible will move forward during the pronunciation of some or all speech sounds. This forward movement will not affect the accuracy of the measurement because the same movement occurs, and the vertical distance between the lines in always remeasured in the same manner with both natural and artificial teeth.

8. The closest speaking space may vary in different. In the series of patients examined, the measurements ranged from 0 to 10 mm, which proves that there is no such thing as "an average" in measuring vertical dimension. Measurement must be made with accuracy as it has been found that increasing the vertical dimension only one millimeter will cause discomfort to the patient

9. The closest speaking space has been found to be constant in each individual. It is felt that the closest speaking space should be constant throughout life. This belief may be accounted for by the "all or none law" of muscle physiology which states that each muscle fiber is in maximum contraction during the stimulus of function. Because this system of measuring vertical dimension is based on physiologic function of muscles while used in speaking under similar conditions, the same level of the mandible are caused by maximum function of the specific muscle fibers involved.

Out of the 44 phonetic sounds of the English language, one or more of the six sibilants s, z, sh, ch, and j in such words as yes, buss, fish, measure, church and judge are the sounds which cause the closest level of the mandible to the maxilla while speaking. In the exceptional cases where other sounds caused the closest level, it was found that the sibilants caused a constant and accurate level of the mandible in relation to the maxilla. The remaining of the 44 phonetic sounds caused wider spaces between the mandible and the maxilla. That was neither constant nor accurate and could not be relied upon as a guide to the measurement of vertical dimension. The closest speaking space as measured in the natural dentition must be reproduced in full dentures after the loss of the remaining natural teeth.

It is always advisable to measure the closest speaking space of all full denture patients at least once a year until it is found that there is an end to discomfort and perhaps to alveolar shrinkage or wear of the artificial teeth. If the closest speaking space remains constant in the full dentures, it is simple to duplicate this same vertical dimension when registering the maxillo-mandibular relation of new dentures, with the additional help of tattoo dots on the alveolar ridges.

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The closest speaking space to measure the vertical dimension in this speaking method must not be confused with free way space of the centric relation method. The free way space establishes vertical dimension when the muscles involved are at complete rest, and the mandible is in its rest position. The closest speaking space measures vertical dimension when the mandible and muscles involved are in the active full function of speech.

STUTTERING (STAMMERING)

Definition:-

Stammering is a disorder of the rhythm of speech in which the speaker knows precisely what he wishes to say but cannot for the moment say it, because of involuntary repetitions, prolongations, or cessation of sounds **(World Health Organization, 1978**). It is more than just a disruption in the smooth flow of words, as the syndrome is typically characterized by emotional reactions to the trouble experienced in speaking. Therefore it should be viewed as a disorder of communication rather than purely a speech symptom. If it persists into adolescence or adulthood it frequently becomes a major obstacle to the formation of close relationship and careers.

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Onset:-

Stammering is a disorder of childhood often occurring between the ages of 2 or 10 years, but more commonly between 2 and 5 years (Blood stein, 1960). It is at exactly this time when non fluency may be observed as a normal stage in language development. The child has ideas which he wishes to communicate, but his expressive language has not developed sufficiently to allow him to do so and therefore there are hesitancies as he plans his utterances. It is vital that a differential diagnosis between normal non fluency and the onset of stammering is made, to prevent the development of a chronic handicap.

Normal non-fluency consists mainly to whole word or phrase repetitions (for example it's ……. It's …… cold today or put the ….. put the …. Ball there), interjections, and revisions (the man…. The boy is happy) with occasional part word repetitions. The stammering child is characterized by an increase in part word repetitions (bbbbbbball), sound prolongation (b…. ball) and the insertion of the schwa vowel after the initial sound (tu-tu-tu-today). Sometimes the child may be seen to struggle to get the word out, disrupting the expiratory airflow. Variations of

the pitch, intensity and rate of the voice may be observed. Concomitant movements of the head and trunk and word and situation avoidance may develop.
Part of the reason that this disorder is so complex, is due to its variability in severity and frequency with time and circumstance.

Aetiology :-

Many theories as to aetiology have been proposed from organic, psychogenic to viewing stammering as a learned behaviour. Despite much research, however, the aetiology is still not fully understood. It is known, however, that there is often a familial pattern. The risk of stammering among first degree relatives exceeds the population risk by a factor of three, and this risk is increased for the offspring of female stammerers. It is quite probably that environmental factors do play a part in the development and maintenance of the syndrome, and that possibly the psychogenic aspects, in particular difficulties with social adjustment, develop as a learned reaction to the handicap. Stammerers often demonstrate poor interpersonal skills, avoid social contact, and do not initiate communication.

Current research is studying neurophysiological theory on the supposition that there is a neurological inadequacy.

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Incidence:-

In childhood, the prevalence in the prepubertal population is 1% dropping to 0.8% at 16years of age. The distribution of stammerers between males and females is three to one. This disproportion increases with age, and the remission of stammering is more common in girls than boys. This has been attributed to differences in constitution, in particular physical maturation and speech and language development, and to the different parental attitudes and expectations of boys and girls (**Andrews *et al.* 1983**.)

Management:-

The speech therapist's assessment of stammering is complex. A quantitative and qualitative assessment of the overt behavioural manifestations of dysfluency is made. Other aspects of speech and language behaviour are assessed and information on education achievements sought. Environmental factors including the child's and parent's attitudes, and other significant persons, are all carefully explored.

Current approaches to therapy can take widely different forms, and is determined by the assessment. Treatment usually is based on three main principles:-

1. Modification of the environmental factors that are contributing to the development and maintenance of stammering may be indicated.
2. Therapy may be needed to modify directly aspects of speech production, with attention to the effective carryover and maintenance of fluency .
3. The importance of changing the child's perception of himself as a stammerer, sometimes needs to be worked upon in therapy.

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PROSTHODONTIC CONSIDERATIONS AND REHABILITATION OF SPEECH

- Speech problems are usually identified immediately following phonetic treatment.
- After denture insertion, it is some times difficult to receive speech habits immediately, but gradual process of retaining tongue positions good compensation can be achieved in later periods.
- Speech adaptation to new complete dentures normally takes place within 2-4 weeks after insertion.
- During fabrication of denture, certain guidelines have to be followed in order to achieve clarity of speech.

1) <u>Effect of denture thickness and peripheral outlines</u>

1) If the thickness of the denture base covering the palatal area is more, then lipsing of the sounds will occur.

   Allen (1958) found that an additional thickness of 1mm in the anterior palatal area made speech awakward and indistinct.

2) The denture base thickness in the postdam area will irritate the dorsum of the tongue which will impede the speech and there is a possibility in producing feeling of nausea and denture may be unseated during sounds, which requires sudden repositioning of the tongue to control and stabilize it.

   The upper denture base in posterior region must be kept thin and the posterior border should be merge with soft tissues.

3) If the lingual flange of the lower denture is too thick in the anterior region, will encroach the space needed by the tongue and this results in faulty production of ‘s’ sound.

It can be corrected by arranging the artificial teeth, in same position as the natural teeth will occupy and shaping the lingual flange so that there will be enough tongue space to establish.

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2) Effect of tooth position on speech

If the lower anterior teeth are arranged too lingually, the tongue is forced to arch itself upto a higher position and the airway is to be too small and there will be faulty pronunciation in 's' and 'z' sounds.

If upper anteriors are too short of occlusal plane the word 'v' will more likely pronounce as 'f'. If upper anteriors are arranged below the occlusal plane the word 'f' will be pronounced like 'v'.

The labiodental sounds like 'f', 'v' are helpful in determining the anteroposterior positioning of the upper incisors and the occlusal plane.

3) Effect of dental arch form on speech:

If the arch is narrow, which will crample the tongue which affects the size and shape of the air channel results in faulty articulation of the consonants like 't, d, l, n, s, t' where lateral margins of the tongue makes contact with palatal surfaces of the upper posterior teeth.

The correction can be done by the slight thickening of the denture base in the center of the palate, so that tongue doesnot have to extend up as far as into narrow palatal vault.

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4) Effect of vertical dimension on speech:

Fymbo (1936) pointed out that defective speech is most frequently associated with increased vertical dimension which may result in difficulty in pronouncing sounds like 'b, m, p, f, v'.

Landa (1947) recommended various phonetic tests to determine proper vertical dimension using sounds such as 's, c, z'.

Silverman (1956) stated that sibilient sound 's' as a mean for determining the correct vertical dimension. He established the "closest speaking space" and used this as clearance area between the dentures.

The bilabial sounds like 'm' is helpful in determining the vertical dimension, when this sound is pronounced there will be passive contact between the upper and the lower lip, which aid in obtaining the correct vertical dimension.

5) Whistle and Swish sounds:

Silverman (1967) stated that the Whistle and Swish sounds are produced during speech due to air abnormally passing over the tongue and through the interincisal space. These sounds may be caused due to decreased overjet.

6) Effect of denture esthetics on speech:

Speech is some times related to patients emotional attitudes towards the denture esthetics.

Lawson (1973) stated that when there is any change in patient mouth, then there will be anxiety reaction will occur some patients dissatisfied with their teeth appearance in denture and to overcome this problem they shows abnormal movement of lip, jaws, and tongue during speech.

CLEFT PALATE

A failure of fusion of the two halves of the palate during the embryological period; between the sixth and ninth week after conception is manifested as the cleft of the upper lip, upper gum ridge, the hard palate, the soft palate, or the combinations of the above. The clefts may be complete or incomplete, i.e. in some cases there was no fusion of the two halves of the structures and in other cases, the fusion had started but was disrupted before the structure was complete.

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Fig. 15: Cleft involving hard & Soft palate

The oral cleft team:-

The essential ingredients of a successful oral cleft team include the freedom for all professionals to give their points of view:-

- The **plastic surgeon** specializes is the modification of soft tissues.
- The **oro-laryoglogist** (ENT specialist), he will evaluate and treat tonsils and adenoids and will perform ear surgery, if indicated.
- The **orthodontist** helps in positioning of the teeth.

- **Prosthodontists** designs and builds prosthesis for the oral cleft client. These may include speech bulbs, palatal lifts, and obturators.
- **Pediatrician** oversees the general health of the child.
- **Audiologist** administers and interprets the routine hearing tests.
- **Speech pathologists** seek to improve the patient's speech.

Surgery for clefts:-

Primary surgery for the cleft is done early in child's life with major considerations given to impious the child's facial appearance. Secondary surgery on the palate usually involves some attempt to improve the speech of the client some of the procedures are designed to move the palate backwards. More popular are the attempts to bring the back wall of the throat forward.

Prosthesis:-

There are certain cases of cleft palate for whom surgery is not the wisest course. Certain clefts are so large or the tissue remaining so scant that the prognosis for good speech, easy swallowing and a good facial appearance is very poor. Essentially prosthesis are artificial substitutes for missing or deficient parts.

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Types of Prosthesis:-

The dental portion of prosthesis may be designed to improve the cosmetic appearance as well as to improve speech. The portion of the appliance that is designed to plug or block the opening in an unrepaired palatal cleft is referred to as an obturator.

Velopharyngeal closure can be brought about by the speech bulb designed by prosthodontist. This prosthesis extends from the palatal portion into the nasopharynx to fill the deficient velopharangeal space. It is used to decrease the hypernasality when the surgery is contra indicated. A palatal left is designed to elevate the middle section of velum and is used in cases in which there is little evidence of enough muscular potential for velopharyngeal closure, even though the palate seems long enough.

A palatal stimulator provides mechanical resistance to the normal movement of the velum so that the client strengthen the weak muscles in the velopharyngeal area.

PROSTHODONTIC REHABILITATION

Obturator is derived from the Latin verb, Obturare, which means “to close” or “to shut off”. This definition provides an appropriate description of the objective of obturation in patients with velopharyngeal incompetence or insufficiency. A prosthesis placed following resection of portions of the bony maxillae and adjacent structures is basically a covering prosthesis to reestablish the oral- nasal partition. The extension superiorly of the obturator into the defect provides the basis for improved retention, stability, and support for the prosthesis. There is very little movement of the tissues bordering these defects. In contrast, obturators constructed for patients with soft palate defects must function in concert with peripheral tissues displaying considerable movement.

Obturator prostheses fabricated for patients with velopharyngeal deficits vary with the location and nature of the defect or deficiency.

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Since most resections included adjacent structures, the delicate functional balance of the velopharyngeal mechanism will also be affected to varying degrees, depending on the extent of the initial resection and the method of surgical defects are lined and /or closed primarily with various types of flaps or a skin graft. Therefore, the prosthodontist may be asked to restore a velopharyngeal defect which may, in part, be nonfunctional. If the soft tissues peripheral to the defect do not display some movement, rarely will speech be normal with either a prosthetic obturator prosthesis or surgical reconstruction. Movement of the lateral and posterior walls and movement of the residual soft palate are essential for either method of rehabilitation.

Immediate and Delayed Surgical Obturation:-

If resection of the portions of the velopharyngeal mechanism is contemplated for control of neoplastic disease, the placement of an immediate or delayed surgical obturator may be indicated. Immediate surgical obturation is most useful in dentulous patients, where the entire soft palate is to be resected. In the edentulous patients, or with patients with limited medial or lateral posterior border resections, delayed obturation may be the treatment of choice. The principle advantage of immediate

surgical obturators for soft palate defects is support and retention of the surgical packing.

Immediate Surgical Obturation :-

Immediate surgical obturators, constructed presurgically, are approximations with regard to the level of placement and the contours of the lateral and posterior margins. The guesswork can be minimized if an extended impression of the soft palate is obtained.

After the cast is retrieved, it is altered to correspond to the proposed defect. The superior- inferior level of the obturator is determined by the plane of the hard palate. The cast is altered to extend the palatal plane to within 2 to3 mm of the estimated position of the posterior pharyngeal wall. The width of the obturator is determined by the width of the soft palate. These guidelines will usually produce a prosthesis that will not be overextended. Adjustments at surgery may be necessary to avoid excessive tissue contact or to provide space for a nasogastric tube. Adaptation during the immediate postoperative period need not be precise, as the surgical packing will correct minor discrepancies. In addition, some patients will have a tracheostomy tube placed at surgery, so speech will be compromised during the immediate postsurgical period.

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Approximately 7 to 10 days postsurgically, the prosthesis is removed along with the surgical packing. The lateral and posterior margins of the prosthesis are checked for tissue contact. Appropriate corrections are made and tissue treatment material is added to the lateral margins of the prosthesis. The patient is instructed to perform head and swallowing movements to activate the velopharyngeal complex and mold the lining material. Often, patients are reluctant to activate the remaining velopharyngeal musculature initially because of discomfort, edema, and possible neurologic deficits. Hence, speech in the immediate postoperative period can be muffled, as lateral pharyngeal wall movements are necessary to control nasal emissions and establish proper resonance balance. As healing progresses and the peripheral tissues display a greater range of movement, trimming and reapplication of a suitable liner will be necessary. As the edema abates and movement of these tissues increases, speech will also improve. The patient is monitored with sequential appointments until the definitive prosthesis can be constructed.

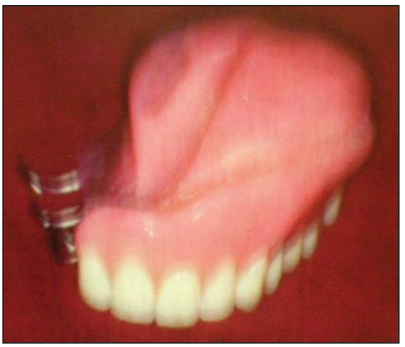

Fig. 16: Immediate obturator

Delayed Surgical Obturation:-

Patients with smaller defects of the posterior or lateral border of the soft palate often are best served with delayed surgical obturation. If the defect is limited, the postsurgical edema will tend to mask the velopharyngeal defect during the initial postsurgical period. As healing progresses, the patient can be considered for a delayed surgical prosthesis .In edentulous or partially edentulous patients, consideration should be given to attaching the delayed surgical obturator to the existing maxillary complete or partial denture.

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Definitive Obturation:-

Patients exhibiting considerable movement of the residual velopharyngeal complex during function have an excellent prognosis for achieving normal speech with prosthesis. Movement of the lateral pharyngeal walls is essential for control of nasal emission.

The obturator is attached to a conventional prosthesis. If the patient is dentulous, a removable partial denture framework retains the obturator. The obturator should be rigid. Therefore, it does not attempt to duplicate the movements of the soft palate. It is a fixed platform of acrylic resin which provides surface contact for the remaining musculature of the velopharyngeal mechanism during function. If the lateral and posterior pharyngeal walls exhibit normal movement, a space will exist between these structures and the obturator when these tissues are at rest. The surrounding space permits breathing through the nasal cavity and the production of nasal consonant phonemes.

The level of optimal obturator placement in the nasopharynx is determined by the position of movement of the residual velopharyngeal mechanism. Passavant's ridge and the anterior tubercle of the atlas can vary in location in relation to normal velopharyngeal closure. Therefore, definite landmarks regarding obturator placement are some that difficult to delineate. As a general rule, the prosthodontist should consider the following guidelines for location of the obturator segment of the prosthesis:-

1. The obturator for an adult patient should be located in the nasopharynx at the level of normal velopharyngeal closure.
2. The inferior margin of the obturator should not extend below the lower level of muscular activity exhibited by the residual velopharyngeal complex.
3. The superior margin of the obturator should not extend above the level of muscular activity.
4. The inferior extension of the obturator will usually be an extension of the palate plane, and extended to the posterior pharyngeal wall.

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Fig. 17: Showing Permanent obturator

Speech evaluation following obturator placement:-

The prosthodontist may require the assistance of a speech pathologist to evaluate articulation errors and inappropriate oral-nasal resonance balance. Cleft palate patients will invariably require speech therapy in order to utilize their obturator prosthesis more effectively, whereas patients with obturators for acquired defects of the soft palate usually do not need this retraining. The articulation test or the Iowa

Pressure Articulation Test can be administered by the prosthodontist, but definitive judgments concerning articulatory deficience should be reserved for the speech pathologist. Patients with hypernasality often exhibit facial grimaces to partially occlude the nostrils and the nasal valve, or abnormal tongue postures as a compensatory adjustment to reduce nasal emission.

The obturator is adjusted to the point where the patient can produce a clear "p" and a sustained "f" or "s" sound without emission of air through the nose, as well as understandable nasal consonarit sounds, such as "m". Several authors suggested that the sustained pressure required for the "s" phoneme may be a reliable method of evaluating the effectiveness of the obturator. Whereas greater intraoral pressure may be required for stop-plosives, such as "p", the sustained pressure required for stop-plosives, such as "p", the sustained pressure required for "s" mitigates the compensatory elevation of the tongue to assist with closure. The tests discussed previously, such as multiview videofuoroscopy, comparative oral and nasal air flow measurements, and oral and nasal endoscopy, will aid in assessing the perceived resonance balance. Nasal endoscopy, especially, can be very helpful, as this instrument does not interfere with speech. Larger openings can be visualized through the scope, while the bubbling of mucous may indicate smaller openings that require correction.

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Fig. 18: Showing Multiview videofluoroscope

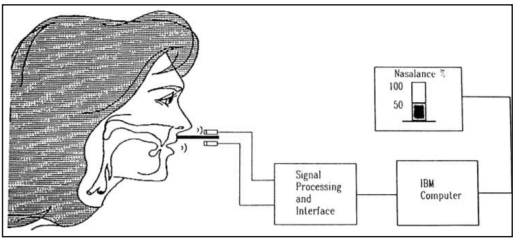

Fig. 19: Schematic view of videofluoroscope

Obturation of Soft Palate Posterior Border Defects:-

Patients in this category have undergone surgical resections of the posterior portion of the soft palate for control of neoplastic disease. They exhibit a variety of defect, but the anterior portion of the soft palate remains intact, with attachment to the posterior border of the palatine bones. It includes the obturation of two prototype defects. First, median posterior border defects, which occur following the surgical resection of lesions of the uvula and the posterior soft palate. Second, lateral posterior borderdefects, which occur following resection of lesions of the anterior tonsillar pillar and the retro molar region. In both instances, the velopharyngeal mechanism may be compromised, and prosthetic obturation is usually the treatment of choice.

Two approaches have been utilized to cross the residual soft palate. One method is to record the soft palate at rest. After the soft palate is circumvented, the obturator is extended superiorly behind the soft palate to the proper level for obturation. This approach will be discussed in this section. A second method is to displace the residual soft palate superiorly with the soft palate extension in order to place the obturator in the proper area in the nasopharynx. Such prosthesis is termed palatal lift prosthesis.

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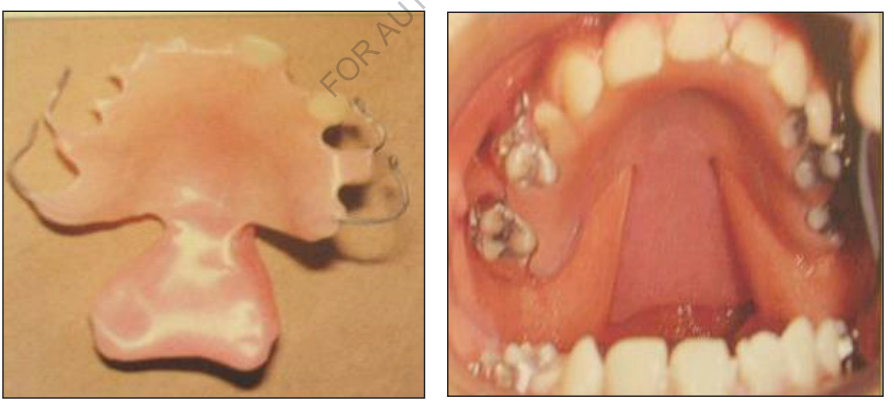

Fig. 20: Obturator with soft palate extension

Implant Retained and Supported Obturator Prostheses:-

In patients with soft palate defects, osseointegrated implants enable the design and fabrication of complete overlay dentures with retentive capacities similar to prostheses for dentulous patients with partial denture frameworks. If the soft palate defect has not resulted in the compromise of the posterior palatal seal area, and the residual palatal structures are favorable, two implants, placed into the premaxillary segment in the region of the cuspids, will be a sufficient supplement to the retention, stability and support derived form the residual structures. However, if the defect has compromised the posterior palatal seal area, and /or the residual palatal structures provide insufficient stability and support for the prosthesis, 4 or more implants should be placed.

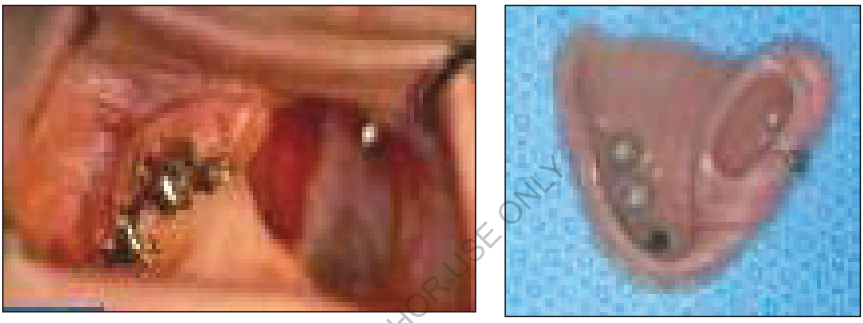

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Fig. 21: Implant supported obturator

Palatal Lift Prostheses:-

The popularity of the palatal lift prosthesis has increased since it was first advocated by Gibbons and Beumer. This type of prosthesis is especially useful for patients with velopharyngeal incompetence who exhibit compromised motor control of the soft palate and related musculature. Examples myasthenia gravis, cerebrovacular accidents traumatic brain injuries, bulbar poliomyelitis, cerebral palsy, or injury to the soft palate (as sequelae following adenoidectomy, tonsillectomy, or maxillary resections), or with cleft palate patients with palatal insufficiency and submucous cleft palate. The objective of palatal lift prosthesis is to displace the soft palate to the level of normal palatal elevation, enabling closure by pharyngeal wall action. If the length of the soft palate is insufficient to effect closure after maximal displacement, the addition of an obturator may be necessary behind the displaced soft palate. Adequate lateral pharyngeal wall movement is necessary for the lift to be effective. A space for breathing should be present laterally between the displaced soft palate and the pharyngeal walls at rest.

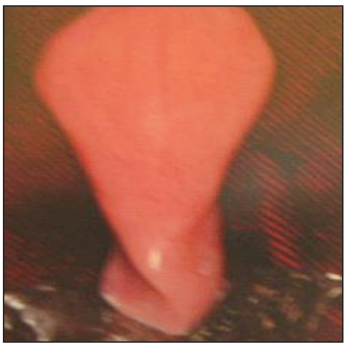

Fig. 22: Palatal lift prosthesis

The advantages of palatal lift prosthesis are as follows:-

1. The gag response is minimized due to the superior position and the sustained pressure of the lift portion of the prosthesis against the soft palate.
2. The physiology of the tongue is not compromised due to the more superior position of the palatal extension.
3. The access to the nasopharynx for the obturator (if necessary) is facilitated,
4. The lift portion may be developed sequentially to aid patient adaptation to the prosthesis.
5. The lift principle has application to a diverse patient population that cannot be treated as effectively with palatal surgery or other types of obturator prostheses.

   A palatal lift prosthesis is contraindicated if: -

   1. Adequate retention is not available for the basic prosthesis,
   2. The palate is not displaceable, or
   3. The patient is uncooperative.

   The displaceability of the soft palate can be checked by the mechanical elevation of the soft palate with a mouth mirror.

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Meatal Obturator Prostheses:-

A meatal obturator prosthesis was first described by Schalit, and later advocated by Sharry. A meatal obturator establishes closure with nasal structures at a level posterior and superior to the posterior terminus of the hard palate. The obturator extends superiorly and slightly posteriorly from the hard palate border, separating the nasopharynx and nasal cavities at the level of the posterior chonchae. There are no

movable tissues in this area and closure is established against the turbinates, the residual vomer (if present), and the roof of the nasal cavity. The palatal defect must be as wide as the area to be obturated, or the rigid meatal obturator cannot be considered. Meatal obturators are used infrequently, but they can be indicated for patients extensive defects of the soft palate who exhibit a very active gag reflex. Indeed, they may be the obturator of choice for edentulous patients when retention is a problem. The meatal extension is not as lengthy as the more conventional obturators previously described, and it may be quite thin in its anterior-posterior dimension, as contact with mobile tissues is not a consideration. Thus, less weight is added to the maxillary complete denture. Also, the downward displacement force from the obturator extension is closer to the supporting tissues of the parent prosthesis.

The disadvantages of this design are obvious. First, the obturator does not enable the patient to control nasal air emission because it is positioned in an area devoid of muscle function. Nasal airflow is created by drilling hole in the obturator or by reducing its lateral extensions. Consequently, the nasal passage is obstructed, leading to hyponasal speech and impaired nasal respiration, or open, predisposing to excessive nasal emission. Therefore, speech therapy is usually not indicated or effective in refining speech after obturator placement. Second, distortions in nasal resonance are evident because the oral cavity and the oropharynx and nasopharynx are increased in size and the nasal cavity is reduced proportionately. Third, the anterior surface of the meatal obturator may act as a dam by hindering normal postnasal drainage patterns, leading to the accumulation of mucous secretions anterior to the prosthesis. Thus frequent removal of the prosthesis is necessary for cleaning. Despite these difficulties, meatal obturator prostheses will improve speech, and they can be adjusted to permit nasal breathing.

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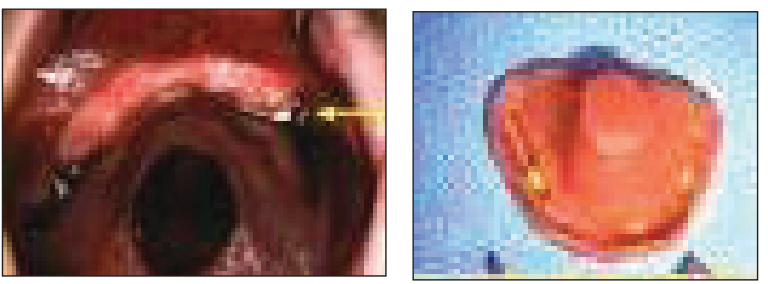

Fig. 23: Meatal obturator

Communication problems associated with cleft palate:-

Clefts of the lip and palate affect speech in two major ways: -
The voice quality becomes deviant, and the articulation is impaired. The voice quality is that of excessive nasality. There are also unique types of articulation errors present in cleft palate speakers. They have more trouble with the plosives, fricatives and affricatives since these require the storing up of air pressure behind the closure or the narrowed opening. Voiced sounds seem to be easier than the unvoiced ones, but the consonant blends present considerable difficulty. The distortion errors are primarily due to nasal emission, the person snorting the sounds out of his nose.

Assessment:-

The assessment of a cleft palate child should be comprehensive and include :-

1. An impression of the child's total communicative effectiveness.
2. Case history information.
3. An oral mechanism inspection.
4. A hearing evaluation.
5. A review of individual's psychological and social adjustment.
6. A language evaluation.
7. An evaluation of the child's velopharangeal competence.
8. Articulation testing.

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Treatment

The goals of therapy are:-

a. To decrease the nasal emission, hyper nasality and the defective articulation.
b. To improve the oral air pressure and oral airflow.
c. To eliminate abnormal foci of tensions and abnormal nostril contractions.
d. To activate the tongue, lip and jaws
e. To improve the respiratory rhythm of speech and their rate and control.
f. To improve velar and pharyngeal contraction.

Air pressure controls:-

Air pressure with in the mouth varies with the various speech sounds. The plosive and the sibilants require the most air pressure. Voiced sounds require less than do the invoiced sounds. Cleft palate patients often use very tight closures and sudden releases. This is unwise since much more air pressure is required for plosives (like /t/ and /d/) than for the loose contact, slow release type.

The fricatives employ a narrow channel for the airflow but cleft palate patients use the narrower ones that require a greater air pressure and so nasal emission tends to occur.

Much of the stimulus valve of a sound can be increased by prolonging its duration. Weaker 's' sound should be held longer. A slightly prolonged /f/ in the word fish even if weaker in airflow will be understood as readily as a quicker, stronger one. Many speech pathologists teach their cleft palate clients to open the mouth widely in speech, as far as they can without appearing abnormal. It improves the speech markedly as any larger opening attracts airflow. Larger mouth openings for the vowels tend to produce looser contacts of the lips and tongue, and they certainly increases the consciousness of the mouth rather than the nose.

Muscle training:-

It is possible to improve the state of air pressure with in the mouth by shutting off the air leak, by improving velopharangeal closure. Many of the muscles are weak and can be strengthened through appropriate. Exercises if surgery or prosthesis has been successful in creating the condition for a possible closure (Mc Willions, Morries, & Shelton, 1984; Karnell and Van Demark, 1986). If the cleft palate patient can flow up a balloon or whistle or if inspection with dental mirror shows good occlusions of the nasopharynx, we should be able to help him use some closure in speech.

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Blowing exercises:-

Blowing exercises have been used more frequently than any other single device for strengthening the palate. Blowing takes air pressure, and if the air is to come out of the mouth, a velopharangeal opening will reduce that pressure enough to reduce the air flow through the mouth to a considerable degree.

Blowing exercises helps the patient to become mouth conscious, they can help him discriminate the two air flow channels; they can help him to increase the amount of oral air pressure needed for good articulations; and they can improve the contraction of the velar and pharyngeal muscles.

PALATOGRAMS

Palatograms are the area of tongue contact for a given sound displayed on an artificial palate through a medium of non scented talcum powder.

Pre-Requisites of Making a Palatogram

1. The artificial palate must be accurately adapted and refined so that it can be worn comfortably without an adhesive until speech is normal and natural. The subject who does not accommodate or who gags after a 15 minutes practice speaking period should not be used, because palatograms of faulty speech would be of dubious value and gagging makes palatography impossible.
2. The subject should be trained to pronounce the sound distinctly, and then to open his mouth with the tongue flat (out of contact with the palate) and not to attempt to swallow until after the palate is removed. Several trials should precede the making of the palatogram to ensure that the patient can pronounce the sound distinctly and immediately open his mouth without a gain contacting the palate with the tongue.
3. The tracing medium should not be distasteful in flavors or appearance and should be of a consistency that will permit ease of application and removes from the artificial palate. The colour of the medium should contrast with the palate sufficiently to display readily the area of tongue contact.
4. The palate must be dried thoroughly before dusting with talc, and care must be taken in inserting and removing the dusted palate to avoid finger contact, which would smudge the tracing. In pronouncing the phoneme, the moist tongue removes the talc from the contact area, leaving a clear tracing.

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A palatographic study of all the vowels revealed tongue palatal contact for all except 'O'. The similarity of the tongue contact area on the palatograms is because phenomes are usually composed of more than one phone and that each phone requires separate articulation. The phone with, occurs singly in pronouncing the vowel 'e' and is prevalent in a, i and u. It occurs as the initial sound in u (ee – o) and as the second sound of a and i (i-ee)

Consonants cannot be used in making palatograms, because the vowels included in the pronunciations involve tongue palatal contact, which would obscure the tracing of the articulation for the stop or affricative. Example: in pronouncing t and d, the occlusive articulations is made first followed by 'e', 'a' follows the

affricative articulations for J and the affricative articulation for K. In pronouncing S, n or l , the mid-vowel 'e' precedes the articulations for the sibilant s, the nasal n, or the lateral l. To make the palatographic study of consonantal articulation, the 'O' was used in conjunction with the consonant to be studied, even though the combination did not result in a standard English work as in pronouncing 'O', the tongue naturally drops back out of contact with the palate and flattens, making it easy for the subject to open his mouth with out raising the tongue.

PALATAL CONTOUR OF THE DENTURE

A few have recognized the importance of palatal contour of the denture for better phonation. **Snow, as early as 1899),** recommended restoring the anterior lingual alveolar area to improve phonetics, particularly the pronunciation of s & sh. **Prendergast (1935**) pointed out that proper thickening of the lingual alveolar area was important for proper speech.

Sears (1949) recommended making a palatogram on cases where the median sulcus of the tongue does not coincide with the midline of the palate. He recommended grooving the palate just above the median sulcus for the patient who had little or no tongue sulcus and thickening this area for the patient who had a deep tongue sulcus. **Pound (1951)** was successful in improving phonetics by contouring the entire lingual aspect of the maxillary denture to simulate the normal palate.

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Speech Tests

The phonetic aspect of denture construction at least deserves equal consideration with esthetics and mechanics and should be checked at the time of the waxed try in when it is possible to alter palatal contour to accommodate speech articulation. The trial denture evaluation should not be considered complete until a phonetic test has been made and enunciation proved satisfactory to both the patient and the operator.

Waxing of the palatal portions of the trial denture should be confined to the area adjacent to the teeth, with just enough wax added to ensure a smooth surface between the base tray and collars of the teeth. It is presumed that the base trays are comfortable, well adapted and approximate the tissues with nearly the same fidelity as anticipated for the completed denture bases. Before the speech tests are started, the mandibular trial denture should be secured with denture adhesive.

1. The first test is of random speech and is best accomplished by engaging the patient in conversation and obtaining a subjective speech analysis by asking the patient how the dentures feel, how his speech sounds to him, and which words seem most difficult to pronounce.
2. The second test is to specific speech sounds. This is best accomplished by having the patient pronounce six or eight words containing the sound and then combining these words into a sentence. The following is a list of the sounds to be tested; opposite the sounds are the words to be pronounced and a sentence composed of these words :-

s and sh	Six, sixty, ships, sailed, Mississippi, sure, sign, sun, shine.	Sixty-six ships sailed the Mississippi. Sure sign of sunshine
t, d, n, and l	Locator, located, tornado, near, Toledo	The locator located the tornado near Toledo.
Ch and j	Joe, Joyce, Joined, George, Charles, church	Joe and Joyce joined George and Charles at the church.
K	Committee, convened, political, convention, Connecticut	The committee convened at the political convention in Connecticut.
f and v	Vivacious, Vivian, lived, five, fifty-five, fifth, avenue	Vivacious Vivian lived at five fifty-five Fifth Avenue.

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In the third test, the patient is asked to read a short paragraph containing an abundance of s, sh, and ch sounds.

If the patient can complete the speech test distinctly, with no difficulty, and if his random speech satisfies him and the operator, it would be unwise to contour the palate to solve a speech problem that does not exist. If, however, problems are encountered in one or more of the areas tested, then palatal contour is indicated and can effectively be accomplished by palatography.

If the palate is to be altered, the entire palate should be contoured to accommodate tongue contact for all palatal consonants. This is best accomplished by systematically displaying each contact area with a palatogram and establishing normal tongue contact.

Palatography for Proper Palatal Contour

The only additional equipment necessary for palatography is some non-scented talc, in inexpensive soft bristle brush for dusting the talc on the palate, and a glass marking pencil to outline the contact area. Palatograms can be easily and quickly made on the trial denture if the following steps are recalled:-

1. Use o with the consonant to be studied, even though the combination is not a word; i.e., to study k, use ko; to study ch; use cho.
2. Train the patient to pronounce the sound and open the mouth without again contacting the palate.
3. Dry the palate thoroughly before dusting on non-scented talc (do not use regular or surgical talc) and shake off the excess powder.
4. Avoid touching dusted palate with the fingers during insertion, but ensure that the denture is well seated before the sound is pronounced.
5. Be sure the patient makes definite palatal contact in pronouncing the sound, but avoids palatal contact after opening the mouth.
6. Avoid contacting the palate with the fingers when removing the denture.
7. Outline the contact area with a wax carver where wax is present, and with a glass-marking pencil where the base tray is exposed.

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To avoid overlapping the tracing and recontouring one contact area to accommodate another, a sequence of palatograms should be followed, and waxing of the palate should be accomplished in steps. First, and s and sh palatograms are made and outlines on the base trays. Where wax is present, the palatogram is outlined with the carving end of the wax spatula; where the base tray is exposed, the outline is made with a glass marking pencil. Before waxing is commenced, the patterns for s and sh should be reviewed. The tongue contact for s is always higher and more anterior on the palate, so that the outline for the s palatogram is the high line and includes some of the anterior teeth, and the sh line is always lower and includes fewer anterior teeth. The sh line (low line) is used as a guide in waxing the posterior alveolar area, and the s line (high line) is used as guide in waxing the anterior alveolar area. The anterior portion of the sh tracing is not waxed until last. Waxing is started around the first molar by adding enough wax to provide a 1-mm margin at the collar. Next, the low tracing line on the palate is sighted directly below this tooth, and enough wax is added to the palate to permit an even contour between this line and the margin of the molar. Then wax is added around the anterior teeth delineated by the s tracing to provide a ½ mm margin at the collars. Enough wax is then added

between the tracing line and teeth to present an even contour. Waxing in the bicuspid area is accomplished by using the anterior and molar regions as a guide for adding wax around these teeth to complete for smooth, even contour between these waxed areas and the palatal tracing line. Waxing around the second molar consists of adding enough wax around this tooth to complete the contour between palatal tracing line and the waxed first molar area. After waxing on the other side of the palate is completed, a palatogram should be taken to cheek to contour. If the area is properly contoured, the tongue tracing line should be even and about 2mm above the original. If the tracing line rises abruptly in a specific area, that area is too thick and should be reduced until the tracing line is even. If the tracing line drops abruptly in a specific area, that area is not thick enough and additional wax will be needed to provide an even tracing. If the entire tracing rises markedly, the area has been over contoured and should be reduced.

The photographs of the waxing procedure are of a case with considerable alveolar ridge resorption, and using the palatogram to outline the area and waxing in steps as described should aid the beginner in establishing normal tongue contact for these cases. After some experience, the entire outlined areas can be waxed in one step.

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The palatogram can be used effectively for any case, including the immediate denture, if the pattern for normal tongue contact is kept in mind and if sensible observation is employed.

The line on the palate outlining the palatogram represents the lowest point of tongue contact in pronouncing s, and the area between this line and the artificial tooth should be of even contour and gradual slope without excessive convexity or concavity. The amount of wax needed to complete this contour is dependent upon the extent and degree of alveolar resorption, and wax should be added only where necessary to compensate for alveolar deficiency. Many times it is not necessary to add wax as far down as the tracing line to complete the contour, and sometimes, as in the case of slight resorption or the immediate denture, it is not necessary to add wax at all, because enough of the alveolar ridge remains to provide proper contour to the base tray.

After lateral tongue contact for s has been established on the trial denture, the speech tests should be repeated, and if speech is satisfactory, further contouring is

unnecessary. However, it is usually necessary to contour the anterior aspect of the palate to facilitate proper s pronunciation.

By using the palatogram to establish normal tongue blade contact in pronouncing s, appropriate portions of the lateral aspects of the anterior alveolar area are included in the contour, leaving only the region between the lateral contact areas to be considered. The area of this region, which is the most critical to proper s pronunciation, is the area midway between the lateral contacts and directly above the median sulcus of the tongue. In pronouncing s, the tongue contacts the alveolar area to occlude the lateral portion of the oral cavity and form a channel for the air stream between the median sulcus and the palate. This channel narrows to a groove at the tongue apex to constrict the air stream, so that is escapes as a hiss. Normally, this jet of air exits at the incisal edges of the teeth to be heard as the typical s, but on the denture, where tooth arrangement has been altered to accommodate mechanics and esthetics, it is usually necessary to provide a path of exit on the palate in the area directly above the groove in the tongue apex. This is best accomplished by inserting the trial denture and instructing the patient to pronounce ess (not so) and hold it so that the groove in the tongue apex can be observed. The chair should be tilted back and slightly raised so that the opertor can look up and into the oral cavity to determine the character of the groove and its proximity to the palate. It is the area directly above the groove that must be altered according to the fault in pronunciation. If the patient whistles and hisses when pronouncing s, the area between the groove and denture base is excessive and will need to be thickened. For the patient with a deep groove (this is common), a slight elevation is usually required. If the patient lisps (substitutes th for s or has a muffled, indistinct s, there is not enough space between the groove and the denture base, and the area will need to be thinned. If the groove in the tongue is broad and shallow, a depression in the denture base may be required, and if there is no groove in the tongue, a groove on the denture base directly above the median sulcus, as recommended by Sears, will be necessary. If the patient substitutes sh for s, the jet of air is probably escaping toward the vault and the area above the groove will need to be extended toward the tongue. This extension must be made with care, because overextension will occlude the air stream and etts will occlude the air stream and sh will be substituted for s.

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There is no simple way of correcting faulty s pronunciation. The fault must be analyzed the area contoured, and the sound tested, then reanalyzed, re-contoured, and retested until satisfactory pronunciation is attained. The words best suited for testing are short words containing the ess sound, such as “hess,” “guess,” “less,” “mess”.

The time required to correct an error in s pronunciation is time well spent, because it is the commonest and most persistent oral inaccuracy of the denture patient and the one that may remain as a characteristic denture whistle to belie the denture.

Proper palatal contour is the key to proper s pronunciation, or all other pronunciation for that matter, and that the palate can be contoured to accommodate phonetics for any sensible both arrangement, including the bizarre class II and severe class III jaw relation cases. There is little doubt that the character of the air stream directed between the upper and lower incisors in pronouncing s will be affected by the relationship of these teeth at the time of exit; therefore, it is possible to soften or sharpen the s by increasing or decreasing the amount of over jet. However, the direction of exit can be controlled by palatal contour to permit considerable leeway in anterior tooth arrangement and still provide good quality to this sound.

Contour of the anterior palate is completed by adding the minimum amount of wax between the low tracing line for sh and the lateral and mid-palatal contoured areas to make a smooth junction. Care should be taken not to thicken the lateral contact areas or alter the median contour. To ensure that enough wax was added to provide tongue contact for the occlusives t, d, and n, a palatogram of t, to should be made. After completing the anterior palatal contour, usually no further contouring is necessary, but the speech tests should be repeated with particular attention given to the pronunciation of ch and j, because occasionally, in contouring the mid anterior alveolar region, wax builds up on the palate below and will interfere with the pronunciation of these sounds. If this happens, a palatogram should be made for ch, cho to outline the area of tongue contact so that alteration can be confined to that area.

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The use of palatograms for contouring the entire alveolar area will be useful to those who adhere to the philosophy of placing the artificial teeth in the same relative position as the dentition. If the posterior teeth are arranged near the center of the alveolar ridge and the anterior teeth arranged to occupy approximately the same position as the originals, then a palatogram on the trial denture is an aid in contouring the palate for normal contact. If, however, the philosophy of arranging teeth according to mechanical advantage is adhered to, then the palatogram would be of limited value in contouring the posterior alveolar area, because the posterior teeth will occupy a position lingual to the center of the ridge on this denture. A palatogram of the s on the trial denture in this case would reveal limited tongue contact in the molar alveolar area, progressively increasing to normal contact in the anterior region,

and adding wax to simulate a natural alveolar contour in the molar area would be a grosser insult to phonetics then not adding wax to complete alveolar contour in this area on the denture with center of the ridge tooth arrangement. Phonetics is better served in these cases by keeping the posterior alveolar area as thin as possible and confining palatal contour to the anterior region. Thickening the vault to narrow the channel for the air stream, facilities s pronunciation in this type of denture, but before wax is added to the vault, a palatogram of k, ko should be made to delineate the area of posterior palatal tongue contact so that this area can be excluded from the waxing.

Satisfactory phonetics can be accomplished with a constricted posterior tooth arrangement so long as the anterior teeth are arranged to permit normal palatal contact. However, if the anterior teeth are arranged lingual to the natural tooth position, they will interfere with the tongue in making palatal contact and impede or occlude the air stream after contact has been made in pronouncing s. For this reason, in cases with severe resorption, where the anterior ridge affords no clue to natural tooth position, a palatogram can advantageously be used in arranging the teeth to ensure that tongue palatal contact is not jeopardized. Considerably more leeway is permitted in arranging teeth toward the labial, because tongue contact is unhampered and the palate can be contoured to accommodate the arrangement.

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CONCLUSION

Speech difficulties as sequelae of oral rehabilitation with complete dentures are generally a transient problem. When encountered the difficulties may not be easily solved. Therefore efforts should be made to avoid them by pretreatment records or assessment of speech and provision of information to patients about likely initial deviation from normal speech, immediately following oral rehabilitation. If persistent difficulties to pronounce certain sounds or other speech disorders persist for more than 2 to 4 weeks, the following protocol is recommended –

1. If the patient has the previous complete denture experience, compare the new set with the old one to diagnose possible design differences of significance for speech production.
2. Make the necessary modifications; soft wax might be helpful.
3. Have the patient's hearing checked. An auditory deficit will prolong the adaptation period and render it more difficult.
4. If the reported/ perceived problem cannot be resolved by dental methods, the patient should be referred to speech pathologist.

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In the past speech therapist have been expected to undertake the diagnosis as well as the management of ones who suffer from speech disorders. Yet a high proportion of children or people referred to speech therapist suffer from diseases which directly affect the structure and function of lips, tongue and palate, or they suffer from conditions which are the primary causes of their speech difficulties, e.g. Mental defect or hearing loss, many show psychiatric abnormalities which may be primary or secondary to their speech defect.

Therefore it is important that the assessment of the person should be regarded as one that merits a team approach, though the team may differ in content according to the nature of the child disability – with the speech therapist as the constant member of the team.

In maxillofacial prosthetics, the clinician may have responsibility of reestablishing velopharyngeal integrity to provide the potential for acceptable speech.

The largest group of patients with defective speech is the patients with congenital clefts of the soft palate. Most acquired soft palatal defects result from

surgical resection of neoplastic disease/ trauma. Prosthodontist play an important role in restoring speech in these patients by giving palatal; lift prostheses.

Not only the face but speech also reflects an individual's inner being. Any abnormality or defect in the same can affect his/ her psychology and social behavior. Hence a prosthodontist play a pivotal role in understanding the basic mechanisms involved in the various speech pathology and provide prudent treatment for the same to enhance an individuals personality.

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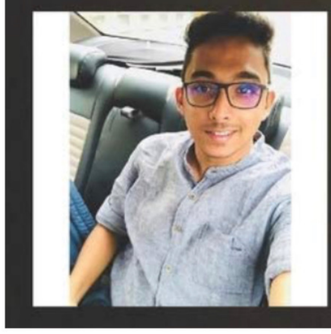
Back

ADVANCED DIAGNOSTIC AIDS IN IMPLANT DENTISTRY

Dr. Faisal Sultan

The ideal goal of diagnostic procedures is the earliest possible identification of the disease process. Conventional efforts evaluating inflammation and past evidence of tissue breakdown remain the standard for disease evaluation. However, evaluation cannot reliably identify sites with ongoing periodontal destruction and does not provide any information of the cause of the condition and the patient's susceptibility to the disease, whether the disease is progressing, or is in remission or whether the response to the therapy will be positive or negative. This is an aid to clinical decision-making, done on patients who are symptomatic and is usually more expensive and can carry more risks than screening tests. Diagnostic tests are also done after a positive screening test to establish a definitive diagnosis and are often called confirmatory tests.



Dr. Faisal Sultan is a practicing periodontist and implantologist in India. Completed his undergraduate in the year 2016 from kerala. and masters in periodontics from Mumbai. He is practising since 2016 and has a well established practice in Kerala, south of India.

Dr. Dr. Faisal Sultan
Author

Dr. Nilesh V Joshi
Author

Dr. Varsha J Rathod
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When Fixed Meets Removable: Custom porcelain crown to enhance esthetics in cast partial denture

Dr. Sumit Bedia

Bharati Vidyapeeth Dental College & Hospital, Navi Mumbai

Introduction: With an increase in demand for esthetics, emphasis must be given to proper selection of teeth being replaced while fabricating any dental prosthesis and removable partial dentures are no exception. While fabricating cast partial dentures, resin teeth are routinely used because of their inherent advantages. However, resin teeth when used to replace anterior single tooth edentulous space may frequently pose problem in shade matching with adjacent natural or restored artificial teeth. This necessitates characterization, the results of which may not be predictable and long-lasting. Use of porcelain denture teeth too do not seem to be a viable option in such cases as these are available in specific shades, are difficult to grind and adjust, are costly and their retention to denture base is always a problem. Further, most of the alloys routinely used for cast partial denture framework fabrication such as cobalt-chromium alloys, exhibit poor bond characteristics with porcelain unless a metal conditioner is applied which increases overall cost.

Methodology: This clinical report describes an innovative technique of using a fixed custom porcelain-fused-to-metal crown (PFM) as a part of removable cast partial denture to match with shade and appearance of adjacent multiple PFM restorations.

Result: NA

Conclusion: This simple and predictable technique can help overcome the problem of shade mismatch which may exist between stock resin tooth of partial denture and adjacent porcelain restorations and it does not require any special armamentarium.

DOI: 10.4103/0972-4052.306389

End

Neha Kawale and 2 more

Calculus: Textbook of Periodontics

Neha Kawale
Varsha Rathod
Anupa Shetty

Calculus

Textbook of Periodontics

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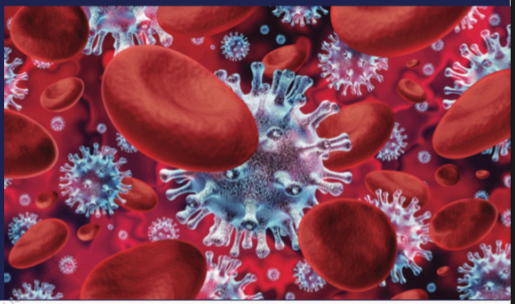
The biological concepts of wound healing, the type and stages of wound healing along with the process of healing and its complications related to the oral periodontium is well explained in this book. Concept of wound healing is well explained at both histological and clinical levels. It also includes healing following various periodontal procedures and recent advancements to accelerate the rate of healing process in periodontology.



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Dr. Aishwarya Udawant is a M.D.S. in Periodontology & Oral Implantology. She did her graduation from Dr. D.Y. Patil Dental College & Hospital and post graduation from Bharati Vidyapeeth Dental College & Hospital. She has a bright academic carrier throughout. She has also participated and presented many research papers in national conferences.

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Aishwarya Udawant
Varsha Rathod

Wound Healing In Periodontology

Biological Concepts & Recent Advances

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Gingival crevicular fluid (GCF) is defined as the tissue fluid that seeps through the
crevicular and junctional epithelium. Many studies on gingival crevicular fluid extend over a period of about 50 years, however its presence is known since 19th century. With so much research now available, it is obvious that GCF provides a unique window for analysis of periodontal condition. The book aims to discuss the clinical significance of GCF, its constituents & methods of collection & processing. The author hopes to guide the readers to understand the role of GCF influencing periodontal health status.

Dr. Divyangana Vashi is a postgraduate dental student, specializing in the field of Periodontology and implant Dentistry. Her keen interest in the field of clinical research led her to pursue the following topic as her library dissertation for fulfillment of her degree of Master of Dental Surgery.

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Vashi, Talreja, Rathod

Divyangana Vashi
Prakash Talreja
Varsha Rathod

Gingival Crevicular Fluid

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Knowledge of the biology of the pulp and dentin, coupled with an understanding of the materials and techniques applied to tissues, will provide a sound basis for restorative dentistry. Such knowledge will make it possible for the dentist to select materials and methods that will produce no or favorable reactions in the tissues to optimally conserve damaged teeth. It should also provide opportunities for new biologic approaches to restorative dentistry. Thus, any commonly used procedures in restorative dentistry endanger health of pulpal & peri radicular tissues more than the disease processes they are intended to correct. These procedures will contribute to reversible & irreversible changes or alterations in the dental structures. The diversity & complexity of these tissues compel us to think how to avoid this and what effect it will have on the pulp & the peri radicular tissues. To optimally achieve this goal, clinicians working with dentin and pulp must have detailed knowledge of normal tooth structure; age-related changes; tissue responses to caries, trauma, and restorative procedures; and the effect of the application of different agents and materials on the tissues.

I have completed my BDS from YCMM & RDF's Dental College and Hospital, Ahmednagar in 2013 and did my internship programme in Government Dental College and Hospital, Mumbai in 2014. Currently Iam pursuing my masters in Conservative Dentistry and Endodontics from Bharati Vidyapeeth Dental college and Hospital, Navi Mumbai.

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Nair, Patil, Jain

Sreeja Nair
Amit Patil
Ashish Jain

Biologic Consideration during Tooth preparation in Operative Procedures

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The aim of developing computer controlled production technologies for use in restorative dentistry is to improve the quality of the construction units and at the same time to lower manufacturing costs by simplifying the method and reducing the production time. Many different computer systems have already been discussed in the literature for dental applications and have also to some extent been used clinically. The computer assisted systems known today differ mainly with regard to the type of three-dimensional data recording system used to image the prepared tooth. In contrast, the automatic manufacturing (CAM) of the pieces is quite similar and consists mainly of a numerically controlled (NC) machine with a material specific milling unit that can be moved in multiple axes in relationship to the piece being worked on.The use of computer technology is justifiable only if computer assisted design (CAD) and computer assisted manufacturing (CAM) produce dental reconstructions that fulfill or improve existing material characteristics and/or clinical quality.

I have completed my BDS from CDCRI,Chhattisgarh in 2009 and currently pursuing my masters in Conservative Dentistry & Endodontics from Bharati Vidya Peeth Dental College &Hospital, Navi Mumbai.

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CAD CAM in Restorative Dentistry

Agrawal, Mali, Jain

Sonal Agrawal
Sheetal Mali
Ashish Jain

CAD CAM in Restorative Dentistry

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The trend toward a heightened awareness of esthetics has challenged dentistry to look at dental esthetics in a more organized and systematic manner, so that the health of patients and their teeth is still the most important underlying objective. But some existing dentitions simply cannot be restored to a more pleasing appearance without the assistance of several different dental disciplines. Today, every dental practitioner must have a thorough understanding of the roles of these various disciplines in producing an esthetic makeover, with the most conservative and biologically sound interdisciplinary treatment plan possible.
This book will brief about approaches towards achieving good and healthy smile.

An enthusiastic periodontist and implatologist, searching the solutions for better oral health and learning the new paradigm of dentistry.

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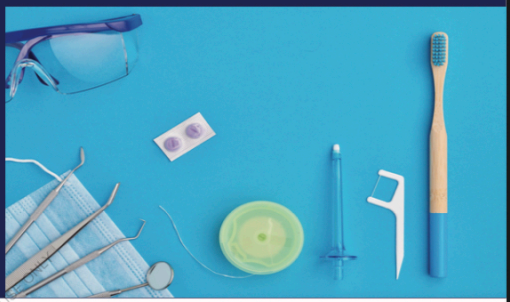
perioesthetics



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Neelam Mishra
Prajakta Rao
Varsha Rathod

Perioesthetic

The team approach to better and healthy smile

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Mishra, Rao, Rathod

With the evolution and advancements in dental science, various new techniques and methods for the replacement of missing teeth have come into foray. Replacement of missing teeth with dental implants have now become the most sought-after treatment modality. Implant overdentures are increasingly used as a viable option to restore edentulous patients and mandibular overdenture has been advocated as a minimum standard of care for such patients, especially in developed nations. Compared with conventional removable dentures, the implant overdenture prostheses offers increased longevity, improved function, bone preservation, and better psychologic results. This book provides an overview on the various techniques and attachments that are available for implant supported overdentures.

Dr Shruti Sai is currently pursuing her Master in Dental Surgery in Prosthodontics at Bharati Vidyapeeth Deemed to be University Dental College and Hospital, Navi Mumbai, India. She has presented many scientific papers in various conferences. Her keen interests are implant and fixed prosthodontics and has an indination towards academics.

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Implant Supported Overdentures

Saisubramanian, Bedia, Ghadage

Shruti Saisubramanian
Sumit Bedia
Mahesh Ghadage

Implant Supported Overdentures

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The concepts of biomedical engineering principles which are applied to the living systems has unfolded a new era in the diagnosis, treatment planning & rehabilitation of patients. One such aspect of this field is the "Biomechanics" which concerns with the response of biological tissues to the applied loads. It uses the tools and methods of applied engineering mechanics to search for a structure-function relationship in the living system. Advancements in prosthetic implant and instrumentation design have been evolved due to the mechanical design optimization theory and practice. This book attempts to provide with the fundamental concepts and principles of dental biomechanics as they relate to long-term success of dental implants and their restorative procedures.

Dr. Akshaya Ambokar is a third year postgraduate student at Bharati Vidyapeeth Dental College and Hospital, Navi Mumbai in the department of Prosthodontics. She has completed her BDS from prestigious Nair Hospital Dental College, Mumbai.

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Ambokar, Shetty, Ghadage

Dr. Akshaya Ambokar
Dr. Uttam Shetty
Dr. Mahesh Ghadage

BIOMECHANICS IN IMPLANTOLOGY

A BEGINNER'S KEY

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3.4.6 Number of books and chapters in edited volumes published per teacher during the year

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication	ISBN/ISSN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
1	Dr. Mamata Kamat	**NA**	Bilateral Orthokeratinized Odontogenic Cyst (OOC) associated with Impacted Teeth: A Critical Appraisal of a Distinct Entity	**NA**	International Conference for Dental Research Presentations 2020	National	**NA**	**NA**	**BVDU, Dental College & Hospital, Sangli**	**NA**
2	Dr. Uma Datar	**NA**	A Case Report of Oral Carcinoma Cuniculatum a Rare Clinicopathological Variant of Oral Squamous Cell Carcinoma	**NA**	International Conference for Dental Research Presentations 2020	National	**NA**	**NA**	**BVDU, Dental College & Hospital, Sangli**	**NA**
3	Dr. Madhuri Sale	**NA**	Third Dimension In Oral Histopathology: A Review	**NA**	International Conference for Dental Research Presentations 2020	National	**NA**	**NA**	**BVDU, Dental College & Hospital, Sangli**	**NA**

4	Dr. Mokshada Badadare	**NA**	Awareness of Virtual Realites Simulators in Dental Education- A Cross Sectional Survey	**NA**	48th IPS National Virtual Conference 2020 Nagpur	National	**NA**	**NA**	**BVDU, Dental College & Hospital, Sangli**	**NA**
5	Dr. Mamata Kamat	**NA**	Molecular Grading of OSCC & its Surgical Margins Future Prospects	**NA**	Pushpagiri College of Dental Sciences, Kerala	National	**NA**	**NA**	**BVDU, Dental College & Hospital, Sangli**	**NA**
6	Dr. Someshwar Golgire	**NA**	Syndromic Vrs Nonsyndromic OKC Case Reports	**NA**	Pushpagiri College of Dental Sciences, Kerala	National	**NA**	**NA**	**BVDU, Dental College & Hospital, Sangli**	**NA**
7	Dr. Bhagyashri Mirajkar	Nonvital open apex Basic Concepts, Materials and Techniques Employed For Its Management	**NA**	**NA**	**NA**	National	Nov-20	978-620-3-02464-7	BVDU,Dental College & Hospital, Sangli	LAP LAMBERT Academic Publishing

8	Dr. Dipali Deshpande	Endodontic Radiology Diagnostic tools, principles and Clinical interpretation	**NA**	**NA**	**NA**	National	Nov-20	978-620-2-92029-2	BVDU,Dental College & Hospital, Sangli	Lambert Academic Publishing
9	Dr. Mamata Kamat	Epithelial Mesenchymal Transition in Oral Squamous Cell Carcinoma	**NA**	**NA**	**NA**	National	Nov-20	978-620-3-19287-2	BVDU,Dental College & Hospital, Sangli	Publishing house: LAP LAMBERT Academic Publishing
10	Dr.Someshwar Golgire Dr. Shraddha Shetti	Forensic Odontology	**NA**	**NA**	**NA**	National	May-21	978-620-3-857061	BVDU,Dental College & Hospital, Sangli	Lambert Academic Publishing
11	Dr. Shraddha Shetti Dr.Someshwar Golgire	Genetics in Orthodontics	**NA**	**NA**	**NA**	National	May-21	978-620-3-861716	BVDU,Dental College & Hospital, Sangli	Lambert Academic Publishing
12	Dr. Dilip Magdum	Connective tissue alterations in oral mucosa lesions	**NA**	**NA**	**NA**	National	May-21	978-620-3-923148	BVDU,Dental College & Hospital, Sangli	Lambert Academic Publishing

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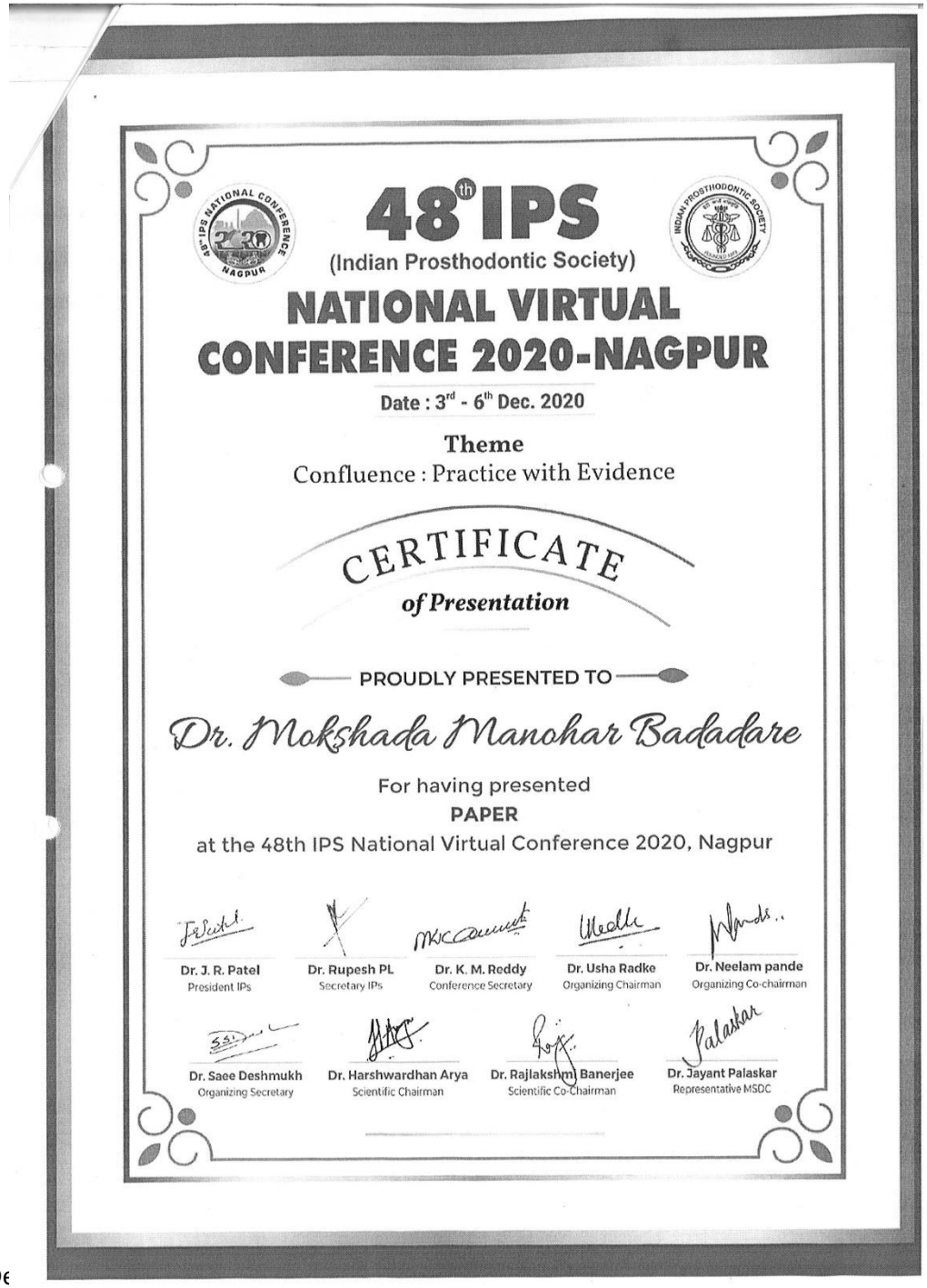

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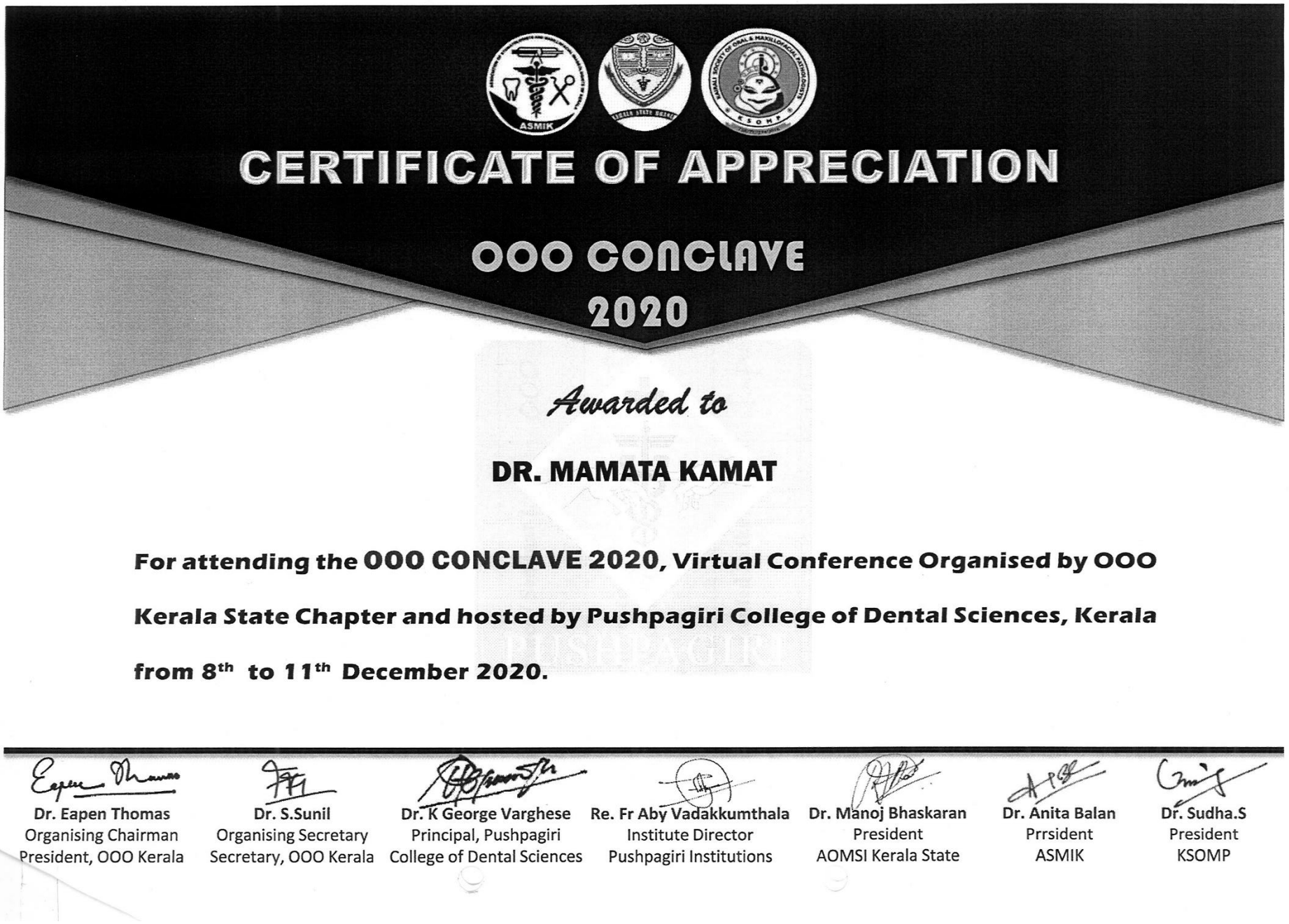
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Oral squamous cell carcinoma is one of the leading cancers of the oral cavity that involves a complex pathogenesis. Epithelial Mesenchymal Transition (EMT) is suggested to play a significant role during cancer progression and metastasis. EMT markers are used in oral cancer to identify tumor invasion and metastasis. This book emphasizes the various mechanisms of EMT along with various molecules involved in EMT and aims to facilitate the readers to acquire a sound knowledge on the process of EMT.

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Mamata Kamat
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Rudrayya. S. Puranik

Epithelial Mesenchymal Transition in Oral Squamous Cell Carcinoma

Dr. Mamata Kamat graduated from SDM college of dental sciences, Dharwad and postgraduation in the speciality of Oral Pathology and Microbiology from PMNM Dental College and Hospital, Bagalkot. Currently she is working as associate Professor at Bharati Vidyapeeth (Deemed To be University) Dental College and Hospital, Sangli and pursuing Ph.D.

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The book of Forensic odontology has been written to simplify the understanding of the forensic science which is a vital instrument for the detection or investigation of crime and the administration of justice, providing crucial information about the evidence found at crime scene, it is especially important that the training and education of forensic scientists provide a solid scientific background and a broad base in criminalistics. An attempt has been made to explain the concept of forensic odontology in simple language and simplest possible terms. . Awareness and applicability of Forensic Odontology in the Indian Defence Forces would be of great help for better and accurate record keeping of the dedicated and vigilant warriors of our army. These records will be of great help for easy recognition of our army men at the time of calamities, wars, and other difficulties. It would also be useful in the identification of terrorists who our country and travel easily in disguise.

Forensic Odontology

FOR AUTHOR U

Dr. Someshwar Golgire, Associate Professor in the department of Oral Pathology and Microbiology, Bharati Vidyapeeth (Deemed to be) University Dental College and Hospital Sangli. He has several national and international publications to his credit and has a keen interest in Forensic Odontology.

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Someshwar Golgire
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Forensic Odontology

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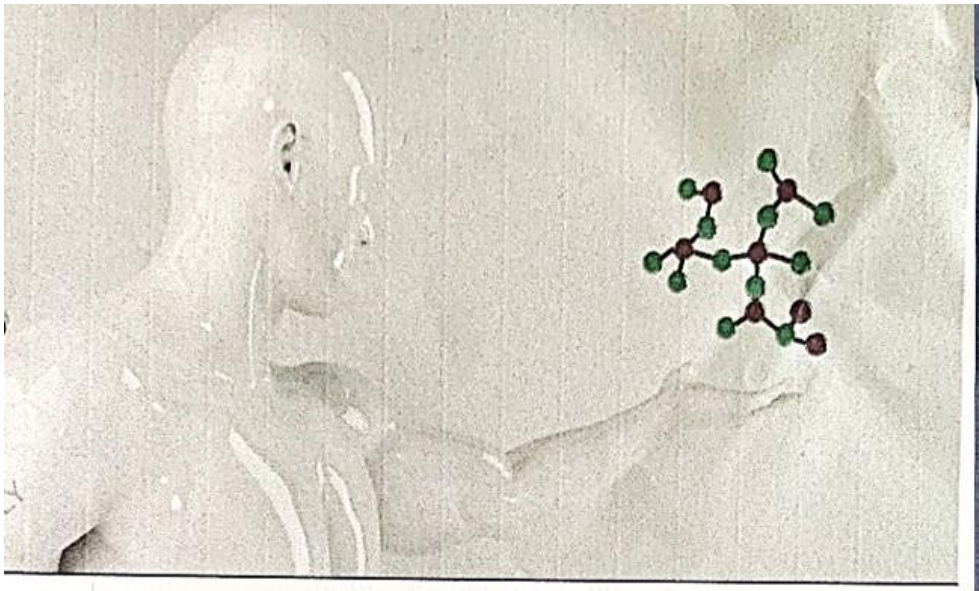

Shraddha Shetti-Golgire
Someshwar Golgire

Genetics in Orthodontics

An Overview

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The book of Genetics in Orthodontics has been written to simplify the understanding of the Role of Genetics in Orthodontics. Tools from genetics and applied translational research will permit precision Orthodontics. During the past 20 years, significant advancements in understanding the genomic basis of craniofacial development and the gene variants associated with dentofacial deformities have resulted in a convergence of the principles and concepts in genetics and in Orthodontics that will lead to significant advancement of Orthodontic treatments. A modern genomic basis will establish major improvements in the treatment of malocclusion and dentofacial deformities as well as many other areas of concern to Orthodontists through the assessment of gene variants on a patient-by-patient basis. This book will help the readers to understand the new concepts of Genetics which have been introduced in the field of Orthodontics.

Dr. Shraddha Shetti-Golgire has completed master in Orthodontics and Dentofacial Orthopedics as well as laser therapist She has interest in genetic basis of Orthodontics.

9 786203 861716

Connective tissue permits almost every part of the body, providing intimate support for blood vessels and nerves of all sizes. It is also the usual arena for the process of inflammation, which commonly occurs when some part of body is invaded by pathogenic micro-organisms. One of the most obvious roles is to hold together and nourish the other tissues of the body. It is able to carry out these functions because it produces relatively abundant amounts of intercellular substances.

Dr. Dilip B. Magdum is Professor and Head, Department of Oral and Maxillofacial Patholgy at Bharati Vidyapeeth Dental College and Hospital, Sangli. He completed his MDS(Oral and Maxillofacial Pathology)in 2004 from Nair Hospital Dental College, Mumbai. He was also EC member of faculty of Dentistry in BharatiVidyapeeth deemed to be university,Pune

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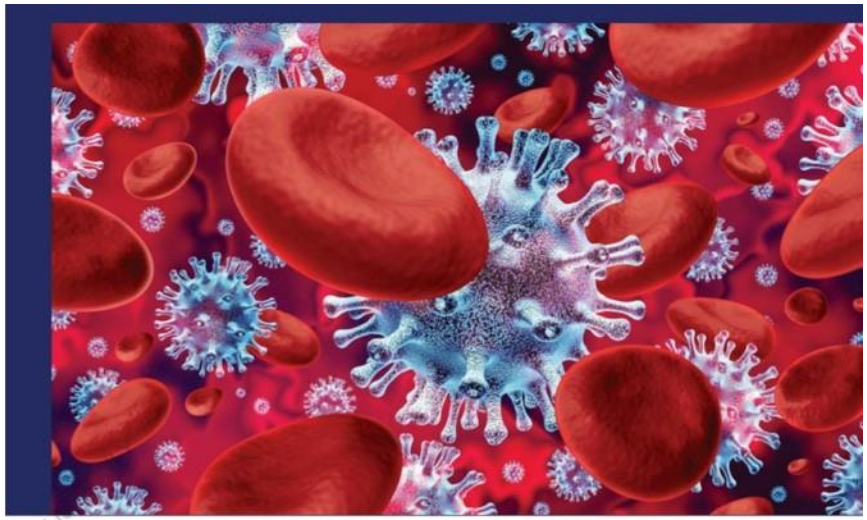

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Connective tissue alterations in oral mucosa lesions.

An overview

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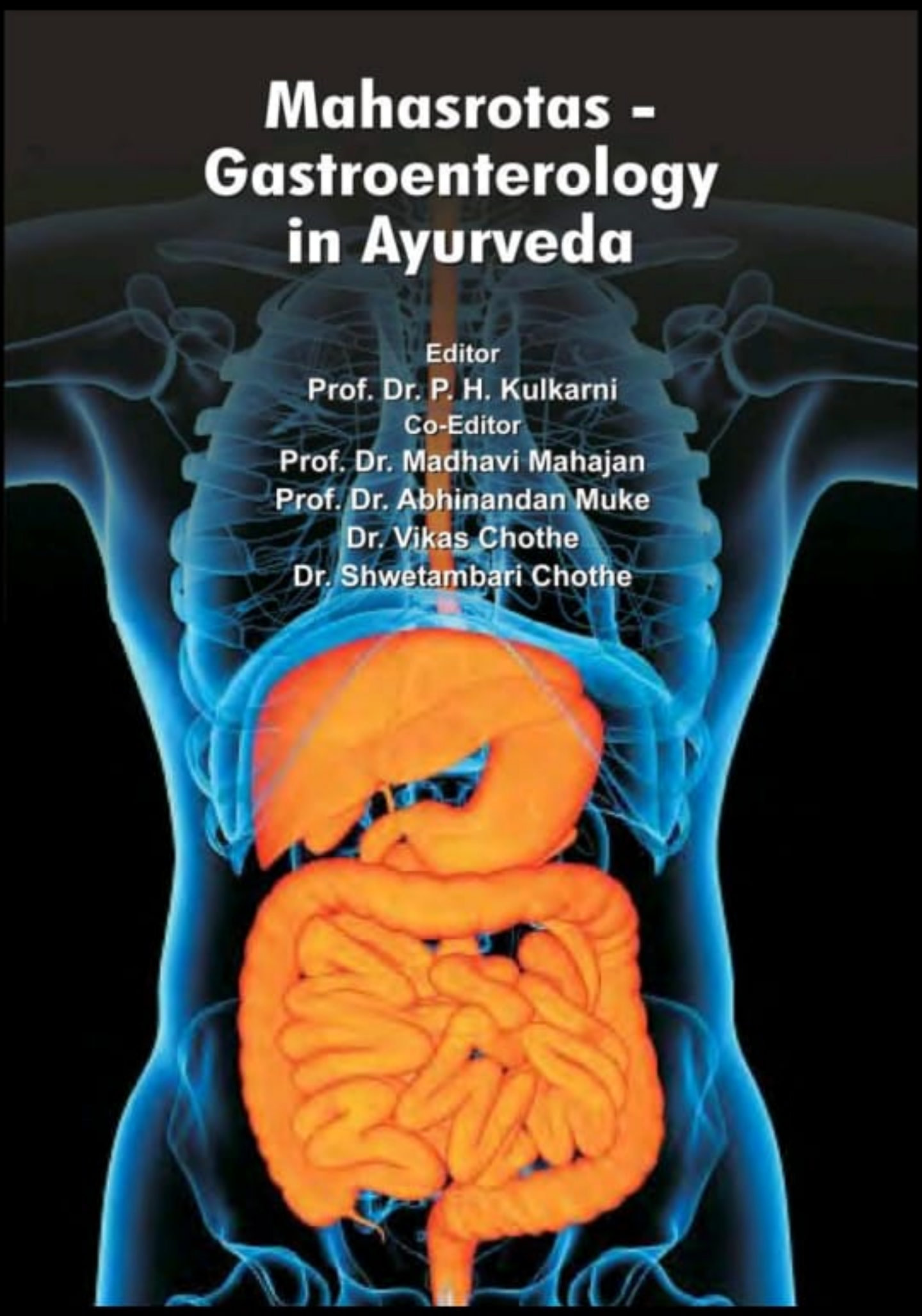

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  2) Effect of Time factor on Health (Co-author)
  3) Concept of Trividh Bala w.r.t. Yuktikrut Bala (Co-author)
  Lambert Edu. Publication, Germany 2013.

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वैद्य सचिन कुलकर्णी

मनकर्णिका पब्लिकेशन

ARTICLE "Comprehending Viral Diseases with Sushruta's Insight"

By Dr. Mrs. Madhuri P. Bhide

Covid 19 Pandemic has collapsed all the economic stability as well as wobbled the medical field. How the tiny and microscopic virus has done as much disaster and harassed the world? When the whole world is questioned and unanswered What our time tested and righteous Ayurved opines about it?

Sushrut the master Surgeon has quoted about the tiny organisms which may harm the mankind in his special chapter "Amanush Upasarga Pratishedh Adhyay" (Ref. Sushrut Samhita Uttartantra 60/3). 'Amaush Upasarga' means the diseases caused due to the organisms or other factors such as undue and erroneous force of planets. In such Agantuk disease (external factors) there is no acute role of any human being of consuming 'Apathya Ahar-Vihar'. The commentrator of Sushruta ,Dalhan explains microorganisms as 'Amanushani- Bhutani'.

These are termed as "Rakshasaha ,Nishacharaha, Makshikaha" which destruct the tissues and cause disaster in the body. Specially Sushrut has warned a doctor to avoid the contact of these infections from the wounds as wounds are open and organisms get easy entry in body.

निशाचरेभ्यो रक्ष्यस्तु नित्यमेव क्षतातुरः | Su U. 60/3

Sushrut has explained how they enter in body and person gets infected.

यथा देहं च देहधृक् ।

विशन्ति च न दृश्यन्ते ग्रहास्तद्वच्छरीरिणम् ।।१९।।

Su U 60/19

The way how suksma and invisible soul enters in body, these micro-organisms enter silently and we do not know when we get infected.

As we know virus are innumerate, Sushrut says they are crores and crores so there is no need to name them. Swine flu virus, corona virus, saars, british virus and so on …….many many more to arrive worldwide even with their mutations.

तेषां ग्रहाणां परिचारका ये कोटीसहस्रायुतपद्मसङ्ख्याः ।

असृग्वसामांसभुजः सुभीमा निशाविहाराश्च तमाविशन्ति ।।२२।।

Su U 60/22

All these viruses are called as "Bhima" and "Atyarth Bhayankar" means the dreadful. The bhutas provoka tridoshas and act as poison and suddenly create diseases.

वैद्यातुरौ निहन्युस्ते ध्रुवं क्रुद्धा महौजसः ।।५५।।

Su U 60/ 54

These can create a dreadful situation and hence doctor should be competent and well equipped.

How to prevent their entry in the body and how to repel them ?

Now a days we use sanitizers and disinfectants ,Sushrut has advised some effective measures for it.

सर्षपारिष्टपत्राभ्यां सर्पिषा लवणेन च ।

द्विरह्नः कारयेद्धूपं दशरात्रमतन्द्रितः Su Su 19/28

Burn the Mustard seeds, Neem leaves, Saindhav salt and cow ghee and make Dhupan twice a day without any fail for 10 days. The dhupan is called as 'Rakshoghna vidhi' and repels the Small organisms. Due to fumigation the rakshas or bhuta become Hatoujas it means they become inactive or their liveliness becomes less. Thus, this bhutas not only merely get repelled but also become Inactive to increase doshas in the wounded patient.

All the world is facing disaster of severe viral infections but as we have come across to the fact that its response to everyone is different.

Many of the patients who had suffered from common cold and fever due to the seasonal changes but all had not faced respiratory arrest. A very few of them that is only ten percent have been faced morbid situation. It is the basic query that why`` immunoresponce of each person is different?

1) According to Sushruta, the 'Atmavan' person who undergoes ideal diet, has equilibrium of doshas and whose dhatus are in healthy condition may suffer from common cold or fever due to the doshavriddhi but can repel the viral infection without any major fatal problem like respiratory distress.

सर्व एव व्रणाः क्षिप्रं संरोहन्त्यात्मवतां सुभिषग्भिश्चोपक्रान्ताः;

अनात्मवतामज्ञैश्चोपक्रान्ताः प्रदुष्यन्ति, प्रवृद्धत्वाद्दोषाणाम् ।।

Sushrut has wisely advised that those people who are "Atmavan "will get the wounds fast cured without any suppuration or complications due to healthy tissues but those with "Pravriddha doshas" take a long time to heal though treated by a great physician and with potent medicines. Though he exemplifies about the wound this phenomenon is applicable to other diseases also.

Atidoshakar ahar leads to suppuration of the wound.

Sushruta refers to the Hitakar Ahar quoted by him.

हिताहितीये यच्चोक्तं नित्यमेव समाचरेत् ।

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Virtual International Conference On Recent Advances & Challenges in Sports Rehabilitation

5th June to 7th June 2021

Background: Smartphones are a very popular and useful devices. There is an ever-increasing use of smartphone in the young population allowing everyone to access the internet, social communication & to entertain themselves anytime anywhere. But over smart phone use can also be related to some somatic complaints, anxiety, depression, stress, insomnia and increasing loneliness. Thus, the current study aims to study the relation between smart phone addiction and anxiety.

Methodology: 30 young adults (18-25 yrs age, 14 females and 16 males) agreed to participate in the study. Demographic details, smartphones addiction scale – short version (SAS-SV) and Hamilton's anxiety scale (HAM-A) were filled via an online questionnaire, to assess the level of smartphone addiction and severity of anxiety.

Result: This study showed that the young adults with mean age 21.55(1.29), have a mean 16.89(9.07) on HAM-A and a mean of 31.7(11.21) on SAS-SV. The correlation between SAS-SV and HAM-A is 0.324. The study showed that 73.4% are high user of smartphones (total score of 25 or above) and 16% of our subjects fall into the category of "moderate level of anxiety" individuals (having total score 18-24) 24% fall into the category of "highly severe level of anxiety" (total score of 24 or above).

Conclusion: The current study shows that smartphone overuse is moderately responsible for increasing anxiety among the participants. As young adults need to develop their skills & knowledge to be competent professionals, they should use smartphones appropriately and be cautious about the negative effects of phone addiction on anxiety.

P-10

Holistic Outlook of Traditional Medicine in Sports

Pooja Raj[1], Ravindra Patwardhan[1], Kirti Bhati[1]

[1]Department of Swasthavritta and Yoga, Bharati Vidyapeeth (Deemed to be University) College of Ayurved, Pune, Maharashtra, India

Background: In ancient vedic era, sports was adressed as "krida" (playing, skipping) and "vyayama" (toughening up, physical exercise) for "exercise" and this demonstrates the ayurvedic principle of balance as too much activity creates imbalance as much as too little.Vyayama (exercise) helps to get rid of heaviness and stiffness of the body as it burns Ama (digestion impurities) and creates more flexibility, lightness, smoothness and easiness which are three pillers of fittness.Sports medicine has two goals to achieve, primarily physical and mental fitness and second goal is treating the sporting injuries of the sportsman. Ayurved can help to achieve both of them through Panchakarma, yoga, Rasayana, Marma Chikitsa etc and herbs which add extra healing edge to the body injuries. Discipline is a bridge between goals & accomplishment which is very important for any sports person and these rules are explained well in Dincharya, Rtucharya and Ratricharya.

Purpose: The present paper intends, in the above context, to identify the possible contribution of Ayurved in the field of sports medicine.The aim of this review is to bring the ayurvedic outlook with various treatment modalities into limelight & factuall research evidence validating it.

Methodology: Traditional Medicine recommendations for prevention & curation of injuries in sports were rationally reviewed in light of published information from several scientific articles & literature

review from Vedic texts were taken into systemic review study.

Conclusion: Ayurvedic therapy with new modern technology in sports if used together,can enhance performance, physical fitness and assist in various sport injuries with several concepts in Ayurveda & rules & regimens for healthy living as a goal for a sports person.

P-11

Importance of Yoga in our Daily Life

Sajad Ahmad Dar[1], Vivek Gulhane[2]

[1]Sant Gadge Baba Amravati University, Amravati, Maharashtra, India
2P.G. Jain Arts College Ansing, Washim, Maharashtra, India

It is rightly said that if we want to maintain a balance between oneself and environment then yoga is necessary for every human. We can't deny the fact that since ancient times in India yoga is being practiced. The 'yoga' word is derived from the Sanskrit which means 'to join or to unite'. Exercises of yoga have a physical effect and also bring a balance between body, soul and mind. Several years ago, sages analysed nature and cosmos through meditation. It is rightly said that if we want to maintain a balance between oneself and environment then yoga is necessary for every human. We can't deny the fact that since ancient times in India yoga is being practiced. The 'yoga' word is derived from the Sanskrit which means 'to join or to unite'. Exercises of yoga have a physical effect and also bring a balance between body, soul and mind. Several years ago, sages analysed nature and cosmos through meditation. Yoga can be practiced in any age it is suitable for people of all ages and requires no 'stunt' skills. It should be included in our daily life. Path of self-knowledge and self-realisation can be attained via positive thinking, perseverance, discipline, right orientation, prayer as well as humble and kindness. The importance of life is the health of our body. If health is not good then we will not be able to achieve our goals or will not remain happy. It is rightly said that "Health is not everything, but without health everything is nothing.

P-12

Effect of Moderate Intensity Resistance Training with Blood flow restriction On Muscle Strength and Girth in Young Adults – A Randomized Control Trial

Tanya Gujral

Noida International University, Greater Noida, Uttar Pradesh, India

Objective: To examine the effects of moderate intensity resistance training with blood flow restriction on muscle strength & forearm girth.

Method: Total of 39 students enrolled in this study were divided into three groups that is group A (control group), group B and group C. Group A performed exercise training without restrictive pressure, group B & C performed exercise training with 50mmHg and 75mmHg respectively. Both the outcome measures were evaluated on day1 and day 12th with the help of digital dynamometer and measuring tape.

Results: Repeated measure ANOVA with Post hoc analysis was done using SPSS software version 20. The result of the study showed significant ($p \leq 0.05$) within subject improvement in muscle strength and muscle girth in all the three groups. However, there was significant improvement in muscle strength was found in between group analysis ($p \leq 0.05$).

Conclusion: The results of the study can be concluded as the partial blood flow restriction (50mmHg)

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ORAL PRESENTATION (JUNIOR CATEGORY) ABSTRACT

OJC 1

To Assess and Correlate Heart Rate Variability, Resting Heart Rate and Body Composition in Judo and Wushu Players

Sapna Yadav[1], Gaurav Kadyan[1]

[1]Department of Physiotherapy, Indian Spinal Injury Center, New Delhi, India

Background: Adequate In any combat sport, where competitors are divided by weight classes, optimal body composition is a major concern. Thus, athletes attempt to maximize the amount of lean tissue, minimize the amount of body fat, and minimize total bodyweight. Monitoring the status of the autonomic nervous system (ANS) via the measures of heart rate (HR), including the variability of HR and HR at rest can be used to understand the physiological state of body.

Purpose: This study aims to assess and Correlate Heart rate Variability, Resting Heart rate and Body composition and HRV in judo and wushu players.

Materials and Methods: Subjects were divided into 2 groups i.e., Judo and Wushu group containing 20 players each. Age (19.85±1.805), height (171.37±5.98), Weight (72.87±11.8), BMI (24.77±3.56). Anthropometric profiling was done with the help of Harpenden calliper and measuring tape to measure the skinfold thickness and body circumference respectively. HRV recordings were taken with the help of Heartwear shimmer ECG device in sitting position in a quiet environment.

Result: Subjects showed significant negative correlation of Resting heart rate with HF, BMI showed significant positive correlation with LF/HF, whereas Body fat % showed significant positive correlation with LF/HF.

Conclusion: There is significant negative correlation between resting heart rate and HRV, and significant negative correlation between Body Fat % and HRV in judo and wushu players.

OJC 2

Efficacy of Ayurvedic Science in the Fields of Sports

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[1]Department of Swasthavritta and Yoga, Bharati Vidyapeeth (Deemed to be University) College of Ayurved, Pune, Maharashtra, India

Ayurveda is an ancient medical science. It is very distinctive system of medicines with indomitable ideologies. As Ayurvedic system of medicines is so adaptable in nature and always trying to cope up with the problems arising in this modern world, with its traditional knowledge and distinctive methodology instigated in Samhitas. Ayurvedic practitioners are always eager to seek the knowledge from various different fields, to do something better for the mankind and Sports medicine is one of those fields that is becoming the new focus for the Ayurvedic practitioners by improving the performance of a sports person in their specific games with their traditional methods. In sports, health, physical fitness and mental fitness plays very essential role towards the performance of a sports person in their specific games. There are various procedures and formulations in Ayurveda that we can be indorsed in sports injuries or prevent them from injuries along with several daily and seasonal regimes to be adapted for the promotion of health of an individual including daily pathya ahara (nutritious diet), vyayama (physical exercise) according to the season, weight and strength of an individual person by increasing the endurance and stamina. Also, some Abhyanga (massage) techniques to strengthen the muscles or to relax the mind of a person. Medicated oils have healing properties, injuries which are musculoskeletal in nature can be healed with various techniques. Yogic and pranayam techniques help

for the cleansing of body and mind respectively. The main focus of this article is to acquaint with the efficacy of Ayurvedic (traditional) science in the fields of sports.

OJC 3

Estimation of Prevalence of Myocarditis in Athletes: A Systemic Review

Pratik Saha[1], Shrishti[1], Lakshmi Ramesh[1], Aparna Sarkar[1]

[1]Amity Institute of Physiology and Allied Sciences, Amity University, Noida, Uttar Pradesh, India

Background: Myocarditis is a leading cause of arrhythmias and sudden cardiac death (SCD) in physically active people and athletes alike. Elite athletes appear to be at an increased risk of viral infection and subsequent myocarditis due to increased pathogen exposure (global travel/international competition) or an inhibited immune system (continuing training during infections/resuming training soon after, strenuous exercise training). Athletes may be at a higher risk of adverse cardiac events. The initial clinical presentation varies, but athletes exhibit non-specific symptoms of fatigue, muscle soreness, increased heart rate at rest and during exercise, and decreased overall exercise capacity However (unnecessary) prolonged disqualification of athletes to avoid adverse cardiac events can cause significant disruption to training schedules and tournament preparation, leading to a decline in performance and ability to compete. As a result, improved risk stratification tools are critical. Among several diagnostic methods like ECG, Echocardiography and cardiac biomarkers, Cardiac magnetic resonance imaging (CMR) should be more focused upon.

Purpose: To assess and contrast the differences in existing recommendations and present a new proposed diagnostic process flow focusing on the use of cardiac magnetic resonance imaging in athletes with suspected myocarditis using the most recent available data,

Methods: A substantial number of correlated research papers were perused to ascertain the results. Furthermore, the availability of mundane information such as risk factor, inhibited immune response, diagnostic procedures was established via incisive analysis of pertinent websites.

Results: Based on scant evidence, primarily autopsy studies and expert opinions, current recommendations generally recommend a minimum of 3 to 6 months of abstinence from competitive sports for the prevention of onset of myocarditis among suspected athletes.

Conclusions: Due to the high level of cardiac stress in highly competitive sports, precise screening modalities are required, particularly for acquired cardiac diseases such as acute myocarditis. Evidence from large multicentre registries, including cardiac magnetic resonance imaging, is required to modify recommendations in athletes with myocarditis. A yearly follow-up examination should be performed on all athletes.

OJC 4

Standardization and Quality Evaluation of Breakfast Chonut Bar

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[1]Food Science and Nutrition, DR.N.G. P Arts and Science College, Coimbatore, Tamil Nadu, India

Breakfast bars are one of the ready-to-eat convenient products occupying larger space in the consumer market which not only satisfy the hunger, but prove as a quality source of nutrients and a convenient means of replacement of a meal. Sprouting process which activate the enzymes of the resting

MULTIFUNCTIONAL NANOSTRUCTURED METAL OXIDES FOR ENERGY HARVESTING AND STORAGE DEVICES

FIRST EDITION

Edited by
Vijay B. Pawade, Paresh H. Salame,
and Bharat A. Bhanvase

Chapter

Advanced Graphene-Transition Metal-Oxide-Based Nanocomposite Photocatalysts for Efficient Degradation of Pollutants Present in Wastewater

By S. Raut-Jadhav, M. V. Bagal

Book Multifunctional Nanostructured Metal Oxides for Energy Harvesting and Storage Devices

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ABSTRACT

This chapter encompasses a detailed overview of recent trends in the synthesis of graphene-transition metal-oxide-based nanocomposites and their applications for the photocatalytic degradation of pollutants. The comprehensive case study of the synthesis of reduced graphene oxide (rGO)-TiO_2 nanocomposites for photocatalytic and sono-photocatalytic degradation of methomyl (carbamate group pesticide) has further thrown some more light on the topic.

Nanocomposites of transition metal oxides and graphene in the form of graphene oxide (GO) and rGO has gained lot of popularity because graphene can significantly enhance the photocatalytic activity of transition metal oxides. Graphene transition metal oxide nanocomposites mainly include composites viz. rGO/GO-TiO_2, rGO/GO-ZnO, rGO/GO-Fe_3O_4, rGO/GO-CuO, rGO/GO-V_2O_5, rGO/GO-Co_3O_4, rGO/GO-MoO_3, rGO/GO-ZrO_2 etc. They can be synthesized by using various methods viz. hydrothermal/solvothermal method, sol-gel method, in-situ deposition/chemical method, etc. The size, morphology, and photocatalytic activity of the nanocomposite is dependent on the method adopted for the synthesis of the nanocomposite.

Graphene-transition metal-oxide-based nanocomposites have witnessed tremendous applications in wastewater treatment. These nanocomposites have successfully degraded many types of organic pollutants, such as dyes, pesticides, and pentachlorophenols. Previous research reports and the case study presented have clearly indicated that these nanocomposites possess high photocatalytic activity as compared to bare transition metal oxides under both UV and visible light. The key beneficial effect of using graphene-based nanocomposites includes the availability of active sites in the form of functional groups useful for anchoring transition metal oxides. Apart from this, graphene can also act as an electron sink and, hence, lower the charge carrier recombination.

Previous Chapter

PROCEEDINGS OF
57th Annual Convention of Chemists, 2020
&
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December 26-29, 2020

ABSTRACTS

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Lifetime Achievment Awardees

Indian Chemical Society

LIFETIME ACHIEVEMENT AWARD, 2020

CONFERRED ON

Professor Padmanabhan Balaram, FNA

Members of the Council and the Fellows of the Indian Chemical Society feel highly honoured to felicitate Professor Padmanabhan Balaram in recognition of his lifetime achievement in teaching and research in the field of Chemistry in general and Biological Science in particular.

Professor Balaram obtained Bachelor's degree in Chemistry from Fergusson College, University of Pune followed by Master's degree from the Indian Institute of Technology, Kanpur and PhD degree from Carnegie Mellon University with Aksel A. Bothner-By. During his PhD, Professor Balaram studied the use of negative Nuclear Overhauser effect signals as probes of macromolecular conformations. After a postdoctoral stint at Harvard University with Nobel laureate Robert Burns Woodward where he worked on the synthesis of the antibiotic erythromycin, Professor Balaram returned to the Indian Institute of Science, where he has rendered stupendous service till 2014. He is currently associated with the National Centre for Biological Sciences, Bangalore.

Early research of Professor Balaram focused on the membrane active peptide alamethicin, leading to a career long interest in the conformational restrictions on backbone folding promoted by the unusual residue alpha aminoisobutyric acid (Aib). The facile formation of 310-helical structures in Aib peptides was established by his studies in the late 1970s. His researches on the use of conformational constraints to direct peptide backbone folding led to the structural characterization of designed synthetic sequences that mimic secondary structures found in proteins. The use of D-Pro residues in nucleating beta hairpin formation, the design of multistranded sheets and the use of beta and gamma amino acid residues in generating hybrid helices were reported from his laboratory in the 1990s. His work on peptide design and analysis of protein structures has been of importance in the design of protein mimics. His laboratory was among the first to structurally characterise beta and gamma amino acid containing peptide structures in the 1990s, a key step in the development of the area of foldamers. His laboratory was also one of the first in India to apply the techniques of biological mass spectrometry in the area of protein chemistry.

The laboratory of Professor Balaram has contributed extensively to studies of the enzyme triosephosphate isomerase from plasmodium falciparum and more recently in the mass spectrometric and transcriptome based characterisation of peptide libraries from marine cone snail venom.

A dedicated academician, Professor Balaram has contributed significantly to the development of Chemical Education and Research in the country. Professor Balaram has built up a vibrant school of chemists and inspired a large number of students and colleagues who are carrying the torch of his mission.

The Indian Chemical Society sincerely wishes Professor Padmanabhan Balaram a long peaceful life with sound health and continuous academic activities for the advancement and propagation of scientific knowledge.

Professor G. D. Yadav
President
Indian Chemical Society

Professor Chittaranjan Sinha
Honorary Secretary
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LIFETIME ACHIEVEMENT AWARD, 2020

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Dr. Jhillu Singh Yadav, FNA

Members of the Council and the Fellows of the Indian Chemical Society feel highly honoured to felicitate Dr. Jhillu Singh Yadav in recognition of his lifetime achievement in teaching and research in the field of Chemistry in general and Organic Chemistry in particular.

Dr. Yadav obtained Bachelor's and Master's degrees in Chemistry from Banaras Hindu University and PhD degree from M S University, Baroda. Dr. Jhillu Singh Yadav, CSIR Bhatnagar Fellow & former Director, Indian Institute of Chemical Technology (IICT), Hyderabad carried out extensive basic and applied research investigations in organic chemistry for the synthesis of over 190 complex natural products of biological relevance. Dr. Yadav specializes in the state-of-the art Asymmetric Synthesis to create new Chiral Centers. He extensively utilized them very effectively in the synthesis of drugs and agrochemicals having self-defensive properties against rice-blast disease, hypersensitive metabolites, anticancer, antibiotics and antifungal agents in a highly innovative manner. He excelled in creating and generating diverse chemical entities relevant to both agro and drug industry.

The insightful instincts of Dr. Yadav made him to foresee the versatility of insect sex pheromones in Indian agro-system. He pioneered the alternative eco-friendly and environmentally safe pest control technologies in India through the application of insect pheromones as major tools in Integrated Pest Management (IPM) for better and cleaner agro-products. His technology development efforts are highly commendable. Some of the drugs developed by Dr. Yadav have been well received by several Indian Industries like Diltiazem, Ketotifen, Mefloquin, Ondasetron (Cipla), Pyrazinamide (SPIC Pharma), Tamoxifin (Cipla) Misoprostol and Carboprost (AVRA Laboratories) etc.

Dynamic leadership of Dr. Yadav created and formulated many interdisciplinary programs at the Institute with the distinct aim to serve the nation. These have since established themselves as centers of excellence at the Institute. Dr. Yadav is an architect of distinction in building potential research groups with state-of-the-art facilities. He is an outstanding Organic Chemist of India. The Web of science (Science Citation Index) has referred him as the best and organic chemist par excellence in the country.

Dr. Yadav has the unique distinction of excelling in both basic and industrial research and received recognition accordingly. He is a fellow of The World Academy of Sciences (TWAS) for the advancement of science in developing countries and has received numerous national and international awards which include the prestigious, Shanti SwarupBhatnagar Prize, VigyanGauravSamman Award, Jawaharlal Nehru Science Award, Ranbaxy Award, Vasvik Award, Goyal Award, CSIR Technology Award, KIA Award (Iran-UNESCO). He is also the fellow of all the Indian Science Academies.

A dedicated academician, Dr. Yadav has contributed significantly to the development of Chemical Education and Research in the country. Dr. Yadav has built up a vibrant school of chemists and inspired a large number of students and colleagues who are carrying the torch of his mission. Two hundred and forty students have received their Ph.D degrees under his able guidance in Organic Chemistry. To his credit, he has more than 1200 scientific publications with 30000 citations and 140 patents.

The Indian Chemical Society sincerely wishes Dr. Jhillu Singh Yadav a long peaceful life with sound health and continuous academic activities for the advancement and propagation of scientific knowledge.

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Professor Debashis Mukherjee, FNA

Members of the Council and the Fellows of the Indian Chemical Society feel highly honoured to felicitate Professor Debashis Mukherjee in recognition of his lifetime achievement in teaching and research in the field of Chemistry in general and Theoretical Chemistry in particular.

Professor Mukherjee obtained Bachelor's degree in Chemistry from Presidency College, Kolkata followed by Master's degree from the University of Calcutta and PhD degree from the Indian Association for the Cultivation of Science, Kolkata. Professor Mukherjee had joined the Indian Association for the Cultivation of Science in 1978, where he has rendered stupendous service till 2010.

Professor Debashis Mukherjee is presently the S N Bose Chair Professor in the S N Bose National Centre for Basic Sciences, Kolkata. He was previously the Director of the Indian Association for the Cultivation of Science (IACS), the Founder and the Chairman of its Raman Centre for Atomic Molecular and Optical Sciences and later the Emeritus Chair Professor.

Professor Mukherjee is a world leader in Theoretical Chemistry, well-known for his pioneering contributions in the field of molecular electronic structure and theoretical precision spectroscopy for electroweak interactions. His formulations of multi-reference coupled cluster formulations are regarded as pioneering and ground-breaking and are now standard works in the field. They are named after him. His cluster cumulant theories at finite temperature -- the corresponding Many Body Formalisms in Statistical Mechanics are also widely known and are increasingly being used in a wide variety of Statistical Mechanics problems.

Professor Mukherjee is the recipient of numerous awards and honors. He was awarded with the prestigious Humboldt Research Prize for his fundamental research in the many electron correlation problem. He is a Fellow of numerous International Academies, including the International Academy of Quantum Molecular Sciences (IAQMS), the World Academy of Sciences (TWAS), the Asia Pacific Association for Theoretical and Computational Chemists (APATCC), the Chemical Pioneer Award of the American Institute of Chemists, the Indian Academy of Sciences (IASc), the Indian National Science Academy (INSA) and the National Science Academy (NASI). He is also a S S Bhatnagar Prize Awardee. He was invited to deliver the Fukui Memorial Lecture as a Fukui Medal Awardee of the APATCC, and Coulson Memorial Lecture of the Center of Computational and Quantum Chemistry in the University of Georgia, Atlanta. He delivered the Jagdish Shankar and the SadhanBasu Memorial Lectures of the INSA.

A dedicated academician, Professor Mukherjee has contributed significantly to the development of Chemical Education and Research in the country. Professor Mukherjee has built up a vibrant school of chemists and inspired a large number of students and colleagues who are carrying the torch of his mission.

The Indian Chemical Society sincerely wishes Professor Debashis Mukherjee a long peaceful life with sound health and continuous academic activities for the advancement and propagation of scientific knowledge.

Professor G. D. Yadav
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Honorary Secretary
Indian Chemical Society

Endowment Lectures

Endowment Lecture

My experience of walking with crystals under UV light †

JJ Vittal
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Crystal engineering tools are successfully utilized to design crystals with desired physical and chemical properties, as these are directly related to their crystal structures.As more and more exotic new crystals are made, unexpected, unusual and unpredictable properties have been accidently discovered. For example, mechanically responsive materials were found to change their shape and size or move in space by light, thermal, pressure or chemical energy. Of these, dynamic molecular crystals undergo various movements like curling, crawling, jumping, leaping, hopping, popping, splitting, wiggling, and exploding, when exposed to heat (thermosalient effect) or light (photosalient effect). These photo-dynamic and thermal-dynamic crystals create new ways of transforming light and heat energy into mechanical work. In this context, we encountered a number of interesting properties such as structural transformations due to solvent exchange, change of composition and dimensionality due to grinding, unexpected photoreactivity of organic crystals and transition metal complexes due to [2+2] cycloaddition reaction, centrosymmetric MOFs showing second-order non-linear optical properties, chemical patterning in single crystals of MOFs,violent popping of single crystals under UV light (photosalient effect), thermosalient effect and photobending.In this talk some of these unusual properties of the crystals will be highlighted.

† Professor G. V. Bakore Memorial Award

Bio-data

JJ Vittal received BSc (University of Madras, 1975), MSc (Madurai University, 1977) and PhD from IISc, Bangalore (1982). After postdoctoral research work at the University of Western Ontario, Canada, he managed the X-ray facility for a few years. He then moved to Singapore in 1997 where he is a Professor of Chemistry at the National University of Singapore. He held a World Class University Chair Professorship at the Gyeongsang National University, South Korea (2009-2013). His recent research interests include various aspects of MOF materials, solid-state structural transformations and photochemical reactivity. He co-authored 'Crystal Engineering – A Textbook' and also co-edited two books on crystal engineering. He is a Fellow of Royal Society of Chemistry, Singapore National Institute of Chemistry and Indian Chemical Society. He won CRSI Medal (2020), Outstanding Chemist Award (2014), CRISP Award (2013), Outstanding Research Award (2011) and Best Scientist Award (2007). JJ has been highlighted in *Angewandte Author Profile* (2014). He founded the *Singapore National Crystal Growing Challenge* in 1997 to promote science through the art of growing crystals. He is an international committee member of Worldwide *IUCr Crystal Growing Competition for School Children* since 2014.

Design of nanostructured materials for photocatalysis and photoelectrochemical applications†

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Utilization of abundant sunlight for a more sustainable future of our civilization is the endeavour of the scientific community. One of the major requirementsfor achieving this is the development of catalysts that are able to utilize light radiation for chemical or electrochemical transformations. Broadly these catalysts are composed either of semiconducting materials or materials that exhibit surface plasmon resonance phenomenon. Nanostructured catalysts based on these materials are an important class of materials as their activity and selectivity can be tailored by variation of characteristics like size, morphology and aspect ratio.Our group has been very active in development of nanostructured photocatalysts[1-4] and photoelectrocatalysts[5,6]with controlled characteristics for the past two decades. We have utilized these materials for photodegradation of organic pollutants and photoelectrochemical splitting of water for production of clean fuels.This review presents a summary of the work carried out in our laboratory on development of photocatalysts and catalysts for photoelectrochemical applications.

Keywords: Photocatalysis; Photoelectrocatalysis; nanostructured materials; water splitting.

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† Professor J. N. Mukherjee Memorial Award

Bio-Data:

Prof Ganguli did his B.Sc(Hons) Chemistry from Hans Raj College, University of Delhi, M.Sc (Chemistry) from University of Delhi and PhD in Solid State Chemistry from SSCU, IISc Bangalore in 1990. He carried out his post doctoral research at Dupont company USA and Ames Laboratory, Iowa State University, USA before joining IIT Delhi. Currently he is Institute Chair Professor of Chemistry and DeputyDirector, IIT Delhi. He is also the founding Director of Institute of Nano Science and Technology (Mohali). His main interest is in the area of design of materials, especially colloidal synthesis of nanomaterials and also in superconducting materials. He has published over 340 papers and has filed five patents (two granted). He is a recipient of the CRSI Bronze Medal(2006)& Silver Medal(2019), MRSI Medal(2007), National Award of Nano Science and Nanotechnology(DSTGovt. of India, 2015), Bangalore India Nano Award(Karnataka Govt, 2017) and the CNR Rao –CRSI National Prize of the Chemical Research society of India(2019), ISCB Award in 2019. He is a fellow of the Indian Academy of Sciences, National Academy of Sciences, India, Royal Society of Chemistry (London) and the Asia-Pacific Association of Materials. He is an Associate Editor of Bull. Mater Sci. and editorial board member of Chem Phys Letts, ACS Mater Letts and the J. Indian Chem. Soc. Dr. Ganguli is also a keen speaker for science in the rural & remote areasand has interacted with more than 320 schools/colleges in last seven years. Dr Ganguli is the coordinator of the Delhi S&T Cluster supported by the office of the PSA, Govt of India.

The Statistical Complexity Measure†

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The product of an information theoretical measure of *order* with another exponential measure of *disorder* can be used to define a class of measures characterising the complexity of a given probability density distribution. Using the *statistical complexity measure* defined [1, 2] in the position space as $C_r = e^{Sr} D_r$, where $S_r$and $D_r$are Shannon information entropy and dis-equilibrium, respectively, along with its counterpart in the momentum space as $C_p = e^{Sp} D_p$, we demonstrate how such measures can be used to probe theelectronicstructureofatomsandmoleculesinwhichjusttheone-electron density is used as the key input parameter. The following four case studies[3-6] will be presented (*i*) the complexity of atoms in the periodic table (*ii*) thecomplexityofthegroundelectronicstateofhydrogenmolecularion(*iii*) complexity and the onset of Wigner crystallization of the confined pair of electrons,and(iv)aphenomenologicaldescriptionofathree-centrechemical insertion reaction.

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† Professor Suresh C. Ameta Award

Bio-Data:

Dr. K. D. Sen (PhD, IIT-Kanpur) F.A.Sc., F.N.A. joined University of Hyderabad in 1977 where he is now the senior most professor. His collaborative research in electronic structure theory with fellow scientists from Belgium, Cameroon, Canada, Chile, Germany, Greece, Japan, Mexico, Nigeria, Spain, Turkey, UK and USA has led to the publication of 8 monographs and 185 research papers. A recipient of Humboldt, Fulbright, and NSERC Canada Research Fellowship, he has been recently awarded the DAAD Research Professorship, Indo-US Professor of Physics of the American Physical Society and the J.C. Bose National Fellowship. International collaboration is his style of doing research since 1978.

Nanozymes and Nanoisozymes for Modulation of Cellular Redox Processes†

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Oxidative stress is caused by an imbalance between the production of reactive oxygen species (ROS) and the biological system's ability to detoxify these reactive intermediates. It is well known that oxidative stress is associated with diverse diseases, including cancer, renal disease, and neurodegenerative disorders such as Alzheimer's and Parkinson's disease. Antioxidant treatment has been found to be unsuccessful in many cases as they promote disease and increase mortality in humans. The reason for this unexpected behaviour is that antioxidants with strong reducing ability can act as pro-oxidants and increase the oxidative stress. Therefore, it is important to develop antioxidants without pro-oxidant activity. In this regard, our group is working on the design and synthesis of antioxidant enzyme mimetics such as small molecules and nanomaterials that can combat oxidative stress without affecting the cellular antioxidant systems. In this lecture, I will discuss our recent results on the development of nanozymes that can be used for cellular and biomedical applications.

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Dr. Govindasamy Mugesh (born 1970) is an Indian inorganic and physical chemist, a professor and the head of the Mugesh Laboratory attached to the department of Inorganic and Physical Chemistry at the Indian Institute of Science. He is known for his studies on mechanism of thyroid hormone action and is an elected fellow of the Indian Academy of Sciences, Indian National Science Academy, Royal Society of Chemistry and the National Academy of Sciences, India. The Council of Scientific and Industrial Research, the apex agency of the Government of India for scientific research, awarded him the Shanti Swarup Bhatnagar Prize for Science and Technology, one of the highest Indian science awards, in 2012, for his contributions to chemical sciences. In 2019, he was awarded the Infosys Prize in Physical Sciences for his seminal work in the chemical synthesis of small molecules and nanomaterials for biomedical applications.

Crystal Engineering of Solid-state Pharmaceuticals: From Synthon to Salt-Cocrystal Drugs†

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The subject of crystal engineering has grown from a fundamental understanding of hydrogen bonding, intermolecular interactions, supramolecular synthons, and crystal packing to improved pharmaceutical applications (1990 to 2015), and recently toward functional materials for sustainable energy, biomass valorization and solar cells as a new phase, coinciding with the oft asked question: what has science done for society lately?

The role of X-ray crystallography and crystal engineering in pharmaceutical development of new and improved medicines will be highlighted. The emphasis in these studies is to modify the physicochemical and pharmacokinetic properties of drugs as well as their crystalline forms to increase stability, solubility, and enhanced bioavailability. Other important properties which can be tuned for pharmaceuticals are permeability, half-life, color stability, cross reactivity for multi-drug compositions, tableting, compaction, etc. Three cocrystal-salt drugs have recently been approved by the US-FDA – Entresto (Valsartan-Sacubitril trisodium hemipentahydrate; Novartis), Steglatro (Ertuglifozin-5-oxoproline; Merck-Pfizer), and Suglat (Ipraglifozin-Proline; Astellas), as well as a few more drugs are in clinical and regulatory pipeline (Tramadol HCl-Celecoxib, Esteve; TAK020-gentisic acid, Takeda). The crystal engineering of multi-component cocrystals (ternary) offers the potential to arm multiple drug payloads in the same pharmaceutical composition.

Representative publications

1) Solubility Advantage of Amorphous Drugs and Pharmaceutical Cocrystals. N. J. Babu, and A. Nangia.*Cryst. Growth Des.* 2011, 2662-2679.
2) Eutectics as Improved Pharmaceutical Materials. S. Cherukuvada, and A. Nangia.*Chem. Commun.* 2014, 906-923.
3) Pharmaceutical cocrystals: walking the talk. G. Bolla and A. Nangia.*Chem. Comm.*2016, **52**, 8342-8360.
4) Curcumin: pharmaceutical solids as a platform to improve solubility and bioavailability. K. Suresh, and A. Nangia. *CrystEngComm* 2018, **20**, 3277-3296.
5) Crystal Engineering. An Outlook for the Future. A. K. Nangia and G. R. Desiraju. *Angewandte Chemie* 2019, **58**, 4100-4107.

† Rev. Fr. L. M. Yeddanapally Memorial Award

Bio-data :

Ashwini Kumar Nangia is a Senior Professor of Chemistry at University of Hyderabad. He completed MSc from IIT Kanpur (1983) and PhD from Yale University (1988). He started his professional career at UoH in 1989 as Lecturer and was promoted to Professor in 2002. His research group focuses on crystal

engineering topics – structure design, inclusion compounds, polymorphism, cocrystals, salts and eutectics, and the applications of these solid forms in pharmaceutical sciences for drug translation. He is a Fellow of three National Science Academies – INSA New Delhi, IASc Bangalore and NASI, Allahabad. He is recipient of the JC Bose Fellowship from DST. He was awarded the Golden Jubilee Commemoration Medal (Chemical Sciences, 2016) of INSA and the Prof. L. K. DoraiswamyChemcon Distinguished Speaker Award for 2016 by IIChE. He has international research collaborations with Russia, Singapore, UK and USA. He is on the Editorial Boards of subject journals, Crystal Growth & Design (ACS), CrystEngComm (RSC), Journal of Pharmaceutical Sciences (Wiley), Chemistry – An Asian Journal (Wiley-VCH). He was appointed Associate Editor of ActaCrystallographica, Section B, IUCr journals in 2017. He has published about300 papers in peer reviewed international and national journals, filed 15 patents, has H index of 60 and over 14,000 citations. He was awarded the Golden Jubilee Commemoration medal of INSA (2016) and Prof. D. N. Dhar Memorial lecture of NASI (2018). He was recently appointed Member of SERB Empowered Committee and as Adjunct Professor at ICT Mumbai (UDCT).

He is founder of spin off innovation and R&D venture Crystalin Research in 2010 under the banner "Chalk to Salt" at Technology Business Incubator facility on University campus. Crystalin Research completes a decade of successful functioning as a solid-state form modification and improvement venture in 2020. He was Director of CSIR-National Chemical Laboratory, Pune since March 2016 and completed his tenure successfully at the end of November 2020.

He was Chairman of India's first and largest Venture Center on NCL Innovation Park, co terminus with his tenure as Director, NCL. He re-joined University of Hyderabad as a Senior Professor of Chemistry in December 2020.

Perfecting Imperfections: Chemistry of Defects in Nanosilica for CO_2 to Fuel Conversion†

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Active and stable metal-free heterogeneous catalysts for CO_2 fixation are required to reduce the current high level of carbon dioxide in the atmosphere, which is driving climate change. In continuation of our work in the field of nanocatalysis,[1-13] recently we showed that defects in nanosilica (E'-centres, oxygen vacancies, and non-bridging oxygen hole centres) convert CO_2 to methane with excellent productivity and selectivity.[12]Neither metal nor complex organic ligands were required, and the defect alone acted as catalytic sites for carbon dioxide activation and hydrogen dissociation and their cooperative action converted CO_2 to methane. Unlike metal catalysts, which become deactivated with time, the defect-containing nanosilica showed significantly better stability. Surprisingly, the catalytic activity for methane production increased significantly after every regeneration cycle, reaching more than double the methane production rate after eight regeneration cycles. This activated catalyst remained stable for more than 200 h. Detailed understanding of the role of the various defect sites in terms of their concentrations and proximities as well as their cooperativity in activating CO_2 and dissociating hydrogen to produce methane was achieved.

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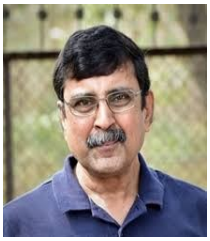
† Professor S. S. Sandhu Award

Bio-Data:

Prof. Vivek Polshettiwar, after his Ph.D. in 2005, worked as a postdoc in France and USA for few years before starting his own independent group at KAUST in 2009. In 2013, he moved to TIFR, and his group is working on the development of novel nanomaterials as catalyststo tackle “climate change”. He has published nearly 100 articles with h-index 54 and around 12400 citations in reputed journals like PNAS, Nature Comm, AngewChem, Chem. Sci., ACS Nano, ACS Catalysis etc. He is the recipient of the prestigious ORISE Research Fellowship at US-EPA. He was awarded as Top-25 cited author in 2011 by Tetrahedron and Young Scientist Award at DSL-2012. He also received an Asian Rising Star lectureship at 15th Asian Chemical Congress (ACC), Singapore (2013), from Nobel Laureate Professor Ei-ichi Negish. In 2015, he was admitted as a Fellow of Royal Society of Chemistry (RSC), United Kingdom. He was awarded Bronze medal by Chemical Research Society of India (CRSI), India. He was also recognized as emerging investigator-material science and 175 faces of chemistry by RSC, UK.He was awarded the prestigious Materials Research Society of India - MRSI Medal 2019 and Fellow Maharashtra Academy of Sciences. In 2020, he received Young Research Awards in Nano Science & Technology by DST, Gov. of India.

Ultrafast Pump-Probe and Single-Particle Photoluminescence Studies of the Caesium Lead Halide Perovskite Nanocrystals†



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The lead halidebased perovskite nanocrystals have generated considerable interest in recent years because of their great potential in photovoltaic and photonic applications.[1,2] An understanding of the photo-induced processes in these systemsis key to proper utilization of these materials in different applications. In this talk, we shalldiscuss how femtosecond pump-probe and single-particle fluorescence based techniques can provide information on the identity and energy states of the photogenerated species,pathways and dynamics of relaxation of the charge carriers, location and nature of the trap states and their role in fluctuation of the photoluminescence of various caesium lead halide ($CsPbX_3$) perovskite nanocrystals.[3-7]

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† Acharya J. C. Ghosh Memorial Award

Bio-Data:

Anunay Samanta is a Senior Professor and Dean of the School of Chemistry at theUniversity of Hyderabad. He joined here in 1990 after obtaining his Ph.D (1987) from IACS (Jadavpur University)and a postdoctoral tenure of little more than two years at the Radiation Laboratory, University of Notre Dame, USA. He has supervised the PhD thesis of 23 students, published 190 papers, which have been cited 9700 times.He is Fellow of all three National Science Academies of India and recipient of many national and international awards such as J.C. Bose National Fellowship, Thomson Reuters India Citation Award, Raman-Mizushima Lecture Award, and APA Award. His current research interests are ultrafast dynamics and single-molecule fluorescence spectroscopy of the perovskite nanocrystals and related materials.

Progress in CO_2 Utilization:from homogeneous to heterogeneous catalysts†

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With modern industrydevelopment, carbondioxide (CO_2) has attractedmore and moreattentionasitsunignorableinfluence on thegreenhouseeffect. While in theaspectofsyntheticchemistry, CO_2isconsideredas an ideal C1 source foritsmerits, such asnontoxicity, economy, renewability, and abundance. Based on this, thetransformationof CO_2intoorganicsusinghomogeneouscatalystshasbecome a highly promising area in modern green and sustainablechemistry. Up tonow,numerousstrategieshavebeendevelopedtoeffectivelyutilize CO_2forthesynthesisofvaluablechemicals[1-6]. Moreover, also heterogeneous catalysts are intensively investigated for the utilization of carbon dioxide, especially Metal-organic Frameworks. Metal-organic frameworks are non-conventional porous materials having a broad spectrum of applications. The catalytic use of MOF-based materials is cutting-edge in the field of scientific and technological developments. Recently, MOFs are being investigated as promising catalysts for synthesizing of industrially important cyclic carbonates under solvent-free ambient conditions. A wide variety of terminal and internal substrates are converted efficiently with high selectivity. MOFs as heterogeneous catalysts are remarkably stable and have structural rigidity, hence recycled for subsequent use with almost the same activity. Therefore, MOF-catalysts are highly efficient for the cycloaddition of CO_2 to epoxides into cyclic carbonates[7-12].

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† Dr. Basudev Banerjee Memorial Medal and Prize

Bio-Data:

Prof. Francis Verpoort, has carried out broad and fruitful teaching and research activity at Ghent University in various areas of chemistry such as organometallics, catalysis, molecular spectroscopy. Moreover, his practical abilities allowed him to highly valorize the research outcome in a spin-off company from Ghent University in the production of commercial ruthenium-based metathesis catalysts applied successfully in organic and polymer syntheses.

In 2011 he was also appointed as Chair Professor at Wuhan University of Technology (China), where he established a research group covering organometallics and materials chemistry. He was appointed as "National Distinguished Expert" in China (2012).

He isPresident of the Board of Directors, International Engineering and Technology Institute, Hong Kong, Editor of Applied Organometallic Chemistry, Chemistry Africa, Frontiers in Chemistry,

And Editor-in-Chief of Nanocatalysis. He is anEditorial Board member of Inorganics, Catalysts, Molecules,Advances in Materials research, andAdviser in the Advisory Cabinet of the Asian Council of Science Editors. He was electedasFellow ofthe Royal Society of Arts (FRSA),and Fellow ofthe Royal Society ofChemistry. Hecontributedwith a considerable number of book chapters, more than 340 full papers, and 20 international patents to the international scientific literature. Some of his articles are among the top 1% highly cited articles in the Royal Society journals

Metallophosphate Materials for Energy Applications†

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Reaction of phosphoric acid mono aryl esters with a divalent metal such as Zn^{2+} in a donor solvent (L) leads to the isolation of tetranuclear metal phosphates $[(RO)PO_3Zn(L)]_4$ whose inorganic core resembles the zeolitic D4R SBU.[1-4] In recent times, we have also unravelled that it is possible to isolate even larger SBUs through small variations in the reaction conditions.[5] On the other hand the reaction of phosphoric acid mono and dialkylesters yield either 1-D polymers or 2-D materials which thermally anneal to produce ceramic materials at temperature lower than 300ºC.[6] Rationalization of these building principles will be presented in this lecture, apart from highlighting the use of this class of compounds as molecular magnets,[7] phosphorus based perovskites,8 and energy related materials.[6]

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† Professor A. S. R. Anjaneyulu 60th Birth Day Commemoration Award

Bio-Data:

Ramaswamy Murugavel received his B.Sc. and M.Sc. degrees from University of Madras and Ph.D. from IISc. He carried out postdoctoral work at the University of Göttingen (1994-1997) and joined the chemistry faculty of IIT Bombay in December 1997, where he is currently the Biswas Palepu Distinguished Chair Professor and a J C Bose National Fellow. He is a fellow of the Indian Academy of Sciences, the Indian National Science Academy, and the Royal Society of Chemistry. He has been conferred with J. C. Bose National Fellowship, Swarnajayanti Fellowship, Alexander von Humboldt Fellowship, DAE-SRC Outstanding Investigator Award, DFG Mercator Professorship, C. N. R. Rao National Prize in Chemical Sciences, S. C. Bhattacharya Award for Excellence in Research in Basic Sciences, DAE Young Scientist Award, CRSI Bronze and Silver Medals, MRSI Medal, and J. C. Ghosh Medal. His research work has been published in the form of 200+ publications.

Diheme Enzyme *Mau G*: Our Understanding towards Nature's Design †

S. P. Rath*

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MauG is a terminal enzyme involved in the biosynthesis of the catalytic tryptophan tryptophenylquinone (TTQ) cofactor of methylamine dehydrogenase (MADH). Although two heme units are physically separated in the enzyme, they share electron efficiently behaving as a single diheme unit. A tryptophan residue, positioned midway between the heme centers, has been postulated to act as a bridge for electronic communications. *MauG*-catalyzed TTQ biosynthesis is accomplished through radical chemistry and initiated using H_2O_2 as the oxidant which produces bis-Fe(IV) redox state (Figure 1). As the two hemes are physically separated by 14.5 Å, a hole-hopping mechanism has been proposed in which the tryptophan residue reversibly oxidized and reduced during electronic communication. These attractive features have prompted us to investigate on such diheme enzyme and the results will be highlighted in the talk[1,2].

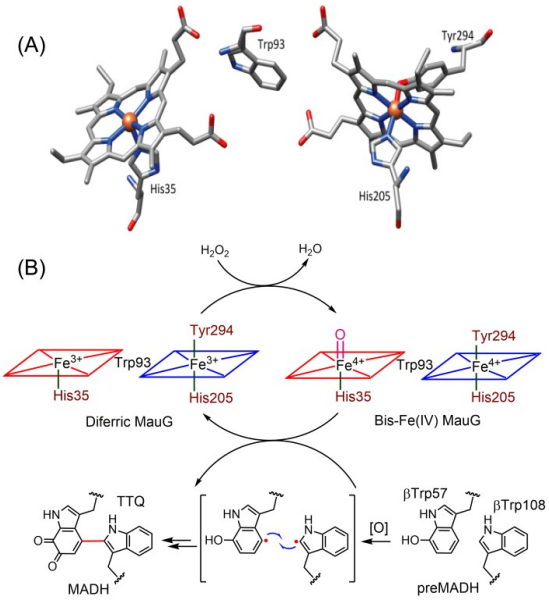

Figure 1. (A) Relative orientation of hemes and the intervening tryptophan residue in *MauG* (PDB ID code 3L4M). (B) Overall biosyntheis of TTQ catalysed by *MauG*.

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Professor R. S. Varma Memorial Award

Bio-Data:

Awards & Honours:

- SERB - Science and Technology Award for Research (SERB-STAR), 2020
- Fellow, Indian Academy of Sciences, Bangalore, 2020
- J. N. Gupta & M. Gupta Chair Professor, IIT Kanpur (2017-2020)
- JSPS Invitational Fellowship, Japan, 2020
- Professor R S Varma Memorial Award by Indian Chemical Society, 2020
- C. N. R. Rao National Prize in Chemical Sciences, 2018
- Fellow, National Academy of Sciences, 2017
- Bronze Medal, Chemical Research Society of India (CRSI)- 2015
- Fellow, West Bengal Academy of Science & Technology, 2017
- Institute Foundation Day Lecture, NIT Patna on January 27, 2017
- Alexander von Humboldt Research Fellowship for Experienced Researcher in 2012
- P. K. Kelkar Faculty Research Fellowship from IIT Kanpur (2009-2012)

Research Details

The family of multiheme proteins constitutes one of the most fascinating molecular machineries designed by Nature to execute a large variety of functions. The functional properties of such important and widely distributed family are largely determined by the arrangement and interaction of their multiple heme cofactors. Rath's group is pioneer in the biomimetic study of this important class of proteins and contributed significantly in understanding Nature's sophisticated design in modulating structure and properties viz., metal spin and electronic state, reactivity, rate of electron transfer, redox potential etc., of the individual heme centre.

Supramolecular chirogenesis is one of the most important interdisciplinary fields to be looked into because of its occurrences in many natural and artificial systems. Rath's group has also contributed significantly in understanding the origin and various aspects of chirality induction, control and amplification at the molecular level.

Current research interests include investigating Multi-heme Proteins & Enzymes, Bio-inorganic Chemistry, Chemical Biology, Medicinal Inorganic Chemistry, and Supramolecular Chirogenesis.

Coherency of Recent Trends in Organic and Medicinal Chemistry†

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While the pharma sector had been deliberating for long on the requirements of knowledge base and experimental skill that a medicinal chemist should possess it is well accepted that organic synthesis remains at the core of the activities of drug discovery program.[1] Thus, any advancement in the area of organic synthesis is expected to enrich the synthetic tool box of medicinal chemists. In recent times sustainability has been the yardstick of the modern developments of organic chemistry resulting enrichment of the synthetic tool box of medicinal chemistry[2] in compliance with green chemistry principles.[3] However, while the modern development of organic chemistry should obviously expand the medicinal chemistry synthetic tool box[4] these newly developed synthetic methodologies are rarely observed in the discovery medicinal chemistry.[5] This results in over dependent on the existing structural framework narrowing the chemical space and hence the scope of IP (Intellectual Property). Thus, a coherent approach encompassing the recent trends in organic and medicinal chemistry is advocated for sustainability in drug discovery research.[6] The present discussion would address the integration of sustainable development of organic chemistry[7] with drug discovery for generation of new therapeutic leads[8] and optimization.[9]

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† Professor P K Bose Memorial Award

Bio-Data:

Professor Chakraborti received Ph. D. degree in Synthetic Organic Chemistry from IACS, Kolkata in 1985 and post-doctoral research training in USA: department of Chemistry, Clemson University (1985-1987) and Medicinal Chemistry, Purdue University (1987-1989).He served Burdwan University (WB) as lecturer of Chemistry (1990-1994) and NIPER-Mohali, Punjab as Assistant Professor (1994-1999), Associate Professor (1999-2001), and Professor (2001-2019) of Medicinal Chemistry. He has guided 40 Ph. D. and 130 Masters' students, published 180 research papers (> 10,000 citation, h index 61), filed 42 patents. He received University Gold Medal, Bardhaman Sammilani Gold Medal, ISMAS Eminent Mass-spectroscopist award, Ranbaxy Research Award (Pharmaceutical Sciences), CRSI Bronze Medal, R V Patel PharmInnova Best Research Guide Awards for "Innovative Ph. D. Thesis" (2017-2018 & 2016-2017) and "Innovative MS Thesis" (2015-2016 &2014-2015) in "Pharmaceutical Chemistry." He is Fellow of Royal Society of Chemistry, Indian Academy of Sciences, Bangalore and Indian National Science Academy, New Delhi.

Regioselective C−H Functionalization of Indazoles and Imidazopyridines†

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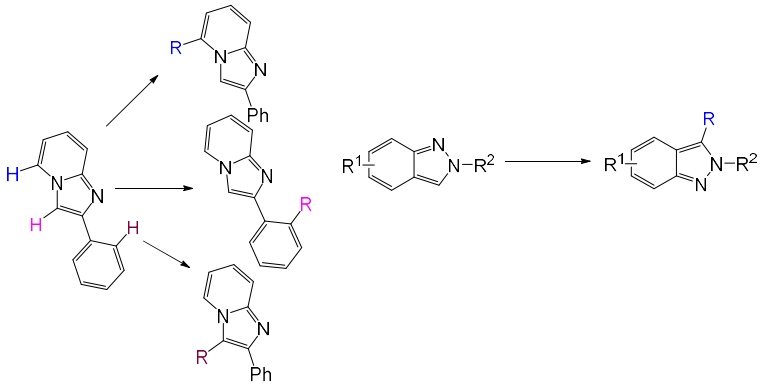
Heterocyclic compounds have gained a great deal of attention as majority of the drugs contain heterocycle scaffolds. So the developments of new synthetic strategies for heterocycles are prime targets of the organic chemists over the years. Imidazopyridine is one of the important fused bicyclic 5–6 heterocycles and it is recognized as "drug prejudice" scaffold due to its wide applications in medicinal chemistry. This scaffold is the constituent of various marketed drug like zolpidem, alpidem, zolimidine, necopidem, saripidem etc. In this lecture I will discuss our recent works on sustainable synthesis of imidazo[1,2-a]pyridines,[1,2] and indazoles[3].



Scheme 1. Regioselective functionalization of imidazopyridine and indazole

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† Professor Dhananjay Nasipuri Memorial Lecture

Bio-Data:

Dr. Alakananda Hajra graduated (M.Sc) from the Department of Chemistry, Indian Institute of Technology, Kharagpur India in 1998. After completing his Ph.D in 2002 under the supervision of Prof. B. C. Ranu from Indian Association for the Cultivation of Science (IACS), Kolkata he joined in SUNY at Albany, USA as a postdoctoral research fellow with Prof. Frank M. Hauser (2002-04). He was also a JSPS research Fellow in the University of Tokyo and worked with Prof. Eiichi Nakamura and Prof. Masaharu Nakamura from November 2004 to May, 2006. He also worked with Prof. N. Yoshikai, NTU, Singapore for one year (2011-2012) as a visiting scientist. His research interests are the development of new synthetic methodologies and green synthetic procedures. He has published more than 167 peer-reviewed articles with more than 6700 citations, giving him a h-index of 42.

Awards / Honors / Membership:

- Professor D Nasipuri Memorial Award for the year 2019 by Indian Chemical Society
- Chemical Research Society of India (CRSI) Bronze Medal Award for the year 2018
- Prof. D. K. Banerjee Memorial Lecture Award for the year 2015 from Indian Institute of Science

Quantum chemistry from molecules to materials†

Sourav Pal*

Indian Institute of Science Education and Research Kolkata

Mohanpur, Nadia- 741 246, West Bengal, india

Clusters play an important role in understanding the transition from atomic and molecular systems to the nano-scale systems. Different types of clusters display interesting bonding and properties. In this presentation, we will describe our research on bare as well as doped gold and aluminum clusters on oxidation reactions, di-nitrogen and C-X bond activation. In particular, we noted the potential of Al-clusters on BN-doped graphene. Density functional theory has been used to obtain the results and insights into the functional clusters. Both periodic calculations based on plane wave basis and molecular model calculations using Gaussian basis sets have been used for our calculations.

*Formerly: CSIR-National Chemical Laboratory, Pune 411 008, India

†Professor A K Chandra Memorial Award

Bio-Data:

Prof. Sourav Pal is presently Director of Indian Institute of Science Education and Research (IISER) Kolkata. He was formerly the Director of CSIR-National Chemical Laboratory (NCL), Pune and worked at NCL Pune for almost 33 years. He was also a Professor of Chemistry at IIT Bombay. He was instrumental in setting up Electronic Structure Theory Group at NCL He is a distinguished theoretical chemist and has contributed to methodological and conceptual developments on many-body electronic structure theory, to the area of density based chemical reactivity as well as to catalytic and hydrogen storage materials using computational material science.

He obtained his 5 years' integrated Master's degree in Chemistry from Indian Institute of Technology (IIT) Kanpur in 1977, received Ph.D. degree from Calcutta University and joined NCL in 1982. He was a post-doctoral fellow at the University of Florida, Gainesville, USA (1986-87) and has been Alexander von Humboldt Fellow at the University of Heidelberg, Germany (1987). He was been visiting Professor abroad at the University of Arizona, Tucson, USA, University of Torun, Poland and the Institute for Molecular Sciences, Okazaki, Japan. He also holds Adjunct Professorship at IISER Pune and IIT Goa. He is also distinguished Visiting Professor at IIT Kharagpur.He served as the President of Chemical Research Society of India for three years from April 1, 2014. He is a member of Executive Council of Federation of Asian Chemical Societies and is Chairman of Chemical Division Council of Bureau of Indian Standards. He is also a member of Board of the newly set up Commonwealth Chemical Sciences In addition, he has served in several important scientific committees in the country. He is presently a member of the Council of Indian National Science Academy, New Delhi.

He has been recognized by several awards and honors for his contributions to science, including the prestigious Shanti Swarup Bhatnagar Award in Chemical Sciences in 2000 and SASTRA-CNR Rao Award in Chemistry & Materials Science for the year 2014, among others. He is a Fellow of The Indian National Science Academy (2003), Indian Academy of Sciences (1996) and National Academy of Sciences (1998), Royal Society of Chemistry (2011) and the Maharashtra Academy of Sciences (1994). He is J C Bose National Fellow of Department of Science and Technology from 2008. He is presently a member of the Council of Indian National Science Academy.

Heis presently in the EditorialAdvisory Board of the Journal of Physical Chemistry, has guided more than 40 Ph D theses and has published more than 280 papers in International peer reviewed journals. He has authored a book titled "Mathematics in Chemistry" and contributed to chapters in several books. He has been invited to deliver plenary / keynote / highlighted lectures in several institutions and international conferences of repute over the years.

Isomerization Reactions in Anionic Mesoionic Carbene-Borates and Control of Properties and Reactivities in the resulting CoII Complexes through Agostic Interactions

Biprajit Sarkar

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Mesoioniccarbenes (MICs) of the 1,2,3-triazol-5-ylidene type are important ligands in organometallic chemistry and catalysis. Most MICs of this type are neutral ligands. Cationic MIC ligands remain relatively rare, and there are very little known about anionic MIC ligands. In this contribution, we will report on bidentate and anionic borate-based MIC ligands. A unique C-N isomerisation reaction in these ligands will be discussed. We will present Co(II) complexes with these isomerized ligands in which the geometry, the spin state, and the reactivity of the metal center can be controlled throughagosticinteractions in the secondary coordination sphere of themetal center. Results from synthetic chemistry, NMR spectroscopy, single-crystal X-ray diffraction, single crystal EPR spectroscopy and theoretical calculations will be discussed.

† Professor R. D. Desai 80th Birthday Commemoration Award

Bio-Data:

Biprajit Sarkar studied chemistry at the University of Delhi and at IIT Bombay before moving to Stuttgart, Germany to work on his PhDwith Prof. W. Kaim. After his PhD he moved to Strasbourg, France as a post-doc in the group of Prof. P. Braustein. Between 2006 and 2011 Biprajit was a „Habiltand“ (Asst. Prof.) at the University of Stuttgart, and between 2012 and 2019 he was an Associate Professor at the Free University Berlin. Since October 2019 he has been full professor and chair of inorganic coordination chemistry at the University of Stuttgart. His research interests are in the fields of redox-active ligands, carbenes, catalysis and switchable molecular materials. Biprajit has published morethan 300 papers in peer-reviewed international journals, and currently servesas a sectioned it or forthe Encyclopedia of Inorganic and Bioinorganic Chemistry.

Invited Lectures

Opportunities, Limitations and Recent Advances in Ionic Liquids as Environmentally benign Solvents for Chemical and Technological Applications

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Chemistry is dominated by the research on different kinds of solution to understand the behaviour of molecules in the solution phase and in molecular solvents. Any liquid may be used as a solvent but quite few are in general use. Solvents are major contributors and high on the list of environmental damage chemicals, mainly because of their large usage and high volatility. The widespread use of volatile organic compounds (VOCs) in many industrial chemical processes is an issue of great environmental concern. It is an extremely important task to search of potentially green and environment friendly alternatives for VOCs. At least a partial solution to this problem may offer by a novel class of molten salts referred to as ionic liquids (having melting point, generally, below boiling point of water), as they possess unique combination of particular properties, unlike molecular liquids, namely negligible vapour pressure (~ 10^{-11} to 10^{-10} bar at room temperature), wide thermal window (~ -50 °C to +250 °C), wide electrochemical window (~ ±3 Volt vs. NHE), non-flammability, high ionic conductivity and a highly solvating capacity for organic, inorganic and organometallic compounds. This unique combination of particular properties leads them to be exploited as "green solvents" and giving them increasing attention in academic and industrial research. The research areas on ionic liquids are growing very rapidly and the potential application are numerous, mainly due to the fact that simple changes in the cation and anion combinations or the nature of the moieties attached to each ion allow the physical properties of ionic liquids such as hydrophobicity, viscosity, coordinating ability, ion selectivity, and chemical and electrochemical stability to be tailored for specific applications. Proposed talk will include the introduction of green solvents, ionic liquids, and current research trends on ionic liquids as green solvents for the chemical and technological applications.

Bio-Data:

Dr. Ramesh Laxminarayan Gardas promoted to Associate Professor in July 2015. Ramesh Laxminarayan Gardas was born and brought up in Surat, Gujarat. He completed B.Sc., M.Sc. and Ph.D. in Chemistry from the Veer Narmad South Gujarat University. Then he joined University of Coimbra and University of Aveiro, Portugal, and Queen's University Belfast, UK for his postdoctoral research on physico-chemical properties and applications of ionic liquids. Then, Dr. Gardas joined the Indian Institute of Technology, Madras, India, in August 2010, as an Assistant Professor in Chemistry, and to full Professor in March 2020.

Dr. Gardas has more than 20-years of research and 10-years of teaching experience. So far, he completed 8 projects (as PI and Co-PI) worth more than Rs. 6.5 crores, guided 11 Ph.D. and 15 M.Sc. project students. Co-authored 4 patents, 4 book-chapters, 7 conference papers and 160 research publications

which received more than 6100 citations with h-index = 38 and average citations per paper of above 38. He delivered more than 150 invited talks and guest lectures.

Dr. Gardas' research group focusses on 'Chemical Thermodynamics' and 'Phase Equilibria' of industrially important solvents and their mixtures. His research group, is unique in the country, focusses on both 'Science' and 'Technology' part of contemporary field – "Ionic Liquids/ Deep Eutectic Solvents as alternative to Volatile Organic Solvents" and significantly contributing in connecting them. His research group substantially contributed to the development of non conventional and environmentally benign solvent systems. Generated extensive databases on their thermodynamic properties and structure-composition-property correlations useful in refrigeration, separation science and crude oil industry. These will have far reaching implications in the design of application-specific solvent systems. His research group strives to design the task specific ionic liquids and to provide an important insight into physical chemistry to regulate their properties for varied technological applications such as phase change materials, CO_2 capturing, dissolution of tank bottom sludge, electrolytes in solar cell and super capacitors, absorbents for refrigeration system, desulfurization of fuels, and also extraction of metal ions, biomolecules and value-added products.

More than 7500 thermodynamic data points measured in his research lab at IIT Madras are included in NIST Standard Reference Database developed by Thermodynamics Research Center, NIST, USA. Dr. Gardas developed a model to explain the density of a variety of ionic liquids over a wide range of temperature and pressure which is referred to and extensively used by the peer scientific community as 'Gardas and Coutinho' model.

In recognition of his outstanding performance as a researcher, Dr. Gardas has been bestowed with several awards by prestigious institutes/ societies including the Mid-Career R&D Award-2020 by IIT Madras. Recently, he has been recognized as (i) Associate Editor of Heliyon, Elsevier journal, (ii) Fellow Royal Society of Chemistry (FRSC), UK, (iii) Publons Top Peer Review Award 2019 (Top 1% of Reviewers in Chemistry), and (iv) one among the world's top 25 'Emerging Investigators' by the Journal of Chemical and Engineering Data, an American Chemical Society Journal.

Analysis of Respirable Crystalline Silica

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Exposures to respirable crystalline silica has many adverse health effects especially to people who works in mines and construction sites.Recommended exposure limit is 0.05mg/m^3as a time weighted average for up to 8 hours/day during a 40-hour workweek. A variety of methods /instruments are available for its determination. Current techniques used for respirable silica are FTIR and XRD.The present talk will be on the comparison of the two XRD method- US NIOSH and UK MDHS based on time, use of chemicals, accuracy and efficiency. US NIOSH filter redeposition filteration method is quite common using XRD, however, method is quite lengthy and tedious. UK method based on direct analysis on filters using XRD is not only time saving but also environment friendly. Dust generator designed for present method is efficiently deposited crystalline silica on filters and straight to the instrument for quantitative analysis against standards. Result outcome shows that UK MDHS method using dust generator provide accurate and precise results in a short span of time and uses no other chemicals except standards, make it environment friendly technique.

Bio-Data:

Dr. Archana Saily Painuly is an Alumni of IIT Roorkee, India and UWS, Australia. She has more than 20 years of experience in quality control analytical and environmental research labs in various capacities both in Australia and overseas. She has an expertise in method development and method validation for NATA and ISO 17025 accreditation for environmental analyses using major analytical instruments. She has immense experience related to NAAC accreditation for higher education institutes of northern part of India.

Her research covers broad spectrum of hydrometallurgical and bio-metallurgical methods with interest from basic mechanism to industrial applications. She has developed cost effective green methodology for recovery of heavy and hi-tech metals.

Dr. Painuly has three Patents to her credit on development of processes for the recovery of hi-tech and strategic metals from low grade ores, spent catalysts and industrial wastes. She is recipient of SEEWRT Research Award by UWS, Sydney and AINSE Award by ANSTO, Sydney to study the metal speciation and geochronology in sediment cores of lake Burragorang. She also received research award from Indian Society of Analytical Scientist, India for her work on removal and recovery of molybdenum and tungsten from wastes. She has been Executive Editor of Journal of Environmental Science, Toxicology and Food Technology since 2012. She currently serves as associate editor, guest editor and editorial board members and reviewers for several International and National journals. Currently she is involved in developing methods for airborne pollutants, soil hazardous contaminants and acid sulphate soils.

Studies of selenium and its species using instrumental, preconcentration and radiochemical neutron activation analysis

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Selenium has long been recognized as an essential trace element. Inductively coupled plasma mass spectrometry (ICP-MS) and neutron activation analysis (NAA) are widely used for its determination. We have taken advantage of the unique features of NAA such as its ability to analyze a few milligrams of solid as well as liquid samples non-destructively and independently of chemical species, and to determine low levels of selenium with excellent precision, accuracy, sensitivity, and detection limits in developing several NAA methods for assaying selenium and its species in a variety of materials.In instrumental NAA (INAA), the long-lived radionuclide ^{75}Se (half-life = 118.5 d) is generally used whichrequires lengthy irradiation, decay and counting schemes. Instead we have developed several methods including cyclic INAA (C-INAA) and pseudo-cyclic INAA (PC-INAA) for the detection of the short-lived nuclide ^{77m}Se (17.5 s) using both thermal and epithermal neutrons followed by conventional and anti-coincidence (PC-INAA-AC) gamma-ray spectrometry for the rapid measurement of picogram levels of selenium in milligram amounts of biological materials with high precision and accuracy.We have also applied these INAA methods in combination with solvent extraction for the simultaneous measurement of low levels of inorganic Se(IV) from Se(VI) selenium species and its co-contaminants such as arsenic and antimony species in natural waters. We have used a PC-INAA-AC method for measuring ppb levels of selenium in infant formulae and baby foodsand compared the results with a RNAA method for reliability, rapidity, sensitivity, and expanded uncertainty. Details of the methods and their applications will be presented.

Bio-Data:

A. Chatt received his Ph.D. in nuclear analytical chemistry from University of Toronto, Canada. He was a Full Professor and Killam Professor of Chemistry, Director of SLOWPOKE-2 Reactor facility, and presently an Adjunct Professor at Dalhousie University, Canada. Professor Dr. Chatt supervised 21 PhD, 17 MSc, 68 BSc students, and 75 postdoctoral fellows. His research interests include development of nuclear analytical and speciation methods. He has published over 190 papers, and presented over 465 invited papers. He is a Fellow of American Nuclear Society and Chemical Institute of Canada. He received many awards including the most prestigious international award in nuclear and radiochemistry called the Hevesy Medal Award. He is Associate Editor of Journal of Radioanalytical and Nuclear Chemistry. His professional activities include serving as a scientific expert for IAEA in more than 12 countries. He served as the President of International Committee on Activation Analysis over a 20-year period.

The application of thermoanalytical methods in the investigation of biologically important systems

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Thermal analysis covers a group of techniques in which a property of the sample is monitored against time or temperature while the temperature of the sample is programmed. In the past few decades, the application of thermoanalytical methods has been extended to the investigation of several types of naturally occurring compounds of biological origin. Thermodynamic analysis of biologically important molecules deals with structural insights and stability studies. It also helps to understand specific and nonspecific macromolecular recognition occurs in biologically important processes. Thus, thermodynamic studies provide an amply of information which is not only of fundamental scientific interest but also of enormous practical applications in biotechnology, pharmaceuticals and drug design. Calorimetry is a thermoanalytical method which directly and quantitatively measures the parameters associated with macromolecular stability and recognition. Structural transitions, like protein folding-unfolding, intermediate state formation and nucleic acid melting can be studied using differential scanning calorimetry (DSC). Ligand–protein, protein-protein, DNA-protein binding interactions can be studied by using isothermal titration calorimetry (ITC). DSC provides precise information on the extent of stabilization or destabilization provided by solvent/co-solutes along with the determination of thermodynamic parameters such as ΔHo, ΔSoand ΔGoof unfolding. The heat capacity of denaturation of the proteins in absence and in presence of different ligands/solvents will provide a quantitative information on the conformational details in combination with spectroscopic measurements. The experimental data obtained from ITC is used to obtain the values of enthalpy of binding (ΔHo), entropy of binding (ΔSo), binding constant (K), Gibbs free energy of binding (ΔGo), and binding stoichiometry. Such quantitative details of interactions of ligands with the proteins provide insights into the groups involved and the forces involved in the molecular recognition process. Thermo-analytical approach is widely being used for obtaining insights into biomolecular stability and mechanism of biomolecular interactions.

Bio-Data:

Dr. Sinjan Choudhary is currently working as Assistant Professor in the Department of Chemistry, UM-DAE Centre for Excellence in Basic Sciences, Mumbai. She obtained her M.Sc. in Biotechnology (2008) from Jawaharlal Nehru University, New Delhi and a Ph.D. in Biothermodynamics and Biophysical Chemistry (2012) from Indian Institute of Technology Bombay, Mumbai. Dr. Choudhary performed fundamental work in Biophysical characterization of protein-solvent and drug-protein interactions and protein folding intermediates using combination of spectroscopy and calorimetry during her Ph.D. Subsequently, she joined UM-DAE Centre for Excellence in Basic Sciences, Mumbai for her postdoctoral studies (2013-2015). As a postdoctoral fellow she was involved in structural characterization of ribosomal proteins from different parasites using different biophysical techniques. She started independent research work on „inhibition of protein fibrillation by small molecules‟ which was supported by DST-SERB Early Career Research Award. Her research work has been published in various reputed international journals. She has also been inducted as Editorial Board Member of Journal of Chemical Thermodynamics. She is recipient of various awards such as “Professor Shantilal Oswal Young Scientist Award” and “Giauque Memorial Award” in recognition of the research work in Thermodynamics and Bioenergetics. Dr. Choudhary‟s current research group is involved in unraveling the mechanism of inhibition of protein fibrillation and aims to exploit natural plant product based therapeutics for prevention of Parkinson‟s Disease. She has obtained SERB funding both at earlier career level and as core research grant.

Actinide ion extraction using room temperature ionic liquids: Understanding the mechanism for fuel cycle applications

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Nuclear power is fast emerging as the suitable alternative energy source to the popular fossil fuel based energy sources. However, the public acceptance of nuclear power largely depends on the mitigation of the long term hazards of the radioactive wastes emerging out of spent fuel reprocessing. Studies on the extraction of actinide ions from radioactive feeds have great relevance in nuclear fuel cycle activities, mainly in the back end processes focused on spent fuel reprocessing and waste management. The recovered actinides can find many applications and hence, are termed as 'wealth from waste' in a true sense. Though traditionally, molecular diluents have been used for reprocessing and waste management activities in the nuclear industry, recently the room temperature ionic liquid (RTIL) based diluents are becoming increasingly popular and hence, needs to be evaluated thoroughly.

The chemistry of the actinide ions is quite fascinating in view of their unique properties such as simultaneous existence in multiple oxidation states, autoradiolysis, large alpha activity associated, etc. Therefore, the extraction of actinides in RTIL based solvent systems due to complex extraction mechanisms makes it a challenging area of research.

By the suitable tuning of the cationic and anionic parts of the ionic liquids, their physical properties such as density, dielectric constant and viscosity can be changed which are considered key parameters in the extraction of the actinides. Aqueous solubility of the RTILs, which can lead to significant solvent loss, can be avoided by appending the extractant moieties onto the ionic liquid, termed as Task Specific Ionic Liquids. While the low vapour pressure and non-flammability of the ionic liquids make them appear as 'green' diluents, their aqueous solubility raises concerns of environmental hazards.

The lecture gives a summary of studies carried out on actinide ion extraction and presents perspectives of its applications in the nuclear fuel cycle with a brief discussion on the mechanism of extraction.

Bio-Data:

Dr. P. K Mohapatra joined Radiochemistry Division, BARC in 1887 after graduating from the 30th Batch of the BARC training school. An Alxander von Humboldt Fellow during 1998-2000, his research interest indude separation of actinides and fission products using novel extractants, in ionic liquid based solvents and novel separation techniques including liquid membranes. In view of his excellent contribution to separation science and technology, he has been elected as an honorary Fellow of National Academy of Sciences, Allahabad. A recognized guide of Mumbai University and Homi Bhabha National Institute (Deemed University), Dr. Mohapatra is an associate Editor of Separation Science and Technology and one of the Editors of Radiochimica Acta. He is also Editorial Board member of several International journals. Currently, he is heading actinide chemistry section and has over 370 publications in peer reviewed International journals.

Advances in Instrumental Analysis - Academia and Industry

Dr. Ajit Datar
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It is over last 70 years; the Instruments for Chemical Analysis are being used. The instruments used for analysis improved very rapidly from where it started to where it is today. Lot of the credit goes to overall development in instrumentation, electronics and computer technology including both hardware and software.

There are five important 'S' of analytical chemistry and all the development of analytical instrumentation, which has happened is around these 'S'. These 'S' are:

Sensitivity Selectivity Separation Structure Speed

In this lecture we will talk about how these 'S' have influenced the development of Analytical Instruments. It was realized that there are three factors; which are necessary to be suppressed to get required precision and accuracy of analysis. These three factors are Sampling error, Background and Noise. The effect of these errors is understood and the development has happened to reduce the effect of these factors. Biological Science is in the fore front and analytical instruments are being developed for analysis of biological samples. Under the current pandemic situation, it is of more importance. The term Omics has been used to get more information of biological system. In addition to

Genomics, Transcriptomics, Proteomics, Lipidomic, there is a new omics called as metallomics. The importance of metal ion and its valence state is getting realized in biological cells. The importance of ICP-MS, Speciation techniques are being used to identify the metallic elements in biological samples.

There are some more areas of concern, like miniaturization, more automation and the process analyser (PAT- Process Analysis Technology). Lot of development is happening in these areas.

The Analytical Instrument Lab in any research institute and in Industry is unfortunately considered as a service provider and there is a belief that there is not much scope of research in the field of analytical chemistry.

As the world of Analytical Instrument is advancing, we need to analyse the situation in which we are. There are three points of a triangle, one is Instrument manufacturers, the other Industrial users and the third is Academic users. The Instrument manufacturers are very well connected with both the users. The users are hardly connected with each other and that is why there is a gap between the Industry and academia.

There are many examples where the academia developed a prototype instrument and transferred the technology to the instrument manufacturer for developing a commercial product.

However, there is a need to develop skills which are required by Industry. We have to change. We have to introduce the syllabi considering the need of Industry and provide hands on training to the students by having some key instruments in the post graduate labs.

At the end, I would like to conclude that we have to get ready for the new generation of analytical instruments, with propre training at the college levels so that skilled man power can be developed for quality research and for the Industry which is striving for the trained man power.

I would like to advice my student friends that they should add skills to the basic qualification. Along with skill development, the students should also have self-development attitude for accomplishing best out of their aptitude.

Bio-Data:

Ajit Ganesh Datar has just retired as an Advisor to Shimadzu Analytical India Pvt. Ltd., Mumbai in the Customer Support Centre. His main job profile was to provide instrumental analysis support to the customers and provide training. Prior to Shimadzu, he was with Thermo Electron and served this organization as General Manager, Advanced Mass Spectrometry. He was responsible for promoting advanced Mass Spectrometry products of Thermo Finnigan in India. He retired in 2007 after completing 58 years. He served for Chromline and IR Technology as Technical Direcor and Sr. Manager respectively for period of 15 years. His first assignment was with Central research Station of Associated Cement Cos Ltd as Research Officer. He served ACC for 12 years. He has developed methods for characterization of catalysts and process products using catalysts. He indigenously developed BET Surface Area Analyser and particle size analyser.

Dr. Datar received his M.Sc. in 1971 and Ph.D. in 1976 from Mumbai University. He was recipient of Department of Atomic Energy Fellowship in 1971 and carried out his Ph.D. research from Analytical Chemistry Division of BARC.

He is a visiting faculty at several colleges in Mumbai. He has several publications in his name and was a guide for Ph.D. in Mumbai University and guided 8 students in the period of 2009 to 2017.

Functional Nanocomposite Materials based Electrochemical Bio-Sensors

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The growing variety of sensors has significant impact on everyday life with increasing demand for minimal costs and potential for real time monitoring. Considering these developmental factors, electrochemical approaches are the most promising due to their simplicity, miniaturization, high sensitivity and specificity. Functional nanocomposite materials have proved valuable in advancing the field of electrochemical sensors. The research in the field of functional nanocomposite materials based electrochemical sensors has earned an exceptional prominence in the recent years, as it has wide applications in clinical diagnostics and biological research. Various kinds of functional nanocomposite materials including carbon based nanomaterials, metal and metal oxides nanoparticles, conducting polymers, metal organic frameworks and / or macrocyclic compound have recently been employed by my research group for the development of electrochemical sensors. Their synergistic effect is found to be highly useful for the sensing of various classes of drugs such as alkaloids, analgesics, antipyretic, antibiotics, etc. at ultra trace level in pharmaceutical and biomedical samples[1-3]. Efficient enantiorecognition of enantiomers is of enormous importance in optically active pharmaceuticals products for effective and safe therapy.

Recently, Enantioselective analyses of multi-chiral drugs were investigated on nanocomposits modified electrodes with chiral selectors based on host-guest interactions employing differential pulse voltammetry[4,5]. This talk will describe some of our recent research on the application of functional nanocomposites for the development of electrochemical biosensors.

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Bio-Data:

Dr. A. K. Srivastava is a former Professor of Analytical Chemistry at the Department of Chemistry, University of Mumbai. He did his M.Sc. and Ph.D. in Analytical Chemistry from Banaras Hindu University in 1976 and 1981 respectively. He was a visiting professor at Michigan Technological University in 2006 and has been a visiting scientist at the US Army Research Laboratory, Aberdeen, USA intermittently during 2006 - 2018. He has guided 10 M.Sc. by Research, 28 Ph.D. and 4 Post-doctoral students. His research projects were funded by UGC, DST, BRNS-DAE and US Army research Laboratory mainly in the areas of Chromatography, Electrochemical (bio) sensors, Energy Materials, etc. He has over 150 publications in high impact international journals and have received over 4300 citations with h-Index of 35.
It is creditable that he has been declared as ‘author with highest number of citations’ in the field of Analytical Chemistry, which earned him the ‘Thomson Reuters Research Excellence India Citation Award – 2015’. He received the ‘Best Teachers Award by Government of Maharashtra and is a elected ‘Fellow of the National Academy of Sciences, India’.

Current Status of Atomic/Chemical Studies of Heavy and Trans- Actinide Elements at JAEA

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The chemical and atomic properties of heavy elements with atomic numbers greater than 100 are attracting an interest; their properties are affected by strong relativistic effects, and advanced techniques of analytical chemistry are required to conduct experiments at an-atom-at-a-time scale.

Recently we have successfully measured the first ionization potentials (IP1) of the heaviest actinide elements, fermium (Fm, atomic number Z = 100), mendelevium (Md, Z = 101), nobelium (No, Z = 102), and lawrencium (Lr, Z = 103) by using a novel method based on surface ionization technique[1,2]. The measured lowest IP1 value of Lr among those of actinides corresponds that Lr would have a loosely-bound electron in the outermost orbital. The comparison of the experimental value and the value predicted by the relativistic calculations strongly suggested that the electronic configuration of the Lr atom would be different from that predicted from the periodic table.

Besides, we also investigated the adsorption properties of volatile compounds of dubnium (Db, Z = 105) on a quartz surface. Adsorption enthalpies of oxychlorides of group-5 elements have been measured[3]. The results show that the volatility of Db oxychlorides could be almost similar to or lower than that of tantalum compounds.

At the presentation, recent activities about studies on atomic and chemical properties of the heaviest elements at JAEA will be introduced. Future experimental plans would be presented as well.

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Bio-Data:

Dr. Tetsuya K. Sato obtained his Ph.D. (Science) from Niigata University in 2003. In the same year, he joined the Japan Atomic Energy Research Institute (JAERI, current Japan Atomic Energy Agency (JAEA)). For his significant contribution in nuclear chemistry, he was awarded the prize from Japan Society of Nuclear and Radiochemical Sciences in 2019.

Neutral, Hydrophobic Fluorescent Probes and their Bio-analytical Applications

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Fluorescent probes are molecular entities used in several sophisticated analytical techniques of spectrofluorimetry. From bioanalytical perspective, these probes are used in probing structure, biomolecular binding and interactions, cellular events and dynamics, analysis of drugs and pharmaceuticals, new drug discovery and cellular drug tracking, environmental monitoring, high precision quantification of biomolecules, etc. These probes can be broadly categorized as: i) intrinsic probes- based primarily on biomolecules like the amino acids, proteins, and antibodies and, ii) extrinsic probes- derived mainly from synthetic molecules, select biological proteins, and quantum dots. In certain situations, these probes suffer from a few disadvantages. For instance, unsuitability of biomolecular intrinsic probes may be due to probe's inadequate fluorescence efficiency, wavelength range, sensitivity and, ability to provide proper information in the presence of multiple fluorophores in the system. Similarly, a biological extrinsic probe like a protein may be unfit due to its generally large molecular size, artifactual response, andphotoinstability.

Due to these limitations, small organic molecules-based extrinsic probes have been developed, which are derived from molecules like acridines, anthraquinones, benzoxathioles, coumarins, cyanine dyes, fluorescein, naphthalene, oxadiazoles, pyrenes, tetrapyrroles, triarylmethanes, xanthenes, etc. However, in many applications, even these probes are found to be inadequate due to their shorter absorption and emission wavelengths, hydrophilic and self-ionic behaviour, etc. While the shorter wavelength renders the probes unfit for biological and medical applications, the self-ionic/charged character contributes towards unwanted ionic/secondary Columbic interactions between the probe and the host system. Such interactions interfere with the fluorescence studies and complicate fluorescence data interpretation.

Considering the aforesaid, attempts have been made to develop neutral, hydrophobic fluorescent probes based on linear small molecules containing >C=C< chromophore. Generally, such molecules are either non-fluorescent or fluoresce inefficiently due to excited state energy dissipation through C,C double bond isomerization. However, it has been found that linear molecules of diarylpolyene series can fluoresce quite efficiently and can be used as neutral, hydrophobic probe in several fluorescence-based analyses. These molecules exhibit dual fluorescence involving locally and conformationally relaxed intramolecular charge transfer states. The emission from these states can be modulated considerably, with solvent and substituent. Further, in the solid state, these molecules can exhibit aggregation-induced enhanced fluorescence due to specific molecular arrangement in the crystal. Also, remarkably enhanced fluorescence is observed from their nanoparticles. The fluorescence probe efficacy of these molecules is demonstrated by studies of the microenvironment of organized assemblies and proteins. Attempts have also been made to develop two-photon excitable molecules, which owing to lower energy of employed

photons, cause less photo-damage and photo-bleaching to the host systems than the corresponding one-photon fluorescence microscopy. Such fluorochromes have brought new dimensions to fluorescence probing, wherein lies a great scope for exploring their bioanalytical applications.

Bio-Data:

Prof. A. K. Singh, a former Professor of Chemistry at the Indian Institute of Technology (IIT) Bombay embodies wealth of expertise and experience in science education and research, policy formulation, and administration. During a career spanning over four decades, Prof. Singh has worked in several key capacities in IIT Bombay and participated in drawing-up and developing academic policies and programs of education and research, and expansion of collaborations both in India and abroad.

He has also been associated in multiple capacities with several national and international educational and research institutions, R&D organizations, prestigious science academies and professional societies, government bodies, administrative and policy making entities etc., to drive organizational excellence. He has also held the position of Director, CSIR-Regional Research Laboratory (present-day North-East Institute of Science and Technology) Jorhat; and, Vice-Chancellor of two major universities, the Bundelkhand University and the University of Allahabad (a Central University). He is currently appointed as Independent Director of Rashtriya Chemicals and Fertilizers Ltd. Mumbai – a Government of India Undertaking, Ministry of Chemicals & Fertilizers.

Prof. Singh's research interest has been multidisciplinary in nature, broadly spanning the areas of organic and bioorganic chemistry, photochemistry and photobiology, with particular focus on: i) developing molecular understanding of structure and mechanism of functions of photoreceptors involved in biological sensory (e.g. vision) and energy (e.g. proton-pump) transductions, ii) excited state chemistry of linear polyenes, iii) photochemical synthesis, iv) design and development of novel molecular entities. His endeavours and contributions are duly recognized by the academic and research organizations, government and corporate bodies, prestigious science academies and professional societies, by awards and honours.

Modified ZnO - Synthesis, Characterization and Catalytic Applications

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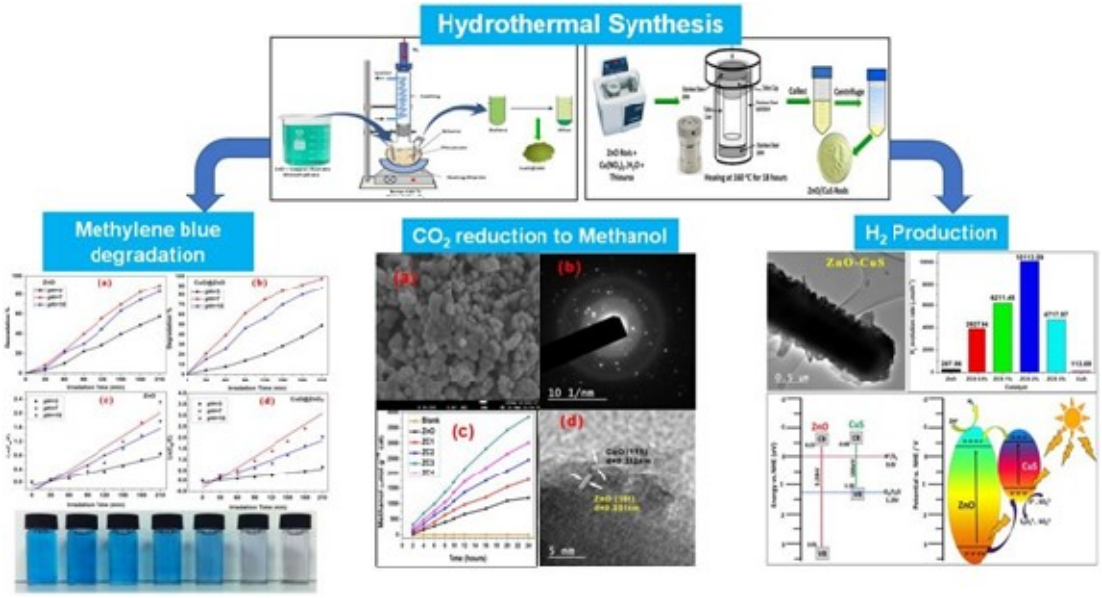
Development of an efficient, stable, economically viable and eco-friendly photocatalysts for hydrogen production has become a major objective in chemistry and a promising avenue to overcome the global energy crisis. In the present work results of the synthesis, characterization and application of nanostructures - ZnO-CuO, ZnO@CuS and ZnO@ZnS-NiS2 are discussed for the degradation of methylene blue, hydrogen production and CO2 reduction to methanol. All the three composites were synthesized by a simple hydrothermal method and well characterized by XRD, FE-SEM, TEM, XPS, UV-Vis-DRS, photoluminescence and hotoelectrochemical studies.



- ZnO@CuO hybrid nanocomposites demonstrated higher degradation activity for methylene blue (5 ppm) of 98% (pH 7), 49% (pH 3) and 87% (pH 10), photocatalytic H2 production rate of 4604 µmol h-1 g-1 and high efficiency for photoreduction of CO2 to methanol inaqueous solution containing dimethylformamide (DMF) and triethylamine (TEA) as electron donor under visible light irradiation.

- Synergistic effect of CuS and ZnO in ZnO@CuS nanorods resulted in increased light harvesting capability and efficient charge separation during the photocatalytic process leading to remarkably high photocatalytic H2 production (10113.59 µmol•g−1h−1) and an apparent quantum efficiency of 22.3% that is nearly ~35 times as high as that of pristine 287.96 µmol•g−1h−1.

- Three-component ZnO@ZnS@NiS multijunction photocatalyst exhibited higher hydrogen evolution activity (140.3 µmol g−1) under simulated solar light irradiation in 4 hrs, far exceeding those of bare ZnO (1128 µmol g−1), ZnO@ZnS (1808.8 µmol g−1) and ZnO@ZnS@NiS (8471.1 µmol g−1) counterparts.

This work provides a facile, controlled method for the fabrication of multicomponent heterostructures used for efficient solar water splitting. In addition to morphological properties, materials properties like surface area, active sites (vacancies, grain boundaries, corners and edges, unsaturation coordination), surface interface reaction are the major influencing factors. Various experimental parameters such as the effect of solution pH, type of sacrificial agent, and catalyst loading have been found to be very crucial that greatly affect the photocatalytic activity.

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Bio-Data:

Dr. B. Sreedhar was awarded his Ph.D. degree in 1990 by Sri Venkataswara University, Tirupati. He is currently working as Senior Principal Scientist, CSIR-Indian Institute of Chemical Technology, Hyderabad. He has received many awards like Best Research Publication (Journal of American Chemical Society) in 2002, CSIR Foundation day Best Performance Award in 2005, IICT Foundation Day in 2006, Hyderabad, Associate Fellow – Andhra Pradesh Academi of Sciences in 2007, Dr. Lakshmi Gold Medal – Indian Association of Solid State Chemists and Allied Scientists - ISCAS in 2007, Hindustan Platinum Award for the Best Poster Presentation – CATWORSHOP-2008 – Institute of Minerals and Materials Technology, Bhubaneshwar, 18th – 20th, 2008, Best Performance Award in New Entrant – 2007, IICT Foundation Day - 2008, Hyderabad, Fellow – Andhra Pradesh Academi of Sciences – 2018.

He is a member Academic Council, Institute of Science and Technology, JNTU, Hyderabad, Board of Studies, Department of Chemistry, Osmania university, Hyderabad, Industry Consultation Committee, Institute of Science and Technology, JNTU, Hyderabad, Board of Studies, Department of Physics, Jawaharlal Nehru Technology University, Kakinada. He is also a life member of Materials Research Society of India, Indian Association for Chemistry Teachers, Indian Association of Solid State Chemists and Allied Scientists, Electron Microscopy Society of India and Catalysis Society of India.

He has 379 Papers published in National and International Journals, 06 US patents and 143 papers presented in National and International Conferences. There are 8 Ph.Ds awarded and 2 ongoing; 45 M. Tech Project works and 75 M.Sc Project works under his guidance.

Occurrence and Potential Health Impact of Phthalates in the Environment

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Phthalate esters are synthetic organic chemicals used in many consumer products including cosmetics, toys, flooring and medical devices, and are ubiquitous within the environment (Gao and Wen, 2016). Humans are constantly exposed to phthalates, with increasing evidence of detrimental health effects (Ejaredar et al., 2015; Jurewicz and Hanke, 2011; Polańska et al., 2016). The European Commission is preparing to amend the Authorisation List (Annex XIV to REACH) with the additional identification of four phthalates as substances of very high concern (SVHCs) with endocrine disrupting effects on human health or the environment (European Commission, 2015). The phthalates in question are bis(2-ethylhexyl) phthalate (DEHP), dibutyl phthalate (DBP), benzyl butyl phthalate (BBP) and diisobutyl phthalate (DiBP). Other phthalates have yet to be studied extensively, and it is predicted that these replacement phthalates may prove to be as dangerous as those under legislative control.

This study examined eleven phthalates in a range of Irish environmental matrices. A novel triple-quad LC-MS method was developed with optimisation of sample preparation (SPE and US). The examination of phthalate burden in Ireland has shown that levels in Ireland are consistent with those reported elsewhere in Europe. Concentrations ranged from N.D. to 95 µg/L in aqueous samples and 0.01 to 315.21 µg/g in solid samples, with DiBP and DBP as the most prolific phthalates. Soil was identified as the largest sink of phthalates in our environment. A wastewater epidemiology approach was employed to assess human exposure to phthalates via measurement of phthalate metabolites. Exposure modelling determined that exposure in Ireland was below regulatory limits, and consistent with previously reported levels. A meta-analysis related the level of exposure to an associated risk, providing the first step in phthalate risk assessment within the Irish environment. This will close the knowledge gap from lack of biomonitoring data and inform future policy.

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Design and Control of Magnetically Tunable Colloidal Materials

Prof. Sibani Lisa Biswal
William M. McCardell Professor in Chemical Engineering
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One of the most exciting areas in colloid research is the control of interparticle interactions to generate new structures. The ease of tuning interactions, size, shape and composition has made these nano- and micrometer sized particles appealing probes for a number of fundamental studies. Recent work has focused on the use of colloidal particles that can act as models for studying the fundamental phenomena of atomic systems. The self-assembly of these "colloidal atoms" has led to investigations of the dynamics of chemical transformations such as nucleation or phase transitions. I will describe the application of a unique colloidal assembly system, with an isotropic interaction potential, to study material properties, such as phase transitions and melting. Magnetic filaments comprised of magnetic particles linked with DNA offer a method to probe dynamics of semiflexible filaments.

Additionally, studies on out of equilibrium phenomena will offer novel dynamic behavior, such as colloidal microscale swimmers. Our results promise to open up new insights into magnetically actuated 2-D materials.

Bio-Data:

Dr. Sibani Lisa Biswal is Professor and Associate Chair in the Department of Chemical and Biomolecular Engineering at Rice University in Houston, TX and leads the Soft Matter Engineering Laboratory. She has a B.S in chemical engineering from Caltech (1999) and a Ph.D. in chemical engineering from Stanford University (2004). She is the recipient of an ONR Young Investigator Award (2008), a National Science Foundation CAREER award (2009), Rice U. Graduate Student Association Faculty Teaching and Mentoring Award (2012), the George R. Brown Award for Superior Teaching (2015), the Rice University Chemical Engineering Alumni Professional Progress Award (2017), and the SW American Institute of Chemical Engineers Best Applied Paper Award (2018).

Particle size analysis of colloidal materials by scattering techniques

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Colloids comprising metals, semiconductors, polymers, surfactants, lipids etc have become an important component in several emerging technologies. Scattering of light, x-rays, neutrons etc have played a key role in understanding the microstructure, size distribution and short range order in such colloidal suspensions. In particular, several nano formulations have been employed by pharmaceutical and cosmetic industries for effective delivery of active ingredients. Recent studies indicate that drug delivery systems employing such colloidal carriers enhance the efficacy, minimise toxicity or even open new treatment modalities thereby leading to improved therapeutics. The average particle size, size distribution, shape and stability of the colloids are important parameters that dictate the efficacy of the formulation. This lecture highlights the application of scattering techniques for ensemble averaged morphological analysis of colloidal suspensions.

Bio-Data:

Dr. P. A. Hassan joined Bhabha Atomic Research Centre (BARC), Mumbai in 1993 and presently serving as Head of Nanotherapeutics and Biosensors Section, Chemistry Division, BARC. He was a visiting researcher at the University of Louis Pasteur, Strasbourg, France in 1995. He pursued his post-doctoral research at the Department of Chemical Engineering, University of Delaware, USA in 2000-2002. He has visited advanced neutron scattering facilities like National Centre for Neutron Research, NIST, Maryland, USA and Institute Lau Langevin, Grenoble, France. He has co-authored more than 140 papers in peer-reviewed journals with a total citation of 5600 and h-index 41 (google scholar). His current research interests include microstructure and dynamics of self assembly, polymers, polyelectrolyte-surfactant interactions and nano drug delivery systems. He is an elected fellow of the National Academy of Sciences, India.

The Saha Institute of Nuclear Physics-University of Calcutta collaboration - an example of many models of analytical chemistry

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The scientific discipline analytical chemistry is the science of many models. This statement has two aspects, first, the analytical chemistry is enriched by the contribution of many fundamental scientific branches, which is obviously true. Today's analytical chemistry has been shaped by the principles of physics, chemistry, mathematics, statistics, engineering, etc. The second aspect is that the analytical chemistry helps to unravel the puzzle of other scientific branches.

For last two decades the Radioanalytical Chemistry and Trace Analysis laboratory of Saha Institute of Nuclear Physics is enormously collaborating with various departments of the University of Calcutta, like Department of Archaeology, Department of Biotechnology, Department of Botany, Department of Chemistry, Department of Environmental Science, Department of Marine Science, etc. These collaborations resulted excellent outcome[1-11]. Apart from University of Calcutta, we had also nationwide inter-disciplinary collaboration with other premier institutes and universities like, Department of Physics, Indian Institute of Technology Roorkee, Department of Physics, Department of Chemistry and Department of Geology, Punjab University, Department of Chemistry, Department of Biological Sciences, Indian Institute of Science, Education of Research, Department of Chemistry, Indian Institute of Engineering, Science and Technology, Department of Microbiology, University of Sikkim, etc. Analytical Chemistry played crucial role in all of these interdisciplinary collaborations and have high output.

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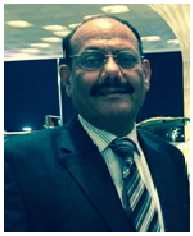
Bio-Data:

Professor Susanta Lahiri is an eminent radiochemist of International fame. He has made pioneering contributions in heavy ion assisted production of clinically important radionuclides. However, his interest has also proliferated in the areas of environmental radioactivity, green chemistry, cosmochemical analysis, bioaccumulation studies, speciation studies, as well as trace analysis. Currently he is working as Senior Professor at Saha Institute of Nuclear Physics, Kolkata, India. He received a doctorate degree from the University of Calcutta in 1994 and the University of Calcutta conferred upon him a D.Sc degree in 2009.

Professor Lahiri received the highest international honour in the field of Nuclear and Radiochemistry, the Hevesy Medal Award in 2015 and became the first Indian to receive the award in the history of ~50 years. The award was instituated in 1968 in honour of Nobel Laureate George de Hevesy. Earlier he received the prestigious associateship of Third World Academy of Sciences (TWAS) twice. He also received Professor J. C. Ghosh Memorial Award (2014) by Indian Chemical Society.

Professor Lahiri is the editorial board member of Journal of Radioanalytical and Nuclear Chemistry and Radiochimica Acta. He is also the member of CERN MEDICIS programme. He has more than 230 publications in international peer reviewed journal and 300 reports in international and national conference. He has guided 13 Ph. D students.



Analysis of functional foods

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Inclusion of function enhancing foods in the diet is a current trend and nutritional necessity. Various plant bioactives (bioactive peptides, botanicals), antioxidants, dietary fibers, functional starches, prebiotics, probiotics, functional lipids, vitamins, minerals, and other dietary supplements, and functional beverages, are few of the functional foods being used by consumers. Most of these foods may follow GRAS (generally regarded as safe) standard and do not go through the approval and scrutiny like a pharmaceutical material. As consumptions of these foods have increased exponentially, many customers and food formulators want to include these additives on the Nutritional Label. Because of rampant use, there is demand for stricter regulations for transparency and claims of the functionality of these additives. Unlike, pharmaceutical actives, there is not a well established path to register and scientifically certify the claims of functional foods. Many ethical producers of the functional foods establish their own analytical protocols to certify the content and functionality of the additives in the formulated foods. This also provides a commercial edge to the ethical manufacturers,

Development of a protocol for known additives, involves use of established methods, recommended by AOAC or other certifying bodies. These methods and protocols may work or need modifications to apply to new formulated products. When a new functional food is formulated with new additive, then there is a strong need to have new protocol. The new protocol involves a development of a procedure, validation of the method in the formulation and conducting Inter Laboratory Uniformity (ILU) tests. For uniform applicability of the protocol, it is advantageous to have an approval of reputable technical body. During the presentation, I will discuss an example of a new dietary fiber. The discussion will cover, defining needs, selecting technology, development of analytical procedure, validation and ILU studies and approval of method by AOAC.

Bio-Data:

Dr. Balasaheb Deshmukh is alumnus of Nagpur University Nagpur. He received his PhD from Nagpur University. He also served as a lecturer at Nagpur University Dept. of Chemistry before moving to University of Pittsburgh Pennsylvania. Later, in Pennsylvania and in New Mexico, he worked on National Science Foundation and National Institutes of Health funded research programs in the areas of ion selective electrodes, lithium ion batteries and cardiovascular drugs. He joined R&D of The Dow chemical Company in 1990 and carried out work in the areas of dielectric materials, cleaners, food additives, controlled release of drugs, and dietary fibers etc. As a Senior Research Leader he led various groups undertaking analyses of polymers, additives, bio molecules, agricultural products, solar cells, surfactants, solvents and process analyses. He has written book chapters on analysis of dietary fibers, published reviews and 52 research articles. He has presented his research work in more than 50 international conferences. He lives in California, USA.

He is a National scholar, received NSF and NIH research awards and was nominated for Harvey Wiley award by AOAC International. He was a BD Tilak Visiting Professor at Institute of Chemical Technology Mumbai 2007. He is also an Ex President of Analytical Sciences Discussion Group, Midland, Ex President Sigma Xi Scientific Research Society Midland Chapter Life member Indian Chemical Society, Member American Chemical Society Member Bioactive Lipids Society, Member Electrochemical Society.

Applying Different Analytical Approaches to Understand Intermolecular Interactions of Therapeutic Agents with Biological Receptors

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Drug-target interactions are basis for any therapeutic effect of drug candidate. Drugs interact with biological molecules via a variety of mechanisms. These largely include non-covalent and, in some cases, covalent interactions as well. In addition, the energetic consequences of such interactions are also important. There are several analytical strategies available to understand such interactions between therapeutic agent and biological receptor. Spectroscopic techniques such as UV, Fluorescence and CD are useful to estimate the strength of interactions. The interpretation of binding interactions can be carried out using appropriate mathematical models such as Scatchard plots or Stern-Volmer quenching constants in case of fluorescence quenching experiments. Some of these methods have been utilized to provide an estimate of the overall binding along with stoichiometric assessment of drug-receptor complex. Besides, computational approaches such as Docking, MD and QM-MM calculations have also been applied to study effectively the structural aspects of these complexes. Computational tools have provided structural information in terms of position and orientation of Anticancer agents in the receptor pockets along with their binding free energy values.

Bio-Data:

Research interests of Dr. Neelima Gupta vary from low coordinated phosphorus chemistry, synthetic heterocyclic chemistry to computational chemistry assisted study of reaction mechanism and drug-biomolecule interactions. She has worked as Postdoctoral Fellow at the EMA University, Germany, prior to joining the University of Rajasthan as Faculty. Presently, she also holds position of Joint Director at Centre for Converging Technologies at University of Rajasthan. She started her research in computational chemistry under DST's fast-track project for Young scientists and later was also a visiting scientist to the Computational Chemistry Group in Phillips University of Marburg under Indo-German cooperation program. Dr. Gupta has completed several research projects and has supervised 12 Ph.D. students and has more than 75 Research Publications in International Journals of Repute. She has authored chapters in International Reference Series - Science of Synthesis (Thieme Chemistry), Topics in Heterocyclic Chemistry (Springer-Verlag) and Methods in Pharmacology and Toxicology (Springer-Verlag). Dr. Gupta has received the "Distinguished Women Scientist Award–2019" from the Indian Society of Chemists and Biologists. She was Awarded for Excellence in Research among Top Researchers of the University of Rajasthan in 2009. As one of the founding Conveners of the CRSI-Rajasthan Chapter, she is actively engaged in Chemistry popularization program and is also Secretary in Chemical Research Society of India's present Governing Council. She has organized several National and International Conferences and delivered more than fifty Invited Talks in National and International Conferences, Symposiums, Workshops in India and abroad.

Novel Practicing Catalysts for Extreme Polyethylenes

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Over past two decades, late transition metal complexes as precatalysts has been extensively studied for ethylene polymerization and oligomerization besides titanium,[1] chromium[2] and vanadium catalysts[3]. These types of homogeneous catalysts, pioneered by Brookhart[4,5a] and Gibson,[5b] have been attracted much attentions by the scientists from academic and industrial views across the world.[6] Indeed, various important developments have been made in not only bench-top researches but also industrial scale-up processes. In addition to conventional polyethylene materials, new types of polyolefinic materials are accessible displaying unique properties and microstructures: highly linear polyethylenes using iron (and cobalt) precatalysts[7,8] as well as highly branched polyethylenes using nickel.[8,9] In fact, simple modifications or variations of the chelating ligands can have profound effects on performance which can manifest itself in higher efficiency and increased thermo-stability. Moreover, these technologies are scalable with linear and highly branched polyethylenes now produced on the pilot plant level.

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Bio-Data:

Prof. Dr. Wen-Hua Sun heads a group of organometallic chemistry and catalysis at the Institute of Chemistry, Chinese Academy of Sciences since 1999, has also been a chair professor in the University of Chinese Academy of Sciences from 2014. He was selected as Fellow of Royal Society of Chemistry and member of European Academy of Sciences. His contributions have had international impacts across the areas of polymerization catalysts for conversional alpha-olefins and polyolefins, biodegradable polymers and bio-massive process as well as their intermediates and reaction mechanism. His major subjects includespolyolefin oriented organometallics and pilot process of ethylene oligo/poly-merization as well as industrial processes.

Multiple Facets of Physical Gels and Soft Nanocomposites

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Physical gels unlike their polymeric counterparts are interesting materials owing to their widespread existence and amenability to tailoring into numerous applications. Much of these are achieved through self-assembly and intelligent applications of Supramolecular Chemistry. In this talk, I shall present various applications that can be achieved using such strategies from first principles.

Bio-Data:

Professor Santanu Bhattacharya is the Director of Indian Association for the Cultivation of Science and is an elected fellow of the Indian National Science Academy, The World Academy of Sciences and the Indian Academy of Sciences. His work has often led to conversations across disciplines in order to identify new areas of research and innovation. Some of the modern methods of therapeutics that he works on are at the cross sections of cell biology, chemistry and materials science. He spearheaded the design of unnatural and natural lipids and peptides, peptide assemblies, which contributed to understanding in membrane biophysics, gene delivery etc. He work also extends to soft gels and polymeric materials, nanocomposites, colloid surfaces; biomaterials, Langmuir films, covalent-organic frameworks and sensor design. He has published over 300 papers and reviews in peer-reviewed journals (h-index > 69). He has been a Professor (2001-), and was the Chairman (2012-15) of Organic Chemistry, at the Indian Institute of Science, Bangalore. Dr. Bhattacharya received his PhD from the Rutgers University, NJ, New Brunswick (1988), and had post-doctoral stint under the tutelage of Professor Har Gobind Khorana, Nobel laureate at the Massachusetts Institute of Technology - the theme of his studies being signal transduction of membrane proteins. He is a recipient of several honors and awards including the S. S. Bhatnagar Prize, Swarnajayanti Fellowship, and National Bioscience Award for Career Development award (DBT), G D. Birla Prize Ranbaxy Prize, Sastra-CNR Rao Award and the TWAS Prize in Chemistry.

Novel Strategies in Electrochemistry: Simultaneous Water Splitting and CO_2 conversion in One Electrochemical Reaction

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It is well accepted now that concurrent to the increase in population, India's rapid economic growth has forced us to recognize the challenge of providing advanced materials to address many problems currently plaguing our nation. Among them, dealing with energy supply, pollution and improved medical care are some of the issues that are being addressed in our lab. We work on the selective processing of inorganic structures with features on the nanometer scale. These materials are known to possess interesting and useful optical, electronic and/or magnetic properties that can subsequently be exploited in a wide variety of applications ranging from novel forms of catalysis to solar energy conversion. The choice of application is contingent on not only the chemical composition of the material but also on the overall morphology, and even more precisely on the accessible surface area. As such, the emphasis in our lab has been to use synthetic inorganic chemistry as a tool to form intricate structures that are then exploited in applications predominantly associated with solar energy capture and conversion. Presented in this talk will be novel electro- catalysts for combining pollution remediation AND water splitting electrochemical reactions. This unique approach will be detailed as to how it can yield value added (and industrially applicable) chemicals and also tackle pollution remediation in onestep.

Bio-Data:

Dr. D. Khushalani is Professor in Materials Chemistry, Department of Chemical Sciences, Tata Institute of Fundamental Research (TIFR), Mumbai . She is the winner of Bronze Medal in Chemistry 2018, DST (Nanomission) Young Career Award in Nanoscience and Technology2016, Fellow of Royal Society of Chemistry (FRSC), Chair of RSC West India Section, Editorial Board Member of Scientific Reports (Nature Publishing Group), member of Indian Academy of Sciences – Women in Science Panel, member of Royal Society of Chemistry, UK – Inclusion and Diversity Committee.

Her area of expertise involves synthesis, characterization and application of a variety of inorganic structures such that (1) the morphology, phase, and size are carefully manipulated so that there is precise control over homogeneity and compositional purity, (2) the ensuing materials are applied in areas exploiting alternate sources of clean energy involving photovolatics and energy storage devices.

Density Matrix Renormalization Group Studies on Polyaromatic Hydrocarbons – Effect of Spin Frustration and Topology

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Polyaromatic hydrocarbons (PAHs) such as acenes have long been studied due to its interesting optical properties and low singlet triplet gaps. Earlier studies[1,2] have already noticed that use of complete valence active space is imperative to the understanding of its qualitative and quantitative properties. Since complete active space based methods cannot be applied to such large active spaces, we have used density matrix renormalization group (DMRG)[3] based approaches. Further small modification to the PAH topology shows interesting new phases of behaviour in its optical gaps. We have understood the effect of these effects based on spin frustration due to the presence of odd membered rings. In this talk, I will discuss these observations from molecular and model Hamiltonian perspectives.[4]

1. The radical character of the acenes: A density matrix renormalization group study, J. Hachmann, J.J. Dorando, M. Aviles, G.K.-L. Chan, *J. Chem. Phys.*, **127(13)**, 134309 (2007).
2. Singlet triplet gaps in polyacenes: a delicate balance between static and dynamic correlations investigated by spin flip methods, C.U. Ibeji, D. Ghosh, *Phys. Chem. Chem. Phys.*, **17(15)**, 9849 (2016).
3. Orbital Optimization in the density matrix renormalization group, with applications to polyenes and beta carotene, D. Ghosh, J. Hachmann, T. Yanai, G. K.-L. Chan, *J. Chem. Phys.*, **128(14)**, 144117 (2008).
4. In the quest for a stable triplet state in small polyaromatic hydrocarbons: an in silico tool for rational design and prediction, M. Rano, S.K. Ghosh, D. Ghosh, *Chemical Science*, **10**, 9270 (2019).

Bio-data :

Debashree Ghosh is an Associate Professor at the Indian Association for the Cultivation of Science. She did her PhD in theoretical chemistry from Cornell University and did a stint of postdoctoral research at University of Southern California before joining her independent research position in India. She is working towards elucidating the mysteries of light matter interaction and uses theoretical approaches to achieve this goal.

The Advantages of 'Broad-band Excitation' and 'Broad-band Emission' Based Analysis

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Generally for complete analysis of multi-fluorophoric systems (like petroleum and vegetable oils, dissolved organic matter in water, urine, blood, polycyclic aromatic hydrocarbons in various media, petrochemicals etc.), conventional emission spectra with single wavelength excitation are not suitable[1]. Technique like Excitation-Emission Matrix (EEM) imposes certain limitations on the rapidity of data acquisition.

'Broad-band excitation' and 'broad-band emission' measurement method have been reported in old literature[1], but they have never been popular due to their poor resolving power and analytical limitations. Our research group has introduced some novel unconventional analytical concepts involving these techniques that have made analytical measurements fairly robust.

Prakash and Mishra have used white light excitation fluorescence (WLEF) measurements using an in-house built fiber-optic spectrofluorometer for analysis of multi-fluorophoric systems. Unlike single excitation and emission based fluorescence measurements, WLEF helped in capturing total fluorescence response of the sample over entire UV and Visible region in a single scan. Prakash and Mishra have successfully demonstrated the utility of WLEF technique for the analysis of pharmaceuticals in bio-fluids[2], dip-probe estimation of fluorophores [3] and estimation of composition of petroleum fuel-biofuel mixtures [4]

Panigrahi and Mishra have utilized WLEF concept in a commercial table-top spectrofluorometer for analysis of oils, urine and optical brighteners [5]; the authors have also demonstrated the utility of broad-band UV excitation in fiber-optic spectrofluorometer for analysis of fluorescent dissolved organic matter using a reflective walled sample compartment[6,7].

A time-resolved fluorescence data acquisition technique termed as "Total Emission Time Resolved Decay" (TETRD) has been proposed; TETRD is recorded by using zero-order diffraction of emission grating in TCSPC instrument[8]. It is effective in collecting all the decay related information expediently. With the use of an appropriate data analysis tool (like Stretched exponential function fitting and global analysis), the multi-component decay profiles could be resolved conveniently.

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Bio-Data:

Professor Ashok Kumar Mishra completed his Master of Science from University of Delhi in 1980 and received PhD from IIT Kanpur in 1985. After a stint in Sambalpur University as a faculty member, and in Gunma University (Japan) as a Monbusho fellow, he joined IIT Madras in 1992. He was a JSPS Visiting Scientist in Gunma University, Japan during 2002-2003. Currently he is working as Professor in the Department of Chemistry, IIT Madras. He also handles the responsibility of Dean Academic Research at IIT Madras.

Prof Mishra is a Fellow of the 'National Academy of Sciences, India'. Awards received by him include 'CRSI Bronze Medal' from the Chemical Research Society of India, 'Acharya P C Ray Memorial Award' from Indian Chemical Society and 'Prof W U Malik Memorial Award' from The Council of Chemists.

Prof Mishra works in the general area of Physical Photochemistry and Fluorescence Spectroscopy. He has an active research group. So far he has guided 27 PhDs, many M.Sc. students, and published about 210 research papers, reviews and monographs.

Luminescent Metal Nanoclusters: Spectroscopic Signatures and Applications

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Metal nanoclusters (NCs) have attracted a lot of research attention of late, primarily due to their advantage of exhibiting size dependent optical properties, better water solubility, biocompatibility, and low toxicity. They are now considered as the next generation fluorophores. In my talk I shall discuss some of the spectroscopic signatures of metal NCs (with emphasis on Cu NCs). Also, how these NCs can serve as a nanothermometer, discriminate between single base pair mis-matches in DNA, specific metal ion sensors, nuclear membrane markers, bio-sensors etc. will be discussed.

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Bio-Data:

Dr. Saptarshi Mukherjee did his BSc and MSc from Jadavpur University and completed his PhD from IACS Kolkata in 2006 under the supervision of Professor Kankan Bhattacharyya. During his PhD tenure, he used time-resolved spectroscopy to study organized assemblies. He moved to Bowling Green State University, Ohio, USA to carry out his post-doctoral research with Professor H. Peter Lu on single molecule enzymology. He returned to India and joined the Department of Chemistry, IISER Bhopal in December 2008 as an Assistant Professor. He became a full Professor in January 2018.

He is also the Deputy Director of IISER Bhopal since March 2018. His research interests include ultrafast and single molecule spectroscopy of luminescent metal nanoclusters, biological assemblies and surface chemistry. He is the recipient of the INSA Young Scientists Medal, founding core member of INYAS, recipient of CRSI Young Scientist Medal and CRSI Bronze Medal. Professor Mukherjee is also the Senior Editor of the journal, Chemical Physics Impact, published by Elsevier.

Molecular Approaches to Control Coherence in Singlet Fission

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Emerging light harvesting materials such organic semiconductors have proved successful in terms of costs but encountered a limit for device efficiency. The fundamental limits based on the Shockley-Queisser detailed-balance model provides a basis for identifying the key limiting factors, related to efficient light management and charge carrier collection. It has been shown multiexciton generation through singlet fission has the potential of exceeding Shockley–Queisser limit in photovoltaic devices. However, only very few materials suitable for singlet fission are available at present and the mechanism of inter- and intra-molecular singlet fission are not fully understood. Detailed knowledge regarding the processes is crucial for developing new materials. In this talk, I will present the molecular design and synthesis strategies to meet the exchange energy and morphology criteria for molecules to undergo singlet fission.

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Bio-Data:

Dr. Patil is Professor in Indian Institute of Science, Bengaluru. He obtained his Ph.D. in Polymer Chemistry), Bergische University of Wuppertal, Germany (2004). He is the recipient of several prestigious awards and recognitions like Swarnajayanti fellowship (2013-2014), Young Affiliates of the World Academy of Sciences (2013), INSA Young Scientist Award (2009), Young Associate of the Indian Academy of Science, Bangalore (2009-2012), Chemical Research Society and Materials Research Society of India Bronze Medal (2012), Professor Kaushal Kishore Memorial Award of the Society of Polymer Science, India (2014), A V Ramarao Research Foundation Young Scientist Award (2012), Microsoft Research (MSR) India Outstanding Young Faculty Award (2009). He is also an Editorial Board Member of iScience, Associate Editor of Resonance - Journal of Science Education and Editorial Board Member of ACS Chemical Health and Safety.

Solubilization Behavior of Hydrophobic Drugs in Pure and Mixed Micelles of Pluronic Triblock Copolymers

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Solubilization study of hydrophobic drugs into pluronic co-polymeric micelles has gained great interest because these solubilized formulations have increased solubility, metabolic stability and circulation time. Moreover mixed micelles manifest synergistic properties, such as increased micelle stability and drug loading efficiency, superior to those of the individual micelles. The solubilization of hydrophobic drugs *viz.* Oxcarbazepine (OXC), Lamotrigine (LAM) Clozapine (CLZ) and Quercetin (QCT) have been studied in pluronics and pluronics-mixed micelles with other amphiphiles such as surface active ionic liquids (SAILs) and Bile salts, Sodium deoxycholate (SDC) employing state of art techniques. UV-visible spectroscopy has been exploited to determine the solubilization capacity of the investigated micellar systems in terms of drug loading efficiency, average number of drug molecules solubilized per micelles (n_s), partition coefficient (P) and standard free energy of solubilization (ΔG). The locus of hydrophobic drugs in different pluronic and pluronic mixed micelles has been adjudged by ^{1}H NMR, Micropolarity, Small angle neutron scattering (SANS) and isothermal titration calorimetry (ITC) measurements. Dynamic light scattering (DLS) have been employed to determine the hydrodynamic diameter (D_h) of loaded and unloaded micelles. The results of the present studies will discuss in detail at the conference.

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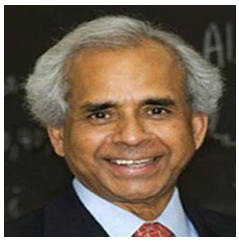
Bio-Data:

Prof. (Dr.) Rakesh Kumar Mahajan has joined back as Professor (Re-employed) on June 2019 at Chemistry Department of Guru Nanak Dev University Amritsar after serving as the Vice-Chancellor of DAV University, Jalandhar from December 2017 to June 2019. Prior to joining DAV University, he has held various prestigious assignments at Guru Nanak Dev University (GNDU), Amritsar. During his tenure as Professor of Chemistry at GND University, he has held several additional posts being the Head of Chemistry Department, Dean in the Faculty of Sciences, Professor In-Charge (Examinations) in the office of Controller of Examinations, Dean, Colleges Development Council and Coordinator in University-Industry Linkage Programme.

His areas of research specialization include Chemical Sensors, Colloids and Interfaces, Environmental Chemistry and Material Science. To his credit lies the publication of more than 171 research papers in several journals of international repute. In addition, he serves as a referee in a number of renowned journals by Elsevier, American Chemical Society (ACS), Springer, Royal Society of Chemistry (RSC), Wiley, Taylor & Francis and many other publishing houses. He is a reviewer of various research schemes submitted to UGC, CSIR, DST and Ministry of Forest and Environment, New Delhi. He is also a subject expert member of many committees of various universities and national organizations.

In lieu of his contributions, Indian Chemical Society bestowed him with P.K. Bose Memorial Award-2009, at Annual Convention of Chemists, Raipur in December 2010. Awarded CRSI Bronze Medal by Chemical Research Society of India at the 16th CRSI National Symposium in Chemistry held at IIT Bombay during Feb. 7-9, 2014. He was elected fellow in the year 2015 of The National Academy Of Sciences, INDIA (F.N.A.Sc.) and in the year 2019 of Punjab Academy Of Sciences, (F.P.A.S.)

Chemistry Beyond Conventional Wisdom*



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One of Chemistry's biggest contribution to materials science is the Mendeleev's periodic table of elements. Created in 1869 before the discovery of the electron and the knowledge of quantum mechanics, the periodic table explains the chemistry of elements in terms of their valence electrons. Zinc, for example, is divalent. With an outer electron configuration of $4s^2$, two Zn atoms bind weakly, but bulk Zn is metallic. The outer electron configuration of noble gas atoms, on the other hand, is ns^2np^6. Because of the closed shells (the octet shell closure), noble gas atoms are chemically inert. Zn being trivalent and noble gas atoms forming chemical bonds at room temperature should be against conventional wisdom. In this talk I will discuss ways in which zinc can assume a +III oxidation state and noble gas atoms, including argon, can form a covalent bond at room temperature. These unexpected features are made possible by the use of highly electronegative clusters that exist in multiply charged states in the gas phase. In particular, $BeB_{23}(CN)_{22}$ cluster, stable as a tetra-anion in the gas phase, can make Zn to assume +III oxidation state, while $B_{12}(CN)_{11}^-$ cluster can bind argon with a binding energy of 0.6 eV. The results are based on density functional theory with dispersion correction and predictive capability. The rational design of clusters with electron affinities far exceeding those of halogen atoms and their ability to promote chemical reactions once thought impossible can usher a new era in chemistry.

*Work performed in collaboration with Dr. Hong Fang and supported by the Department of Energy

Bio-Data:

Dr. Puru Jena is Distinguished Professor of Physics at Virginia Commonwealth University. He served as Program Director at the Materials Science Division of the National Science Foundation during 1986-87 and as Jefferson Science Fellow and Senior Science Advisor at the US Department of State during 2007-08. Dr. Jena's research covers a wide range of topics in nano-structured materials, condensed matter Physics, and materials Science. He is the author of more than 630 papers including 13 edited books. His Google citations and H index are 31,000 and 87, respectively. He has given over 500 invited talks in 32 countries, including over 250 invited talks at international conferences and has organized 60 international conferences. Some of Dr. Jena's many honors include Fellow of the American Physical Society; Outstanding Scientist of Virginia; Presidential Medallion, University Award of Excellence, and Outstanding Scholar of Virginia Commonwealth University; and Outstanding Faculty Award from the State Council of Higher Education of Virginia. He has served as a member of numerous scientific panels at the National Academy of Sciences. National Science Foundation, Department of Energy, Army Research Office, Virginia Governor's task force on green energy technologies and co-chair of the Presidential Commission on bilateral scientific collaboration between USA and Russia.

Cucurbituril-based Functional Supramolecular Assemblies: Prospective Applications

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Of late, there is an upsurge in the research of supramolecular assemblies of organic guests using various macrocyclic receptors and biomolecules as they provide a unique way to control the sophisticated nanoarchitectures to create supramolecular functional assemblies. Among many different strategies for making such functional assemblies, non-covalent host-guest interactions have recently received large attentions in a variety of scientific fields due to their unique assembly characteristics and functional performances. Macrocyclic hosts such as cucurbiturils, calixarenes and cyclodextrin derivatives have gained immense research interest because of their ability to host, in a highly selective manner, certain types of guest molecules such as metal cations, protonated alkyl and aryl amines, cationic dyes, amino acids and drugs through ion-dipole interaction and hydrophobic interactions. The presentation will cover some of the recent work on the spectacular molecular properties of macrocyclic host-assisted functional assemblies of few organic dyes/drugs having technological and biological importance and their projected applications toward the aqueous dye laser, fluorescent sensors, ^{99m}Tc generator bed, amyloid fibril inhibitors, antibacterial agents and controlled drug delivery.

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Bio-Data:

Dr. Jyotirmayee Mohanty is working as an Associate Professor in the Radiation & Photochemistry Division, BARC, Mumbai. She did her PhD from the University of Mumbai in 2002. She received the Alexander von Humboldt Fellowship for Experienced Researchers-2013. She has also received many awards like CRSI Bronze Medal-2017 from the Chemical Research Society of India, Scientific & Technical Excellence Award-2011 from DAE, Samant Chandrasekhar Award-2011 from Odisha Vigyan Academy, APA Prize for Young Scientist-2010 from the Asian and Oceanian Photochemistry Association, Distinguished Lectureship Award-2009 from the Chemical Society of Japan, Max-Plank Fellowship (2002-2003). She is the Associate Editor of Frontiers in Chemistry (Supramolecular Speciality Section), Visiting Scientist at Jacobs University Bremen, Bremen, Germany (Nov. 2013-Jan2014), Fellow of National Academy of Sciences (F.N.A.Sc.), India, Fellow of Maharashtra Academy of Sciences(F.M.A.Sc.). She has 96 publications in high impact and reputed International journals such as J. Am. Chem. Soc., Angew. Chem. Int. Ed., Chem. Commun., Chem. Eur. J., etc including 2 Patents and 4 Book Chapters.

Extraction of Essential Oils from the Peels of Pomelo Fruit and Their Dispersion in aqueous based media with or without a Surfactant for Targeted Applications

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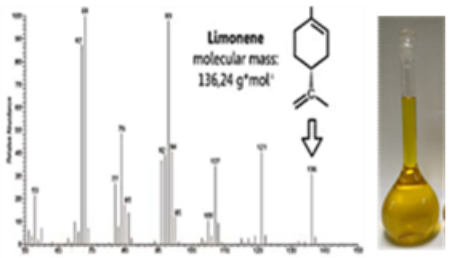
Fruit peels which are generally disposed haphazardly adding to environmental problems in the country in general and the state of Manipur in particular are rich sources for essential oils. We have developed a simple mechanical method for extraction of essential oils from the peels of Pomelo fruit (Citrus maxima, local name – Nobap)grown abundantly in Manipur. We have also set up a hydro-distillationunit using glassware apparatus in the laboratory for extraction of the essential oils. Both the methods are simple, effective and user friendly.

Pomelo Plant

Pomelo Fruit Peels



GCMS of the essential oil

The preliminary studies showed that the oil extracted by the mechanical method is superior to the one extracted by the hydro-distillation method both in terms of the quantity and the quality.Results from GC-MS, UV-Vis and FT-IR revealed that limonene is the major component of the essential oil constituting about 79% while others likePinene, Myrcene, etc. are present as minor components.The essential oil exhibited the antibacterial activities against both B.subtilis and E.coli. The ternary phase diagram of the oil and water with an organic alcohol or a non-ionic surfactant or their mixtures have been developed with a view to dispersing the oil in aqueous based media. The surfactants studied include TX-100, Tween-20, Tween-40, or Igepal. Among the surfactants studied, Tween-20 was found to be most effective dispersant. Formation of gels in specific regions in the systems containing TX-100, Tween-80, or Igepal was observed which can be de-gelled by addition of an organic alcohol. The details will be discussed during the talk.

Bio-Data:

Dr. Homendra Naorem is Professor of Physical Chemistry at Manupur University. His research area of interest lies in Self-aggregating systems, surfactants, dyes, polymer, dye-polymer-surfactant interactions, entrapment of dyes in soft gel network materials, development of dye sensitized solar cells, etc. He has published more than 50 papers. He has received many awards like DST-MASTECH Young Scientist at PSU, IACS, Kolkata(1997), JC-Bose Visiting Professor at SPS, JNU, New Delhi(2009), Honour Medal from DAV Women's College, Amritsar(2011), Centenary Award Medal Talk from Shanxi University, Shanxi, China(2012), BN Gosh Memorial Award and Medal (2012) by the Indian ChemicalSociety, Appreciation Award from Chemistry Department (2014) NEHU, Shillong. Professor Naorem is a member of several professional bodies like CRSI for the terms 2011-14 and2014-17, elected executive Member Indian Soc for Surfactant Sc& Technology (ISSST), Indian Thermodynamics Society(ITS), Secretary General, NE Chapter of ISSST, Life member Indian Chem Soc, Polymer Soc India. He has undertaken more than 9 major projects and produced 8 completed PhDs.

Allosteric Regulation of Molecular Tunnels

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Molecular tunnels in multifunctional enzyme systems allow the passage of labile intermediates. In most cases this process is governed via allosteric cues that aid in transfer of signals. Here, we investigate the mechanism of ammonia passage in bi-functional enzyme formylglycinamidine (FGAM) synthetase that catalyzes a key step in the essential purine biosynthetic pathway which help synthesis bases that act as building blocks for DNA and RNA. Ammonia is produced in the glutaminase domain and it traverses to the FGAM synthetase domain, via a ~ 25 Å long transient hydrophobic tunnel converting formylglycinamideribonucleotide (FGAR) to formylglycinamidineribonucleotide (FGAM). The enzyme has an extra 200 amino acid domain at the N terminus which has been shown to be essential for function but possesses no active site residues[1]. The exact allosteric switch as well as the path followed by ammonia had remained elusive for decades. Some insights into the pathway emerged via carrying out RISM calculations[2,3]. Here, by a combination of X-ray crystallography and biochemical studies, we unravel the origin of the allosteric switch. Combinatorial molecular dynamics studies, validated by experiment, reveal that the partially unfolded state of a catalytic loop that resides near the FGAM synthetase active site is key towards transmitting the signal via the bridging N-terminal domain. This facilitates the restructuring of the glutaminase site to its active form along with the concomitant formation of the ammonia tunnel. Furthermore, a dual gating mechanism controls the release of ammonia via a timely swinging motion of the two extreme gates. This study asserts that substrate channelling is modulated by allosteric hot-spots that alter the protein energy landscape thereby, allowing it to adopt transient conformations, paramount for function.

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Bio-Data:

Dr. Ruchi Anand completed her PhD in 2004 from the Department of Chemistry and Chemical Biology at Cornell University, USA. After conducting postdoctoral research at Sloan Kettering and the University of Pennsylvania she joined IIT-Bombay in 2008 as an Assistant Professor. Her laboratory employs a combination of X-ray Crystallography, Cryo-EM, biochemical and biophysical tools to understand molecular mechanisms with implications to human health. Her current research interests follow a multipronged approach where she has contributed to two major areas, antimicrobial resistance and biosensors development. Towards the first goal of combating drug resistance she focuses both on unearthing enzyme systems that can serve as new therapeutic targets as well as is involved in understanding the origins of antibiotic resistance itself. Her recent work with bacterial transcription factors has paved the way to structure-guided development of biosensors for aromatic pollutants. Since 2016, she has been serving on the Editorial Advisory board for ACS Sensors. She was the recipient of the National Academy of Sciences Fellowship (FNASc) in 2019 and also won the National Women Bio-scientist Award, Department of Biotechnology, in 2018 and was awarded the CRSI bronze medal for 2020." She was also awarded the DBT-Wellcome Trust Alliance Senior Fellowship earlier this year.

Plasmonic Platforms for SERS: From Fundamentals to Translational Research

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Excitation of surfaceplasmons in metal nanoparticles is associated with collective oscillation of conduction electrons, leading to the generation of a large electric field on its surface which decays with distance.[1,2] Generation of such rather large electric fields around metal particles resulted in numerous interesting advances in the area of spectroscopy; for example, surface-enhanced Raman scattering (SERS).[3] Precise assembly of plasmonic materials of desired size and shape allows further modulation of their optical and field effects.Assembled plasmonic nanostructures create regions of enhanced electric fields at the nanogaps (hot spots) due to surface plasmon coupling, which are significantly higher compared to the monomeric nanostructures.[4-6] Owing to the enhanced electric fields, analyte molecules placed at the nanogaps of assembled nanostructures showed considerably large enhancement in the spectroscopic signals. We have investigated the effect of the field on SERS at the vicinity of plasmonic nanoparticles and hot spots and further translated these concepts for the design of plasmonic platforms, which can identify molecules of importance in health, environment and safety.[7-10] Taking these ideas forward,we have developed of a customized Raman spectroscopy device (with the technical support of Prof Chandrabhas Narayana of JNCASR, Bangalore) interfaced with an in-house developed plasmonic platform based on various core-shell plasmonic nanostructures and data processing software for rapid detection of pesticide/insecticide residues from vegetables and fruits (supported by IMPRINT Project). These aspects will be presented.

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Bio-Data:

Dr. Kakkudiyil George Thomas (born 1961) is an Indian photochemist, nanomaterial scientist and a professor at the Indian Institute of Science Education and Research, Thiruvananthapuram. He is known for his studies on photoresponsive nanomaterials and is an elected fellow of the Indian National Science Academy and the Indian Academy of Sciences The Council of Scientific and Industrial Research, the apex agency of the Government of India for scientific research, awarded him the Shanti Swarup Bhatnagar Prize for Science and Technology, one of the highest Indian science awards, in 2006, for his contributions to chemical sciences. K. George Thomas, born on 13 May 1961 in the south Indian state of Kerala, did his early schooling at his home state before joining Savitribai Phule Pune University from where he completed his master's course (MSc) in chemistry in 1983. He returned to Kerala for his doctoral studies under the guidance of K. Saramma and secured a PhD from the University of Kerala in 1989. His post-doctoral studies were at the Photosciences and Photonics Group of Manapurathu Verghese George at National Institute for Interdisciplinary Science and Technology (NIIST) as a research associate and after completion of the studies in 1994, he continued at NIIST to start his career as a scientist. Subsequently, he joined Indian Institute of Science Education and Research, Thiruvananthapuram and serves the institution as a professor while continuing his researches at NIIST. He has also had various stints at the University of Notre Dame in 1999, 2003, 2004 and 2005 as a visiting faculty and is an honorary faculty fellow at Jawaharlal Nehru Centre for Advanced Scientific Research.

Quantum Dots to Perovskites. How Semiconductor Nanostructures are Shaping Light Energy Conversion

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Semiconductor nanostructures with tunable photoresponse can capture the visible and near IR photons quite effectively. By controlling the size and composition one can tune the photoresponse of semiconductor nanostructures in the entire visible region. Assembling these nanostructure assemblies on electrode surfaces in a controlled fashion is an attractive approach for designing next generation solar cells.[1,2] The key advantage of semiconductor nanostructures lies in designing thin film solar cells with low temperature processing. These advantages significantly decrease the energy payback time since less energy is consumed (and hence a lower carbon footprint) during their manufacture.

The early studies which focused on the synthesis of semiconductor quantum dots and elucidation of charge carrier dynamics have led to the evolution of high efficiency metal halide perovskite solar cells.[3,4] In the present talk light induced charge carrier generation and transport across interfaces which are important in the operation of solar cells will be discussed. Photoinduced segregation in mixed halide perovskite has a direct influence on decreasing the solar cell efficiency as segregated I-rich domains serve as charge recombination centers.[5] Recent developments in utilizing semiconductor quantum dots in light energy conversion will be discussed.

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Bio-Data:

Dr. Prashant V. Kamat is a Rev. John A. Zahm, C.S.C., Professor of Science in the Department of Chemistry and Biochemistry and Radiation Laboratory at the University of Notre Dame. He is also a Concurrent Professor in the Department of Chemical and Biomolecular Engineering. Professor Kamat has for more than three decades worked to build bridges between physical chemistry and material science to develop advanced nanomaterials that promise cleaner and more efficient light energy conversion. He has published more than 450 scientific papers that have been well recognized by the scientific community Thomson-Reuters has featured him as one of the most cited researchers in 2014, 2016 and 2017. He is currently serving as the Editor-in-Chief of ACS Energy Letters.

Bioorganometallic Chemistry: Synthetic Strategies and Biomedical Applications for Metal-Peptide Bioconjugates

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Our group uses the unique spectroscopic and chemical properties of organometallic complexes in metal-peptide conjugates for biomedical applications. The experimental challenge is to identify air- and water stable organometallic compounds with the desired properties, and to devise methods for the mild, biocompatible synthesis of bioconjugates with these metal complexes. Similarly, biomedical properties of peptides have been tailored by their conjugation to organometallic moieties.

This presentation will highlight various synthetic strategies to obtain bioactive metal-peptide bioconjugates that have been developed in our group, and will present some exemplary biomedical applications of such metal-peptide conjugates. I will show how the versatile reactivity of metal complexes can be matched with peptide chemistry and purification techniques. Potent novel anticancer agents based on a number of different metals such as Fe, Ru, Re, and Au were developed, characterized and tested for their antiproliferative activity against a range of different cancer cells. Here, I will also present results on organometallic derivatives of neuropeptides which bind to the opiod receptors, which in turn belong to the now-famous class of G-protein coupled receptors (GPCRs). The solution structures by NMR of a Cp*Rh complex covalently linked to GPCR-binding peptides like somatostatin and enkephalin was reported by us, and the binding to the opiod receptors was investigated by NMR and molecular modelling. More recently, our group prepared the first metal derivatives of the peptide dermorphin, which unlike enkephalin has excellent specificity for the μ-opiod receptor. A hitherto unknown binding mode was discovered, and the physiological consequences were investigated experimentally, including *in vivo* experiments in mice. Finally, utilizing a novel uncatalyzed, chemoselective cycloaddition reaction for bioconjugation we could link Au complexes to peptides with high yield and purity. Biochemical and cell biology results are presented that support enzyme inhibition as the mode of action. Interestingly, these Au-peptide bioconjugates show no cross-resistance to the well-established Pt antitumor drugs.

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Bio-Data:

Prof. Dr. Nils Metzler-Nolte is the Professor and Chair of Inorganic Chemistry I, Ruhr-University Bochum since 2006. He was the Dean of the Ruhr-University Research School for Graduate Studies during 2009 – 2012 and the Vice-President for Early Career Researchers and International Affairs of Ruhr University Bochum during 2010 – 2012. He has received several awards and honors like the Karl-Ziegler-Fellowship of the German Chemical Society in 2001, Award for Innovative Teaching, Ruhr University, 2010, Julius van Haast Award of the Royal Society of New Zealand, 2015, Elsevier Award for Outstanding Achievements in Bioorganometallic Chemistry, 2019. He was also a Visiting Professor at the Universities of Milan (Italy), Stellenbosch (South Africa), Paris 6 (France), Auckland (NZ) and Fellow of the Royal Society of Chemistry, 2016. He was the Chairman of Third German Ferrocene Colloquium, Heidelberg, 2005 and the fifth International Symposium on Bioorganometallic Chemistry (ISBOMC'10), Bochum, 2010, Chair of the 2016 Gordon Conference "Metals in Medicine" (with K. Franz, Duke Univ., NC), Speaker of DFG Research Unit (Forschergruppe) FOR 630, 2006-2013 and Councillor of the Society of Biological Inorganic Chemistry (SBIC) 2012 – 2015. He acted as the Guest Editor for Thematic Issue of Chemical Reviews "Metals in Medicine", 2019; Associate Editor for Bioinorganic Chemistry Dalton Transactions, 2013 – 2019 and is now designated as the Editor-in-Chief for Journal of Biological Inorganic Chemistry (JBIC). He has more than 200 papers in international peer reviewed journals, 20 Reviews and Highlight articles (with peer-review), 8 book chapters, 1 book, 2 edited books. 2 Patents and 9 journal covers. He has received more than 9600 citations, average 45 citations per paper with h-Index = 50 (as in Sept 2019).

Metal-organic frameworks: a propitious way out for the problem of hydrogen storage

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The escalating threat of global warming poses a serious concern regarding global climate change, at an alarming rate, as well as the rising demand of energy worldwide with population growth necessitates the exploration of alternate energy sources. Hydrogen, in this context, is a potential alternative to fulfill these requirements, but it presents several other problems associated with its production, delivery and storage. In this context, porous metal-organic frameworks (MOFs), with high surface area, chemically tunable structures, have been considered as a potential hydrogen storage material. However, weak interaction of H_2 with MOFs requires cryogenic temperature for significant uptake. In this talk, we will highlight the key challenges faced and the possible solutions in the field of hydrogen storage. The talk will focus on the understanding of the mechanism of hydrogen adsorption in MOFs and strategies to design MOFs with increased hydrogen uptake capacity at room temperature.

Bio-Data:

Dr. Arunachalam Ramanan is Professor in the Department of Chemistry and former Heads of School of Interdisciplinary Research (2016-18) & Department of Chemistry (2012-15) at IIT Delhi. He has a long-standing interest in solid state chemistry and Materials chemistry. Since his graduation, he is fascinated by the diversity in solid-state structures (disorder, intergrowth, isostructures, polymorphism, supramolecular isomerism, amorphous) and the need to manipulate molecular aggregation to control its physico-chemical properties. His recent research interests include utilization of hydrogen bond and metal-ligand oordination to design multiple forms of pharmaceutical solids as well as coordination polymers and MOFs. His laboratory investigates crystallization process with an objective to obtain molecular insights into the phase transformation of aggregating molecules leading to a particular form of the solid.

Applications of nanotechnology in Oil & Gas sector

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Applications of nanotechnology in energy sector, especially relating to fuels and lubricants & renewables are being explored world over. Use of nanomaterials instead of conventional additives is perceived to enhance performance at lower treat rate. However, stability of various inorganic and organic nano dispersions in hydrocarbon medium during processing, storage and application is a critical issue. Though many groups and organizations are successful in synthesizing and characterizing nanopowders followed by their initial solubilization or dispersion of such kind of nanoparticles in hydrocarbon/oil medium, severe problems are being encountered in maintaining their long term storage stability in oil matrix especially at low and normal temperatures as well as under accelerated test conditions. This aspect, coupled with the prohibitive cost of procured nanoparticles is acting presently as major deterrents for adopting these nanodispersions on a large scale as effective alternatives for the conventional additives towards oil and gas applications.

IOCL R&D Centre made an initiation in nanotechnology research for development & deployment of nanotechnology interventions in the application of fuels and lubricants. Several nanomaterials and nanodispersions have been synthesized using both top-down and bottoms up approach and explored for desired performance. Some of these nano-products were scaled up controlling the quality of the same. Stability issues of such dispersions were effectively addressed during development. Patent applications were also filed for preparation and evaluation methodologies of such dispersions. Attempt to enhance the performance by application of nanotechnology in alternatative and renewable will also be touched upon.

This topic highlights some of the IOCL developmental work and application results of IndianOil's patented nanodispersion in different products along with associated challenges. A few case studies including field validations of these nanodispersion in respective product formulations will also be presented.

Bio-Data:

Dr. Samit Kr Hait is the Chief Research Manager of IOCL R & D Centre. He has obtained his PhD from Jadavpur University. His area of research interest is Energy, Surface science, material chemistry. He has 30 International publications in the journals of repute, 15 patents, 18 years of experience in energy sector and nanotechnology application and is the recipient of Bangalore Nano Innovation Award, FIPI Innovation of the year-team award

Metal Fluorides as Nonconventional Support for Palladium nano-particle for hydrogenation under ambient conditions

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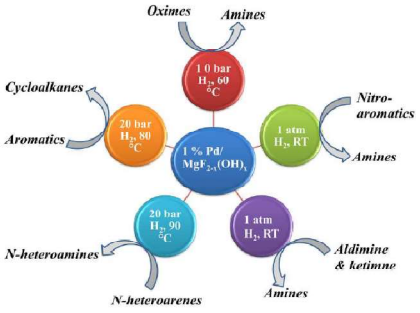
Metal fluorides are emerging as new hi-tech materials in catalysis, ceramics, thin optical films, anti-reflective coatings, hosts for laser devices, and energy storage devices.They are used in different forms such as simple binary, oxy / hydroxyl, complex or doped fluorides, etc. By using or combining different metal cations in the fluoride matrices, it is possible to prepare materials with a wide range of desired properties. Metal fluorides possess the strongest electronegative element, which generates a higher Lewis acidity on the metal center compared to their corresponding oxides and other metal halides. A support plays a vital role in heterogeneous catalysis, hence a large number of supports has been explored for synthesis of efficient catalysts. Support not only helps adsorption and desorption of reactants and products but also has a substantial influence on the electron transfer, adsorption capacity, chemical and electronic structure of the active metal. The metal support interactions in catalysts depend on the characteristics of the support such as surface area, crystal facets, crystal size of the catalysts and acidity/basicity of the support. Palladium has been extensively used as catalyst in many organic transformations which include formation of C–C, C–O, C–N bonds, oxidation, and hydrogenation. Among all reactions, hydrogenation of organic molecules is probably one of the most important chemical reactions for the synthesis of many compounds. Heterogeneous catalytic hydrogenations are significant reactions that find comprehensive industrial application in the production of pharmaceuticals, agrochemicals, fine chemicals, flavors, fragrances and dietary supplements.



We have explored metal fluorides as non conventional support for palladium nano particles as catalysts for various reactions including hydrogenation of various functionalities like C=C, C=N, -NO_2, -C=O, aromatic ring etc. To our surprise Pd supported on MgF_2 has shown very high efficiency for hydrogenation of C=C, C=O, -NO_2 under ambient conditions and hydrogenation of aromatic ring and reductive amination under milder conditions. The high efficiency of the catalyst was attributed to the very strong metal-support interaction due to acidic nature of the support which led to the formation of palladium nano sheets and very high metal dispersion. The catalyst shown very high efficiency for recycle without any Pd leaching and very high efficiency with only 1% Pd loading leading to very high TON &

TOF. The activation of hydrogen was by heterolytic cleavage on the Pd centre. In many cases the Lewis acidic centre of metal fluoride support helped activation of substrate leading to enhanced activity/selectivity.

Bio-Data:

Dr. Shubhangi B. Umbarkar is the Principal Scientist at Catalysis Division, CSIR-National Chemical Laboratory, Pune. She obtained her PhD from IIT Bombay (1996) in Organometallic Chemistry and pursued her Postdoctoral research as DAAD fellow in Karlsruhe Germany (1998). Her research areas are Environmental catalysis, Rare earth based catalytic materials for automotive applications using Indigenous raw materials (IREL), oxidative desulfurisation, Vvalorisation of bio-derived materials like glycerol, lactic acid, lactates, edible & non-edible oils, Ddevelopment of mesoporous solid acid catalysts, in situ FTIR spectroscopic characterisation, organometallic complexes for catalytic oxidations. She has 74 Publications, 15 patents and 20+ scientific and industrial Projects. She has more than 10 co-operational stays at other Universities abroad. She has guided 9 PhD, 5 M.Tech, 3 M. Phil and 7 M.Sc. students.

Sustainable Chemistry – Growth driver of tomorrow

Dr. Ramkumar Dhruva
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Chemistry plays an important role in our lives. We eat them, we drink them, we breath them, and we are made of them. Chemicals are present in 95 percent of manufactured goods, from simple everyday items to hi-tech applications.

Global trends - like population growth, continued urbanization and increasing demand for high-quality consumer goods - provide opportunities for growth in the chemical industry. Asian chemical industry is very diversified, and its home market represents the fasted growing region globally. Asia will contribute close to 80% of the growth in chemical production until 2030. China will continue driving global demand and capacity expansion. The Indian chemical industry is valued at ~$165bn and it is expected to grow at a CAGR of ~9% in the next 10 years contributing significantly for the growth of Indian manufacturing sector.

The global chemical industry is on the cusp of transition and is actively engaged in developing technologies and solutions to create a carbon-neutral, resource-efficient and circular society.

Focusing on sustainable development and especially on circularity, our industry will actively contribute to meeting the commitments of the Paris Climate Agreement, the UN Sustainable Development Goals as well as objectives of the just announced European Green Deal. This offers opportunities for new innovations both in products as well as processes.

This presentation will touch upon some selected solutions and technological innovations that help to keep materials (considering the technical, economic feasibility of doing so) through reuse of materials, resource recovery and waste recycling technologies. It also explores the use of alternative & more sustainable feedstock as a building block of tomorrow's chemical value chains.

Long-term success is only possible if we integrate sustainability deeply into our businesses. As chemical companies, we are only successful when our solutions, products and technologies add value to society. Achieving success needs even closer collaboration than before between industry-players, researchers, and policymakers.

Bio-Data:

Dr. Ramkumar Dhruva was born in India in 1968. In 1996 he earned a Ph.D. in Organic Synthesis, Photo & Electro Chemistry from Indian Institute of Technology, Madras. He was a research chemist in Polymer Dispersions Laboratory in BASF AG, Ludwigshafen, Germany when he joined BASF. Later he became the Chief Executive, BASF Coatings (India) Pvt. Ltd, Mumbai India. Then he became the Vice President, and Senior Vice President BASF Coatings Solutions, Asia Pacific, BASF East Asia Regional Headquarters Ltd., Hong Kong / BASF Japan Ltd. Now he is the President, Monomers, BASF Belgium Coordination, Center Comm. V., Waterloo, Belgium.

Cellulose material for adsorptive removal of heavy metals and organics – mechanism

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Water pollution is an important issue worldwide. Researchers are working on eco-friendly, sustainable development for the remediation of wastewater. The small and medium-sized industries situated in India's rural areas and 3rd World industries produce large quantities of wastewater containing heavy metal and dyes. As they are situated in rural areas, these industries' problem is forced to drain their wastewater into the local water bodies and agricultural field. Thus it may enter into the food chain. In rural areas, no typical effluent treatment facility is available. Researchers have used different agricultural wastes and their by-products as an adsorbent to remove heavy metals and dye from the wastewater stream. Thus the agricultural wastes and their by-products have an advantage of their low-cost and widely available rural areas.

The agricultural waste and its by-products are cellulosic and contain cellulose, hemicellulose, lignin, and a minimal amount of specialty chemicals are the main constituents. Cellulose is a polysaccharide consisting of a linear chain of several hundred to many thousands of β (1-4) linked D-glucose units. Hemicellulose belongs to a group of heterogeneous polysaccharides formed through biosynthetic routes but different from that of cellulose. Mannose is the essential hemicellulose monomer, followed by xylose, glucose, galactose, and arabinose. Some mannose is acetylated at the C2 or C3 positions, with, on average, one substitute group for every three to four hexose units. Lignin is an alkyl-aromatic polymer.

The cellulosic materials contain different functional groups and are responsible for the binding through electrostatic attraction, hydrogen bonding formation, n–π interaction, and π–π interaction. These interactions may not give very high adsorption capacity than the synthetic adsorbents, but very useful for the rural areas in the 3rd World countries. This paper deals with the possible mechanism of binding the heavy metals or organic pollutants present in wastewater with the agricultural waste and its by-products.

Bio-Data:

Dr. Sudip Kumar Das is currently Professor and Former, Head in the Department of Chemical Engineering, University of Calcutta. He has completed his M. Tech. and Ph.D. in Chemical Engineering from the Indian Institute of Technology, Kharagpur and graduated from the University of Calcutta in Chemical Engineering and Chemistry Hons. He is also actively engaged in research related to different fields of Chemical Engineering, like single and multiphase (gas-liquid) flow through pipelines and piping components, multiphase flow through coils, fluidization and inverse fluidization, wastewater treatment technology, heavy metals and organic pollutants removal from wastewater, Process Plant Safety, Computational fluid dynamics, artificial neural networks and machinable glass-ceramics. He has published 1 book, 15 chapters, more than 200 papers in National and International journals and presented a large number of invited lectures in the Conferences. He has been a reviewer for more than 125 National and International journals. He is member of Refrigeration and Air Conditioning Sectional Committee, ME 03, Bureau of Indian Standard, also in professional societies like, Indian Institute of Chemical Engineers (life), Institute of Engineers (Fellow), IEEE, Indian Association for Air Pollution Control (life), Indian

Chemical Society (Fellow), Millennium Institute of Energy and Environment Management (life), International Congress of Chemistry and Environment (Fellow). He acted as the Head of the Chemical Engineering Department, University of Calcutta, 2010-2012, 2017-2019. He also served as Hony. Secretary 2006-2007, 2014, 2018 and Hony. Treasure 2005, 2011-2013 in the Indian Institute of Chemical Engineers. He also served as Hony. Treasure 2017 to till date in Indian Chemical Society. He also acted as Chairman, Calcutta Regional Centre, Indian Institute of Chemical Engineers, 2012-2014. Hony. Secretary and Hony. treasure for several years in the Calcutta Regional Centre, Indian Institute of Chemical Engineers.

Engineering an Aqueous Energy Dense Manganese Dioxide|Zinc Battery to Challenge Lithium- Ion's Dominance

Dr. Gautam G. Yadav
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The current landscape of energy storage systems is dominated by lithium-ion batteries because of their high energy densities, and continuous improvement in performance through the last few decades for use in a number of applications. They certainly have been a boon for rapid societal development; however, they also have had major disadvantages like high cost, severe toxicity, high chances of flammability and ethical concerns about the use of cobalt. Aqueous batteries containing manganese dioxide (MnO_2) and zinc (Zn) have the theoretical capacities to deliver high energy densities comparable to some variations of lithium-ion batteries, have lowcost and toxicity, and high material abundance to be used as an alternative battery compared to the current status quo. However, MnO_2 and Zn have been highly irreversible and accessing close to their theoretical capacities has been very challenging. The current status quo in aqueous batteries has been to intercalate Zn and H-ions into layered structures to deliver modest capacities, which also has unfortunately resulted in limited energy densities. These layered structures, although novel, face limitations like their layered counter parts in lithium (Li)-ion batteries, where the capacity is limited to the host's intercalation capacity. Low voltage of ~1.1-1.4V is another Achilles heel of aqueous Zn-anode batteries, where it is simply not comparable to the high voltage properties of Li-ion. MnO_2|Zn batteries can compete with Li-ion because of its safe and abundant raw materials, nonflammable electrolyte and theoretical energy density, however, sufficient advances are required for it to be considered a truechallenger.

In this talk, we will present a new strategy to enable a new generation of energy dense aqueous- based batteries, where we exploit the conversion reactions of nanosized MnO_2 and Zn electrodes to extract significantly higher capacity compared to intercalation systems. Accessing the conversion reactions allows us to achieve theoretical capacities of 617mAh/g (~30mAh/cm^2) from MnO_2 and 810 mAh/g (~30 mAh/cm^2) from Zn anodes, respectively. The high areal capacities help to attain unprecedented energy densities of 210 Wh/L, which is the highest of all aqueous-based batteries. We will also present our work on identifying new Mn-based conversion compounds that give higher capacities and demonstrate its application in the case of small-scale automobile. We will also present our breakthrough work on breaking the 2V barrier in aqueous Zn batteries, where we have demonstrated for the first time in the field of energy storage >2.55V and 2.9V MnO2|Zn aqueous batteries capable of accessing the theoretical capacity, which can truly challenge Li-ion's dominance. Finally, we will briefly present our commercialization experience, and how market forces and application have guided the design and research of these batteries.

Bio-Data:

Dr. Gautam G. Yadav is a world-leading materials scientist and electrochemist, working as the Director of Advanced Battery Development at Urban Electric Power (UEP) in New York. He earned his doctoral degree in chemical engineering from Purdue University, where he specialized in synthesizing 1D complex metal oxide nanowires for thermoelectric applications and lithium(Li)-ion batteries. Prior to joining UEP, Dr. Yadav worked as a Senior Scientist at the CUNY Energy Institute, where he led the advancement of highly energy dense aqueous-based batteries based on manganese dioxide (MnO2) and zinc (Zn) as a replacement for the expensive and dangerous Li-ion batteries for grid-storage applications. He is the primary inventor of the reversible second-electron MnO2 technology and the breakthrough high voltage (2.45-2.8V) MnO2|Zn battery, which are published in Nature Communications and ACS Energy Letters, respectively. He has authored 19 publications and filed over 26 patents on MnO2|Zn technology, which have been licensed by UEP. At UEP, Dr. Yadav is leading a team of engineers and scientists to bring the second-electron MnO2 and high voltage (2.45-2.8V) MnO2|Zn battery to commercialization.

Carbon recycling: Gas fermentation turning sustainable carbon into fuels and chemicals

Dr. Sean Simpson
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Atmospheric CO_2 has accumulated to levels unprecedented since the Pliocene Epoch (> 2.6 million years ago). Although the effect of elevated atmospheric CO_2 on the climate has been predicted for 60 years, it wasn't until the 2016 Paris Agreement that nations agreed plans to abate atmospheric CO_2 release. These plans necessitate that sustainable carbon resources increasingly displace fossil resources as feedstocks for fuel and chemical production. The economic crisis triggered by the COVID-19 Pandemic has now added urgency to the demands for a move away from traditional polluting production systems. The opportunity being highlighted is that the public finance used to stimulate economic recovery be targeted at a technolgied that enable a circular, sutainable economic model. Numerous technology solutions have been proposed to enable this transition. Gas fermentation is the most recent of these. This technology uniquely offers a path to produce impactful volumes of sustainable fuels, chemicals and food from abundant, low value above ground carbon feedstocks.

LanzaTech is pioneering the commercialization of a gas fermentation process that allows the continuous production of fuels chemicals from gases at scale. Our first commercial plant is commissioned in China. Further commercial plants are in design or under construction with the process having been demonstrated with live feeds of waste gas from numerous industries and synthesis gas produced from agricultural wastes and municipal waste.

The potential role that gas fermentation could play in enabling a circular economic model has been enhanced through the development of a complete suite of synthetic biology techniques in gas fermenting organisms. This has led to an array of new chemical products being produced from gaseous feedstocks. In this way gas fermentation is a vital bridge in the effort to create value from waste streams as part of an increasingly circular economic model.

Bio-Data:

Dr Sean Simpson is current founder and Chief Science Officer for LanzaTech. H obtained his Masters from University of Nottingham (UK) and PhD from York University (UK). He has written over 20 publications and 200 patents. He has received a number of awards including the 2015 US Environmental Protection Agency(EPA) Presidential Green Chemistry Award, the 2014 Sanitarium, NZ Innovator of theYear Award, the 2013 Kea NZ World Class New Zealander in Science Award, and the2011 Ernst and Young Entrepreneur of the Year, New Zealand.

Robust, fluorine-free, proton- and hydroxide-conducting membranes for the hydrogen economy: from discovery to commercialization

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Ion exchange membranes which are capable of conducting protons or hydroxide ions have broadly been applied in electrochemical energy storage and conversion technologies. Electrochemical systems relying on alkaline-based active components possess unique advantages over their acidic counterparts but at the same time are associated with greater challenges. This presentation will focus on recent progress research trends incorporating these polymers into membranes, catalyst layers, and electrochemical energy storage and conversion devices. The challenges of integration that need to be overcome to meet critical requirements will be discussed, together with a summary and perspective for future directions.

Bio-Data:

Dr. Steven Holdcroft is President of the Canadian Society for Chemistry (CSC), a Professor of Chemistry, and former Chair ofthe Department. He holds a Tier 1 Canada Research Chair in Electrochemical Materials. He has research programs in ionic polymers, electrochemistry, and fuel cell technology, and has authored/co-authored of more than 300 peer-reviewed articles. He was the Technical Program Chair of Pacifichem 2010 and Technical Program Chair and Congress Vice-Chair of Pacifichem 2015. He serves on the Editorial Advisory Board of the journals Chemistry of Materials (ACS) and Energy and Environmental Science(RSC). In 2018 with three former students, he cofounded Ionomr Innovations Inc., a 25-person SFU spin-out company commercializing electrochemical membranes for clean energy applications. For services to the community,Dr. Holdcroft was awarded the Macromolecular Science and Engin¬eering Division Award of the Chemical Institute of Canada (CIC) and is a recipient of the Canadian Society of Canada RioTinto Alcan Award for contributions to Inorganic chemistry or electrochemical research. In 2018, he was recipient of the outstanding Alumni Award for Academic Achievement from his alma mater.

Applied Chemistry and Industry-Academia Interaction in India: A Personal Take

Dr. Amitava Pramanik
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Indian Chemical Industry, thanks to the pioneering efforts of Acharya PC Ray back in 1892 and subsequently by several businessmen and entrepreneurs, grew significantly to about 180 billion-dollar business today, the sixth largest in the world. Although India is the third largest consumer of polymers and fourth largest producer of agrochemicals in the world and chemicals account for 12.5% of India's total exports, its contribution to global chemical industry is mere 3.4%. Bulk chemicals like petro- and agri-chemicals hold the limelight with small but significant contribution to fine and specialty chemicals like paints and colorants, flavours and fragrances, surfactants, chemicals for textile finishing, personal care, construction, water treatment, adhesives etc.

This discrepancy – if I may say so – lies largely due to the way Applied Chemistry is treated in the premier academic institutions in India as well as insignificant industry-academia interactions. Barring a few exceptions, most of the Chemistry Departments of reputed Indian Universities and Research Centres are unaware of the needs of Indian Chemical Industries. The industries on the same token hardly depend on inputs from Indian Academia. One can hazard a guess that the number of theses that provide the coveted PhD degree in Chemistry by all Universities across India to serve any of the Chemical Industries in India in a year is close to zero. It does not speak well for a nation that aspires to prosper on all aspects, certainly in Chemistry in which it possesses a long inheritance.

The talk will highlight some personal experiences on Industry-Academia relations and its output as well as a couple of practical recommendations on how this can be changed for the better.

Bio-Data:

Amitava Pramanik received his Ph.D. in Co-ordination Chemistry from Indian Association for the Cultivation of Science affiliated to Jadavpur University, Kolkata in 1993. After a couple of years of post-doctoral research in the same institute, he joined Unilever R&D in Mumbai in early 1995 and later moved to its Bangalore campus in 2004. He worked in various capacities, initially as a research scientist on specialty chemicals and later on novel synthetic materials including nanomaterials for Unilever's Home Care and Personal Care businesses. In his last role till October 2018, he was Unilever's global leader on the Strategic Science Group on Functional Materials. He has published ~40 papers and ~65 patents and worked on developing new products in the areas of specialty inorganics, micronutrients, photostable sunscreens, water purification, surface modification including non-stick surfaces, nanoparticulate antimicrobials, silk proteins etc. Since November 2018, he has been heading the Targeted Research Initiative in Society for Innovation and Development, Indian Institute of Science Bangalore.

Macromolecular Engineering in Self-healing Polymers using dynamic "Click" Chemistry; Preparation to Applications

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It has been 100 years since Professor Herman Staudinger, the Nobel Laureate in 1953 published the first article on **"macromolecules"** in 1920 which has been the founding stone of today's **"Polymer Age".** Now polymers have been the most widely used industrial materials in the human life. Now-a-days polymers are not only used in household and commodity materials, but they are being used in hi-tech as well as in strategic materials. The major disadvantage of using the polymers is its longevity compared to other materials like metals and ceramics etc. Self-healing polymers have the inherent ability to heal the micro-cracks and scratches generated on them. In 2013, the World Economic Forum andthe Global Agenda Council announced the self-healing technology is one of the most important technologies in materials science and engineering.

Since the pioneering work of Professor Barry Sharpless in late 1990s, **"Click"** reactions have been wonderful synthons to prepare varieties of functional materials for different important applications. They have several advantages; they are carried out at mild reaction conditions with significantly high yields and with desirable stereoselectivity. In Polymer Science, **"Click Chemistry"** has been widely used to prepare smart self-healing functional polymer materials having application in advanced materials. In this case, different click reactions, like Diels-Alder reaction, Alder-ene reaction, ES-click reaction etc. will be discussed. Several examples will be shown how the tailor-made functional polymers prepared via controlled radical polymerization can be elegantly modified into self-healing polymer using different "click" reactions. These functional polymers were based on polyacrylates, polyurethanes, and commercial elastomers. The applications of these functional polymers were explored in self-healing materials, ultra-hydrophobic coatings and self-healable elastomers. This talk will delineate the preparation of different functional polymer materials as well as their applications.

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Bio-Data:

Nikhil K Singha is a Professor at Indian Institute of Technology, Rubber Technology Centre and is also an associated faculty of School of Nano Science & Technology, Kharagpur. His research interest is in tailor-made functional polymers and elastomers, smart self-healing, self-cleaning, super-hydrophobic polymer materials, block, graft copolymers, electro-active, bio-active polymers and tailor-made polymer composites and polymer gels via controlled polymerization & their applications in self-healing and self-cleaning coatings, fire-retardant materials, space applications, advanced tyre applications, smart biomaterials, green & sustainable materials and process. He has received many awards like the Fellow of Royal Society Chemistry (FRSC), Prof. M. Santappa Award (2014) by Society of Polymer Science India (SPSI), MRSI Medal by Material Research Society of India (MRSI) (2013), Fulbright Senior Fellowship (2013), Fifth Polymer Foundation Award by Prof. Sukumar Maiti Polymer Award Foundation (2012), Visiting Scientist in University of Sheffield, UK with fellowship from Royal Society, London, UK (2006), in Institute for Polymer Research, Germany with INSA-DFG&DAAD fellowship (2008 & 2011) and in EPFL, Switzerland, Fellowship from Swiss Federal Institute (2009). He has supervised 19 Ph.D. students and is the editorial board member of European Polymer Journal and Frontiers in Chemistry (Polymer Section) Frontiers in Chemistry (Polymer Section). He has published in 170 peer-reviewed journals, 13 patents 10 book Chapters.

Fuel Quality & the history and role of fuel additives

David Claydon
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This paper will highlight the important role that fuel additives have played during the last ten decades to allow fuel specifications to be met in the most cost effective way. In addition we will discuss how multifunctional performance additives have enabled car manufacturers to met stringent environmental air quality requirements.

We will consider how fuel additives have and continue to improve the quality of fuels leading to:

1. Solutions related to environmental concerns
2. Economic benefits (imports/exports)
3. Retail competition and the production of branded fuels
4. Meeting the OEMs desire for better fuel quality in order to protect vehicle performance

Bio-Data:

David Claydon has a degree in applied chemistry and has had 40 years experience working in the fuel additive industry. His career began in 1980 working in the fuels technical service department of Paramins, a division of Exxon Chemicals based in the UK. This position involved supporting the application of cold flow improvers at refineries in order to help optimise refinery economics. In 1995 David moved to Ethyl Petroleum additives as technical service manager for fuel additives. This new role involved technical support and development for a wide range of refinery and performance additive packages for Europe and the middle-East. The company currently operates as Afton Chemical LTD.

David is currently a senior technical advisor for fuel additives and is this role plays an important part in ensuring that Afton Chemical has the appropriate technology to become and maintain its position as a market leader in performance additives for diesel fuel and to expand the company position in gasoline and heating oil additive markets. David has presented a number of technical papers and is well known and respected within the oil and additive industry.

An Entrepreneurial disruption to combat COVID 19 through Nanotechnology

Dr.Swapan Kumar Ghosh
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As declared by World Health Organization (WHO), presently the whole world is facing apandemic and a global crisis caused by a novel virus that was discovered to be the cause of a largeand rapidly spreading outbreak of respiratory disease, including potentially fatal pneumonia, inWuhan, China (starting January 9, 2020). The virus was provisionally designated 2019-nCoV and later given the official name SARS-CoV-2, the disease caused by the virus was officially named Coronavirus Disease 2019 (Covid-19) by WHO.The SARS-CoV-2 is an enveloped, positive sense, single-stranded RNA virus. Coronaviruses are so named because of their characteristic solar Corona (crown-like) appearance when observed under an electron microscope. This appearance is produced by the peplomers of the surface (or spike; designated S) glycoprotein radiating from the virus lipidenvelope1.The SARS-CoV virion is spherical with an average diameter of 78 nm.

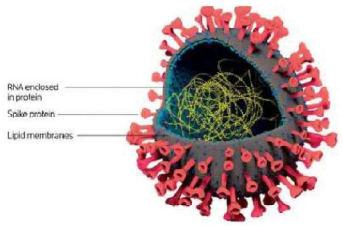

Figure 1: Anatomy of COVID-19 Virus (Figure from New Scientist Journal)

SARS-CoV-2 is delicate but highly contagious virus capable of spreading primarily from personto person around the world. It also spreads when an infected person cough or sneezed and a dropletlanded on a surface or object, a person when touches that surface has the virus on it, then touches nose, mouth or eyes, could pick it up. On the personal level hygiene measures are recommended to prevent the spread of disease, especially in the institutions where individuals are in contact with patients or contaminated fomites. Washing hands with soap and water or with alcohol based handrubs is effective for interrupting virus transmission. Although viruses don't grow on any nonliving surfaces but recent studies show Corona viruses can remain viable or infectious on metal, glass, wood, fabrics and plastic surfaces for several hours to days, irrespective of the surface looking dirty or clean. Though, the Corona viruses are relatively easy to destroy, using simple disinfectants like ethanol (62-71%), hydrogen peroxide (0.5%) or sodium hypochlorite (0.1%)[2] by breaking the delicate envelope that surrounds the tiny microbe. However, it's practically impossible to sanitizethe surfaces all the time and it doesn't guarantee that the surface won't get contaminated again. It's a much wiser solution in such a scenario if the surface can repel the pathogens, making it nonstick and/or 'sanitize by itself' by neutralizing the contaminated pathogens quickly, thus eliminating the possibilities of transfer of microorganism to human body and its subsequent spreads. Study shows that the spike glycoprotein of COVID-19 allows the virus to dock and bind to the ACE2 surface proteins of human epithelial cells in the respiratory track, thereby infectingthese cells.

Association of the COVID-19 spike glycoprotein with host ACE2 surface protein is acrucial step for infection.

Our research aim was to create surface coating with relatively low surface energy value which may repel the spike glycoprotein to anchor the surfaces of landing, also use of active chemicals those could inactivates the spike glycoprotein as well as viral nucleotides.

Literature survey shows that the nano-particles (NPs) of various metals and metal oxides like Zinc Oxide nanoparticles (ZnONPs)[3], Cuprous Oxide nanoparticles (CuONPs)[4], Silver nanoparticles(AgNPs)[5,6], Nano sized Copper (I) Iodide particles (CuINPs)[7], Gold nanoparticles on Silica nanoparticles (Au-SiO_2NPs)[8] and also some Quaternary ammonium cations commonly called QUATs[9] are very promising to inactivate virus and are well proven.

The product we have developed, NANOVA HYGIENE+™ as an antimicrobial coating for the surfaces like fabrics, plastics, metals and concretes contains the cocktails of non-migratory QUATs and positively charged AgNPs as bioactive nanoparticles and dispersing this into binderpolymers. This anti-microbial coating also shows extremely low surface energy value (>20mN/m)[10] and behaves as an omniphobic surface by repelling water and oil together. Contact angelswere >130^o and >50^o when measured against water and hexadecane as probes[10], respectively. This coating has proven test reports[11] on protection against bacteria pathogens up to 99.9% as per the global standard JIS Z2801. The coated surfaces also have evidence to work effectively against fungi[12] and algae pathogens.

From available published data in literatures, we can safely opine that NANOVA HYGIENE+™ would be a potential coating candidate to repel and inactivate Virus on the surface, hence could be a potential material to address the present problem of COVID-19 spread through surface touch. When tested in microbiology lab NANOVA HYGIENE+ ™ demonstrated successful performance against HUMACORONA VIRUS (229E) (A type Alpha Coronavirus) at NelsonLab, USA , Bovine Coronavirus (S379) (A type Beta coronavirus 1) from Eurofin, Italy, and MS2, RNA virus a surrogate virus in place of Picoma viruses such as Poliovirus and humanNorovirus from accredited NABL lab in India and products show efficacy of > 99% while tested as per global standards ISO, JIS, EN and AATCC. Finally, we have tested for its antiviral efficacy on SARS-CoV-2 (virus responsible for COVID-19 disease) and obtained very successful datawith efficacy >99% in after 3 months old surface. Further NANOVA HYGIENE+ ™ has been tested for its nontoxic properties as per globalstandard of Nontoxic Acute Dermal Skin Irritation Report (OECD 404) and global leachingtest for food contact US FDA 175.300 and these test results confirms that the technology is nontoxic and safe to use.

Based on the results, Its shows that NANOVA HYGIENE+ TM has numerous applications virtually for all surfaces like fabric (mask, gloves, doctor coats, curtains, bed sheet), metal (lifts, doors handle, nobs, railings, public transport), wood (furniture, floors and partition panels), concrete (hospitals, clinics and isolation wards), plastics (switches, kitchen and home appliances) and potentially could save many lives.

Product is now successfully commercialized, and distribution started in Indian and some of the foreign markets.

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Bio-Data:

Dr. Swapan Ghosh, the founder of Nova surface-care Centre Pvt Ltd. is a polymer scientist with over 30 years of research experience in academia and Industrial R&D. Dr. Ghosh worked as Assistant Professor in Venture Business Laboratory of Yamagata University in Japan and, after moving to India, worked in reputed Indian companies including Pidilite, Asian Paints and Shalimar Paints. Dr. Ghosh more than 100 innovative products and published more than 30 scientific papers in international peer- reviewed journals and have 8 product patents in his credential. He has also guided two PhD dissertations in affiliation with Bombay IIT and ICT, respectively.

Crude Oil to Chemicals Conversion –Molecular Management Strategy

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Globally petroleum refiners are adopting Crude Oil to Chemical (COTC) process technologies for addressing chemical/petrochemical demand growth and maintaining sustainability in the emerging scenarios like e-mobility, alternate energy sources, etc. In the past century energy potential of crude oil has been unfolded and maximizing fuel yield was the primary focus for every refiner. About 5-10% crude gets converted to Petrochemicals in current day fuel refinery with certain extend of integration for petrochemicals. To unleash the huge chemical potential of crude oil, molecule level management is now getting prime importance and extensive research activities are taking place across the globe for developing novel processes focusing to maximize chemical yield from crude oil. Life cycle assessment of molecule tracking each and every molecule, starting from its generation point to its end application, is also getting importance. Life cycle assessment and molecule management together need to be applied for developing new process to reengineer the molecules towards more useful purpose. Further, it will be also be beneficial for reducing carbon footprint as well.

IndianOil's efforts are geared towards in-house technologies aiming to maximize light olefins while producing BTX (Benzene Toluene and Xylene) precursor. IndianOil's COCT configuration is the potpourri of conventional and new processes technologies. Based on the molecule management, the conventional and new process technologies have been configured and placed in such a manner so that the targeted molecules can be fed to the appropriate process units for yielding maximum chemical potential. INDMAX technology is developed which employs circulating fluidized bed reactor and unique catalyst recipe of medium pore and pentasil based zeolites with hierarchial pore structures for sequential breaking of hydrocarbon C-C bonds for producing very high light olefins. INDALIN process is developed for cracking of naphtha molecules using lesser energy than Steam cracking with high light olefin yields. A novel technology, 'indLPet' is developed to convert di- and tri- aromatics of LCO (Light Cycle Oil) streams, which would have burned off as diesel, to Toluene Xylene isomers and C9-aromatics, exemplifying molecule management. Efficient residue management is achieved through residue hydrocracking process, 'indResid' with a novel catalyst and reactor configuration to effect high degree of residue conversion (~95 wt%) to distillates, which further can be converted to olefins. This paper describes the features of the some of the IndianOil technologies, which are an integral part of COTC configuration for higher yields of Chemicals.

Bio-Data:

Dr. Madhusudan Sau is a Chemical Engineer, MTech from IIT Kanpur and PhD from University of Akron, USA. He has been working in the R&D Centre of Indian Oil Corporation past 28 years and currently he is Chief General Manager (Refining Technology). His area of work includes new Process and

Catalyst Development, Process modeling and Technical services, troubleshooting and optimization, Catalysts selection in the area of Refining Technology.
His major contributions are Development, Scale-up and Commercialization of indeDiesel technology & Hydro-teating Catalysts, Process optimization of refinery process units to improve middle distillates yield and GRM improvement. He has published over 36 papers, filed 140 Patents and has 6 Awards in his credit.

Advanced Characterization for Industrial Catalysis

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This paper will survey several critical techniques used to unravel the complex nature of industrial catalysts. Foremost, an industrial catalyst must have high activity and selectivity and be regeneratable with long lifetime. The catalyst needs to be strong so as not to fall apart but also contain macro and micro porosity to allow diffusion of feed components in liquid and/or gas phase. Residence times for target molecules can be adjusted by changing the porosity to produce the desired products with high selectivity. The catalyst active sites need to be resistant to poisons such as sulfur, iron and other trace metals. Ideally industrial catalysts are resilient not only under normal operating conditions but also through occasional upsets. Although there are many tools required to understand these properties, x-ray absorption spectroscopy remains one of the few to probe active metal sites during operando (working state) conditions. This is made possible by the high penetration power of x-rays that can probe catalyst active sites through reactors and gas/liquid feed components and quantitively measure the local atomic environment of active metals. We will present a few examples of how Advanced Characterization for industrial catalysts help understand their complex nature.

Bio-Data:

Dr. Shelly D Kelly received her PhD from the University of Washington in Physics in 1999. Currently, she is senior manager of X-ray, Modeling and Spectroscopy group at Honeywell UOP. Her research is focused on understanding catalysis, molecular sieves and sorbents for petrochemicals and fuels industry with emphasis on Advanced Characterization techniques, including operando and in-situ X-ray Absorption Spectroscopy (XAS). She has participated as a lecturer in XAS workshops in the U.S. and abroad, reviewer of general user proposals for access to synchrotron user facilities, and as beamline advisory team member for the Inner Shell Spectroscopy (ISS) beamline at NSLS-II. She is an executive member of Materials Research Collaborative Access Team (MR-CAT) beamline at Advanced Photon Source. Shelly has contributed to 83 peer reviewed papers, 5 book chapters and 1 U.S. Patent.

Analytical Chemistry Section

AO-1

Award Presentation

Award Oral

DMNDC- An intramolecular charge transfer dye for the detection of amyloid fibrils

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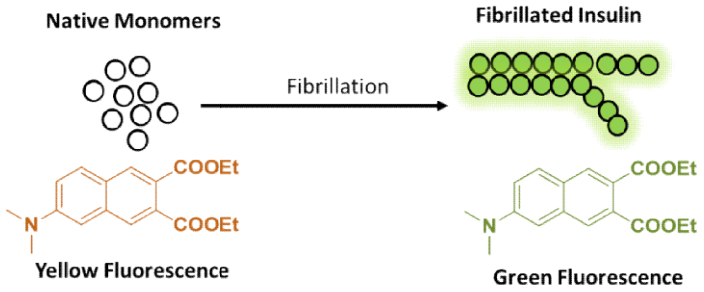
Proteins are large macromolecules involved in various functions in the body including DNA replication, catalyzing metabolic reactions and so on. The misfolding of proteins leading to aggregate formation is associated with various diseases like Alzheimer's, Parkinson's, Type-II Diabetes.[1]Researchers are always on the lookout for novel molecules which can inhibit the aggregation of proteins as a means to prevent these diseases. Apart from inhibition of aggregation, the ability to detect these aggregates plays an important role to diagnose these diseases at an early stage and prevent them from having far reaching effect on human beings. Till date, Thioflavin-T(ThT) has been used as a gold standard for monitoring fibrillation of proteins due to the huge enhancement in fluorescence intensity upon binding to fibrils. However, ThT suffers from disadvantages like small stokes shift and also shows interference while studying fibrillation kinetics in presence of small molecules.[2] Moreover, the use of intrinsic fluorescence of tryptophan and tyrosine as a means to study aggregation has not been much successful due to their inherent weak quantum yield.[3] This has necessitated the researchers to develop small fluorogenic molecules for monitoring amyloid formation.

In our study, we have used insulin as a model protein for studying amyloid related diseases, which is known to undergo fibrillation at the site of repeated injections in diabetic patients and also during its industrial process. Here, we describe DMNDC as an intra-molecular charge transfer dye which exhibited varying fluorescence properties according to its surroundings. As an alternative to ThT, DMNDC was found to be an excellent probe for the detection of amyloid fibrils with alarge stoke shift, a huge enhancement in fluorescence, and an excellent blue shift (~70 nm) in fluorescence upon binding to fibrils.[4] DMNDC was found to exhibit no significant effect on insulin fibrillation when used in molar excess as an inhibitor. This suggested the use of DMNDC as an amyloid sensor and not as an inhibitor.



Interestingly, DMNDC was later found to efficiently detectamyloid formation of α-synuclein protein associated with Parkinson's disease. Additionally, the efficient cellular internalization of DMNDC and low cytotoxicity makes it an efficient molecule to be used in biological systems.

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AO-2

Effect of Heavy Metal Concentration in Ground Water Due To Fly Ash At Janghir Champa Region in Chhattisgarh

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The present study focused on the groundwater contamination due to fly ash disposal of coal-fired thermal power plant into a non liner ash pond. Tendubhata were selected as study site around ash pond of Marwa thermal power plant. Groundwater samples were collected on random basis using composite sampling method. Ten heavy metals like Ca, Cu, Cd, Cl, Zn, Pb, Ni, Cr, Mn, and Fe were detected in groundwater samples in different areas of janghir champa. Heavy metal concentration is detected by AAS was used for groundwater assessment. The observed results revealed the exceeding value of heavy metals prescribed by WHO, Indian standard and CG standard for groundwater.

Keywords: Groundwater, Fly ash, Thermal power plant, ash pond, heavy metal.

AO-3

Efficacy of Vitamin C in Prevention of Methemoglobinemia Caused by Nitrate Containing Drugs in Diabetics and Nondiabetics

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The drugs containing nitrates like isosorbide dinitrate, isosorbide mononitrate and glyceryl trinitrate, etc., trigger the oxidation of hemoglobin which is manifested in the pathological disorder named methemoglobinemia. It was considered interesting to investigate the preventive roles of vitamin C towards the toxic effects of nitrate containing drugs used for the prevention of angina. The aim of the present work is to find whether these drugs need to be administered with special care to diabetic patients who are more prone to develop methemoglobinemia.Vitamin C (500mg/day) was administered orally to reduce the methemoglobin (metHb) level in both the diabetic and nondiabetic patients consuming nitrate containing drugs regularly, keeping diabetic and nondiabetic patients not on nitrate drugs as control. MetHb level was found to be lower after the treatment with vitamin C for 30 consecutive days than that before the trial with statistically significant two tailed p value. Additionally, fasting insulin level was also found to decrease after 4 weeks of consumption of vitamin C with moderate lowering of fasting serum glucose level as well, indicating a higher insulin sensitivity for the treated patients.

AO-4

Gallium doped TiO_2 nanoparticles for adsorption - desorption behavior of tea polyphenols

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Tea polyphenols have unique properties in the field of nutritional, medicinal and fine chemical industries. However, since they remain assembled together in the tea extract, methods to purify and separate them from one another become a challenging task. Chromatography, membrane separation, precipitation, etc have been reported to have served the purpose. Adsorption based methods are mostly favored for their clean technology. The present work deals with the synthesis of pure and gallium doped TiO_2 nanoparticles followed by adsorption and desorption study of different tea polyphenols. The TiO_2 nanoparticles were synthesized by using titanium isopropoxide as a source of titanium and pluronic F-68 as a surfactant. The gallium doped TiO_2 was prepared by taking the ratio of Ti:Ga equal to 1:10 and 1:20. Finally calcination at 400 and 600 °C was performed to get the pure TiO_2 and Ga doped TiO_2 material. Then these materials were characterized using different analytical techniques like, N_2 adsorption-desorption and Brunauer–Emmett–Teller (BET) method, Fourier Transform Infrared Spectroscopy (FTIR), Powder X-ray diffraction (PXRD), solid state UV-vis spectroscopy, transmission electron microscopy, etc. Finally catechin, gallic acid, epigallocatechin gallate and caffeine were chosen as tea polyphenols to study the adsorption and desorption behavior of the prepared titania materials. The adsorption experiment was studied upto 7 hour with varying pH range from pH 1 to pH 9 using all the six set of titania nanoparticles. The adsorption data suggested that, the 1:10 Ga doped TiO_2 nanoparticle calcined at 400 °C (indicated as Set 3 TiO_2) could adsorb catechin and gallic acid upto 100 % for 5 h shaking in pH 5 medium. Whereas, 1:10 Ga doped TiO_2 nanoparticle calcined at 600 °C (indicated as Set 4 TiO_2) could adsorb epigallocatechin gallate upto 99 % for 5 h shaking at pH 1 medium. The adsorption of catechin, epigallocatechin gallate and gallic acid followed Langmuir Isotherm. Water was taken as desorption medium and gamma radiation, shaking, sonication and UV radiation were used to stimulate the desorption process. The conventional Folin –Ciocalteu method was used to examine the desorption behavior of the highest adsorbed material. The desorption study showed that from Catechin and gallic acid adsorbed Set 3, Catechin was not desorbed at all while gallic acid could be desorbed using 72 h irradiation with gamma energy (dose rate1.313 KGy/h). The Set 4 sample with epigallocatechin adsorbed in it could be desorbed upto 96 % under sonication for 30 min. Thus, the polyphenols could be selectively separated from one another using mild desorption conditions and hence can be used for further applications.

AO-5

Clinical Impact of Caffeine on the Diabetic Patient'sSerum: A Spectroscopic Study

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Diabetes is a leading cause of diabetic neuropathy(DN), but its harmful consequences are avoidable with early detection and treatment.DN is associated with the accretionin oxidation of sorbitolwhich is potential sources of hyperglycemia-induced oxidative stress[1,2].Thussorbitol measurement in serum can serve as a good indicator in the diagnosis and monitoring of the diabetic complications[3]. To remove the surplus sorbitol from the body, proposed binding of sorbitol with caffeine (1,3, 7-trimethylxanthine) was investigated.Isothermal titration calorimetric (ITC) experiments clearly indicate binding sites (i.e., 3.89, 1.40, 2.07) between sorbitol and caffeine at the complexation ratio of 1:1.2, 1:1.5 and 1:3. Blood glucose level was measured spectrophotometrically where glucose was oxidised to gluconic acid, and produced H2O2 in turn oxidizes a dye (4-amynoantipyrine) in a quantitative enzyme-catalysed reaction[4].The blood glucose level obtained from non-diabetics groups were compared to a similarly aged group of diabetics treated aggressively with caffeine doses (10 mmol L−1) adjusted for changes in blood glucose in order to achieve and maintain serum sorbitol level.Caffeine helps in interpreting screening and development of DNby fluorometric enzymatic analysis of sorbitol level on the diabetic patients (mean age 44± 0.43 years, range 24-64 years). Further the effect of caffeine is compared with a non-diabetic subject is established by UV-Vis (λ_{max} = 340 nm) and fluorescence spectrophotometry.Association constant (K= 214 M^{-1}) is determined for sorbitol by NADH concentrations.Caffeine can be helpful in both reducing the sorbitol level and also chances of development of DN by introducing small doses of caffeine.The sensitivity of this screening program in detecting diabetic neuropathy disease compared with the serum of healthy adults has been checked and found efficient and 80%accurate.The present method can be helpful in suggesting a plausible remediation for treating DN.

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AO-6

γ-Irradiated Selenium Nanoparticles for Optical Sensing of a Cancer Biomarker

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Early detection and supervision of cancer using cancer biomarkers is a well-focused area in recent research and development field. Carcinoembryonic antigen (CEA) is a protein present at very low levels in the blood of adults (<2.5 ng/ml in non-smokers and <5.0 ng/ml in a smoker). The CEA blood level may be increased in certain types of cancer and in certain non-cancerous conditions. A CEA test is most commonly used to diagnose colorectal cancer. Low sensitivity and specificity of different established methods (electrochemiluminescence, potentiometry, electrical, electrochemical methods, etc.,[1] demand special attention. In this novel study, a simple, rapid, efficient and cost-effective method is reported using selenium nanoparticles (SeNP) for the optical detection of CEA. Results establish efficacy of prepared SeNP to sense CEA in serum medium even at its low concentration using UV-visible spectroscopy. γ-irradiated (24h) Se nanoparticles (γ-SeNP) was found to have higher sensitivity towards CEA compared to non-irradiated SeNP as it could deliver higher signal enhancement owing to its higher surface activity and charged nature.Results also indicate that presence of glucose, cholesterol and bilirubin in serum does not interfere with CEA sensing. In fact, significant increase in detection thresholdwas achieved in presence of glucose, cholesterol, bilirubin and in their combined physiological conditions as the limit of detection (LOD) obtained is manifold less as compared to an otherwise healthy condition.Thus, this detection method could also be applied efficiently to the patients having these comorbidities. Results make this optical method to be a sensitive as well as a specific one for the superior detection of biomarkers. This proposed approach is practical and holds the potential for clinical diagnosis of CEA.

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AO-7

Efficiency of Resin bound gold nanocomposite materials en-route of dye adsorption from aqueous solution

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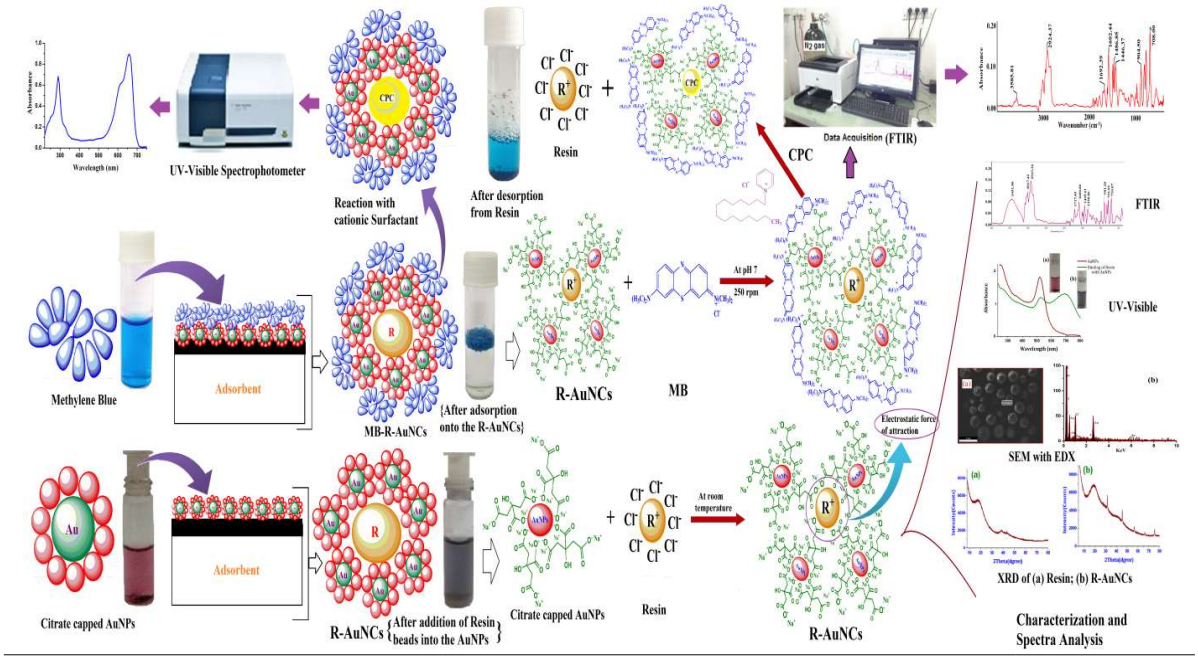
The citrate-capped gold nanoparticles (AuNPs) and anion exchange resin (activated Amberlite XAD-4) were used for the formation of resin bound gold nanocomposites (R-Au NCs), to remove the dyes from water sample due to the large surface area to volume ratio. Adsorption of commercial reactive cationic dye, methylene blue (MB) from water, onto the R-AuNCs was carried out in this present work. Fourier transform infrared (FTIR) spectroscopic and UV-Vis spectrophotometric analysis were performed to confirm the adsorption phenomenon onto the surface of the R-Au NCs and also characterized by sanning electron microscopy with energy dispersive X-ray analysis and X-ray diffraction analysis. The IR absorption peaks for nanocomposites was obtained at 3451 cm^{-1}, 2923 cm^{-1}, 1717 cm^{-1}, 1600 cm^{-1} and 1445 cm^{-1}, which is corresponded to the stretching vibration of O-H, symmetric stretching of C-H, stretching vibration of C=O, and stretching vibration of C=C respectively. The calibration curve gave a higher linearity in the range between 5-25 μgL^{-1} with correlation coefficient (R^2) 0.989 and limit of detection of 0.2 μgL^{-1}. The percentage adsorption efficiency (Q_e) was obtained to be 77.64 %. The advantage of the present method is easy, low cost and efficient for monitoring of the removal of dye from water sample.

Graphical abstract



Keywords: Nanocomposites; Immobilization; Resin; Methylene Blue; Adsorption; FTIR; UV-Vis spectroscopy.

AO-8

Design of D-mannitol and PPG#400 Based Aqueous Biphasic System for Extraction of Drugs Recommended in Covid-19

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Aqueous biphasic system (ABS) offers a green alternative to the traditional liquid-liquid extraction system in which toxic, volatile and inflammable organic solvents are used1. ABS is generally composed of two mutually incompatible aqueous solutions of polymer-polymer, polymer-salt, salt-salt, carbohydrate-polymer etc., at a certain thermodynamic condition[1,2]. According to literature, the carbohydrate-polymer system is one of the least studied systems. Carbohydrates have the advantage of having nonionic, nontoxic, biodegradable nature with cheap and easy availability. In this work, a polymer-carbohydrate based ABS consisting of 18% (w/v) aqueous solution of D-mannitol and PPG#400 (100%) has been constructed at 309 K. The phase diagram of the newly formed ABS was plotted using Merchuk equation. The advantage of the newly designed D-mannitol based ABS is that it is free of ionic materials in contrast to most of the previously reported ABSs which are either composed of highly concentrated ionic salts or ionic liquids. The present ABS was found suitable to extract L-ascorbic acid (Vit-C), Ivermectin and Doxycycline which are widely recommended for the current treatment of COVID-193-5. The extractions are studied at different pHs (3, 5 and 7) of D-mannitol rich phase. The polymer rich phase of the ABS was collected for spectral study to determine the extraction percentages. The percentages of extraction of L-ascorbic acid are 19%, 21% and 30% respectively at pH 3, 5 and 7. The percentages of extraction of Ivermectin are 79%, 84% and 87% respectively at pH 3, 5, 7 and 62%, 68% and 69% respectively for Doxycycline extraction.

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AO-9

Nitrogen-Doped Carbon Quantum Dots-MnO_2 Nanowires Based Fluorescence Probe for Detection of Cholesterol, Glutathione, AChE and Pesticide

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Cholesterol and glutathione has attracted extensive attention because in human fluids is clinically important analytes and their sensitive detection is significant in diagnosis. In this study, FRET based fluorescence "switch-off-on-off" of nitrogen doped carbon quantum dots (N-CQD) in the presence of MnO_2 nanowires have been successfully applied to fabricate a fluoremetric biosensing platform for detection of cholesterol, glutathione, AChE and pesticides. The cholesterol and ATChI could be oxidised by cholesterol oxidase (ChOx) and acetylcholinestrase (AChE), in accompanied with the formation of H_2O_2 and thiocholine intermediate respectively. Thus H_2O_2, thiochoine disulfide and glutathione disulfide produced from oxidised glutathione resulted in the decomposition of MnO_2 nanowires (brown) to give Mn^{2+} ions (colorless), which induced the absorption of MnO_2 nanowires decreased and the fluorescence of N-CQDs increased consequently gives sufficient recovery of fluorescent signal. Vice versa fluorescence intensity is decreased in presence of chlorpyrifos pesticides due to inhibition of AChE. The sensing platform shows a sensitive response to cholesterol, glutathione and chlorpyrifos pesticide in linear regression ranges of 10 to 150 nM, 20 to 200 nM and 1 to 35 µM, with the detection limit and LOQ of 16.06 nM, 8.47 nM, 7.40 µM and 50.32 nM, 25.67 nM, 22.43 µM are obtained by fluorescent method. This promising strategy was successfully applied in monitoring the cholesterol, glutathione and pesticide such a consecutive recognition process provides valuable insights for bio-analysis.

Keywords: N-CQD, MnO_2 Nanowires, Cholesterol Oxidase, Cholesterol, Glutathione, Acetylcholinestrase, Chlorpyrifos.

AO-10

Separation of radioarsenic, ^{71,72}As from alpha particle irradiated gallium oxide target

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Importance of no-carrier-added (NCA) radioisotopes is well-known in nuclear medicine. Radioisotopes with suitably short half-lives have bio-medical applications. Few arsenic radioisotopes have suitable nuclear properties applicable for imaging and treatment. ^{74}As (17.77d), ^{72}As (26.0h), ^{71}As (65.3h), ^{70}As (52.6min) are potential isotopes for positron emission tomography (PET) or single photon emission computed tomography (SPECT). ^{72}As-^{77}As can form a theranostic pair, where ^{72}As act as imagingand ^{77}As as radiotherapeutic agent. ^{71,72}As was produced by irradiating gallium oxide target by 46 MeV α-partcles. ^{71,72}As was separated from target matrix by liquid-liquid extraction (LLX) using tricaprylmethylammonium chloride (Aliquat-336) and trioctyl amine (TOA) diluted in cyclohexane. Complete separation was observed at 2 M HCl + 0.01 M Aliquat-336 and 3 M HCl + 0.1 M TOA. High separation factors could be observed between bulk Ga and NCA As radionuclides. Bulk gallium was completely extracted in the organic medium by both the anion-exchangers, TOA and aliquat-336. No-carrier-added ^{71}As was obtained in the aqueous medium without any contamination from the target matrix at best conditions. This radiochemical separation is simple and fast for separating radioarsenic from gallium oxide target. Since NCA ^{71}As was present in aqueous medium, the radioisotope can be directly used for further applications.

AO-11

Non-contact laser based spectroscopicanalytical technique for condition monitoring of industrial materials

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Quantitative atomic-analysis relies on atomic absorption/ emission/ fluorescence principles. Laser induced breakdown spectroscopy (LIBS) is a novel atomic-analysis technique that uses laser produced plasma for generating aerosol/vapour as well as ionization, which is attractive for industrial materials. It does not need any sample preparation like acid digestion and is non-contact and almost non-destructive.LIBS was tested for several industrial materials including transformer-insulation, Si-R insulation and coal quality-monitoring.

Immature failure of transformers due to Cu-contamination of oil impregnated pressboard (OIP) insulationhave been threatening power industry (also reported by CIGRE) [1,2]. LIBS has been tested successfully for condition monitoring of OIP and identifying the level of degradation using several parameters such as intensity, plasma persistence time and depth of diffusion [3-6]. Figures 1a and 1b show the LIBS spectra of virgin and aged OIP material, indicating several Cu emission lines detected. Industry OIP sample was tested using LIBS by large-area Cu-intensity imaging (Figure 1c).Innovative variations of LIBS, such as molecular LIBS and spatially resolved spectrally integrated LIBS were also found to be useful for better understanding of the degradation and improved the utility of LIBS as an analytical technique [7-8].LIBS was also found to be useful in identifying presence of rare-earth elements in coal and quality-monitoring.

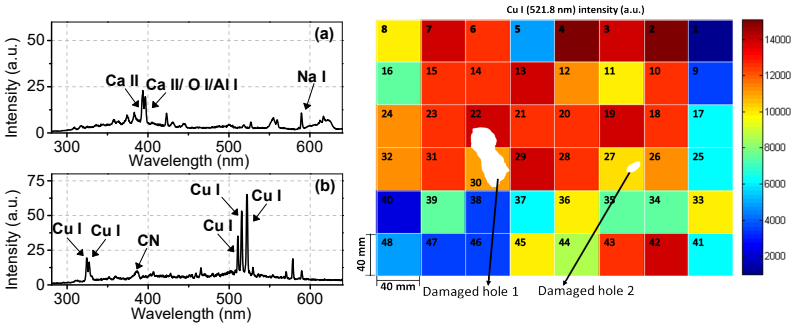

Figure 1 UV-Vis LIBS spectrum of (a) virgin (un-aged) OIP material (b) aged OIP matrial (c) LIBS intensity map of failed OIP insulation collected from TNEB

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AO-12

Developing scenario of titania-based building materials for environmental remediation

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The present review article is aimed at analysing the different aspects of titania-modified building materials towards environmental remediation. The possibility of degradation of different toxic environmental pollutants like VOCs and NOx by the titania-modified paints, cements and other building materials has been discussed. The major role of titania resides in its photocatalytic activity that renders the materials' potent for degrading these obnoxious compounds. The application of TiO_2 both in small and in large scale and the mutual relationship of the amount of TiO_2 with the amount of main building block constituents are discussed in detail. Application of daylight or lamplight, energy, time, and atmospheric conditions has also been dealt with. This review article solely focuses on titania-incorporated building blocks and is an endeavour to propagate a new horizon for our future pollution-free perspectives. Several environmental and product-related parameters that affect the efficacy of these modified matrices have been taken up. The present scenario in the industrial fields has also been assessed. Finally, a critical view is also presented that highlights the shortfall and areas open for further research and development in this particular field.

Award Poster

Colorimetric and paper-based sensor for selective detection of lead using PVA functionalized silver nanoparticles: Experimental and theoretical approach

AP-1

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We report a plasmonic colorimetric sensing strategy using polyvinyl alcohol (PVA) modified silver nanoparticles (AgNPs) and paper-based analytical devices (PADs) for selective detection of lead (Pb). Method is based on the measurement of red shift of localized surface plasmon resonance (LSPR) absorption band of AgNPs/PVA in visible region after the addition of Pb(II) using UV-Vis spectrophotometry and color intensity of PADs was recorded with Smartphone followed by the processing in ImageJ software. The mechanism of color change and red shift ($\Delta\lambda$) of LSPR band from 410 nm to 550 nm is due to the interaction of Pb(II) ions towards the PVA through strong ion-dipole interaction perturbing the stability AgNPs which further directed the aggregation of particles. The calibration curve gave a good linearity in the range of 20-1000 μgL^{-1} with limit of detection (LOD) of 8 μgL^{-1} by colorimetry and 50-1000 μgL^{-1} with LOD value of 20 μgL^{-1} using PADs. The advantages of using AgNPs/PVA as plasmonic colorimetric probe and PADs found to be simple, low cost and selective for determination of lead from surface water and industrial waste water samples.

Keywords: Silver nanoparticles, PVA, colorimetric probe, paper based analytical devices, lead, water samples.

AP-2

Isolation and Identification of Pinocembrin-7-*O*-[42 2 ,62 2 -(*S*)-Hexahydroxy Diphenoyl]-β-D-Glucose from *Macrosolen capitellatus*: *In vitro* and *In silico* Studies to Explore its Anticancer Potential

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Mistletoes are extremely important plants and their extracts have been widely used as a complementary medicine towards cancer therapy. In this context, we have studied the leaves of a South Indian Mistletoe, Macrosolen capitellatus (Wight & Arn.) Danser, a parasitic plant belonging to family Loranthaceae. A bioassay-guided isolation and LC-MS dereplication strategies have led to the isolation of pinocembrin-7-O-[4", 6"-(S)-hexahydroxy diphenoyl (HHDP)]-β-D-glucose (1).This is the first report showing the presence of 1 not only in this plant but also in the genus Macrosolen. In this study, the aforementioned parasitic plant was collected from two different host plants, Mangifera indica and Phyllanthus emblica, which were extensively studied chemically by various research groups. We have observed that 1 is present in both samples of M.capitellatus, while a thorough literature search showed that this compound 1 has not been reported from either Mangiferaindicaor Phyllanthusemblica. These observations indicated that the producer of 1 is nothing but parasitic plant M.capitellatus. This compound has shown moderate anti-proliferative activity against MCF-7 cell line (IC 50 value-15 µM). A computational protein binding study has been performed on 1 against 25 crystallographic proteins of the BRCA-1 gene of breast cancer. The results showed interactions having - 9.33 and-8.99kcal/mol binding energy with the proteins IDs 1T15 and 1T29 respectively; which suggests that this scaffold has the potential to develop further. Macrosolencapitellatus(A) Leaves and (B) stems Bio-assay-guided isolation Isolation of compound Invitro cytotoxicity assay on MCF- 7 Molecular docking Spectral analysis Dereplication of known compound by LC-HRMS referring dictionary of natural products

Acknowledgements

Dr.Abhijeet S. Kate , Dr.Khemraj Bairwa, National Institute Of Pharmaceutical Education and Research – Ahmedabad (NIPER-Ahmedabad)

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OP-1

General Presentation

Oral Presentation

Analytical Method Development and Validation for the Determination of Isoniazid in, Isoniazid (300 mg) and Ethambutol Hydrochloride (800 mg) Tablets"

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A simple method using HPLC system with reverse phase chromatographic technique was developed for the quantification of Isoniazid, in a fixed-dose combination (FDC) of anti-tuberculosis drug product (Isoniazid and Ethambutol Hydrochloride Tablets)

OP-2

Fabrication ofAu@AgBimetallic Nanoparticles for Selective Detection of Lead in Onion Sample

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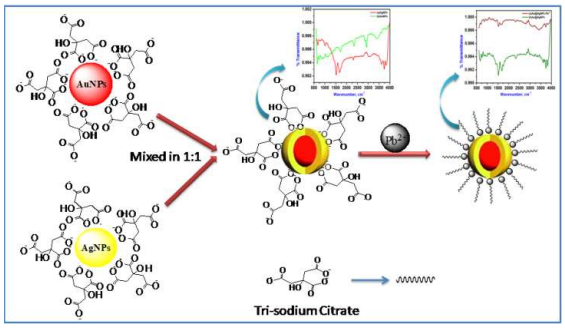
Here, we report a novel and facile Gold-Silver (Au@Ag) colorimetric method for determination of leadion (Pb^{2+}) in onion(*Allium cepa* L.) samples collected from different areas of Chhattisgarh. Au@Ag bimetallic nanoparticles (BiMNPs) were chosen as sensing probe to demonstrate and optimize the method for determination of Pb^{2+} using UV-Vis, transmission electron microscope (TEM), diffuse reflectance fourier transform infra-red (DRS-FTIR) spectroscopy and energy dispersive X-ray spectroscopy (EDX). The DRS-FTIR transmittance peak observed for Au@AgBiMNPs at 1500-1700 cm^{-1} was enhanced by addition of Pb^{2+}. It has also been confirmed by shifting ofplasmon band towards higher wavelength. This shifting of bandhave been further used for the optimization of different analytical parameters and for the determination of Pb^{2+} *via.*Au@AgBiMNPs. A linear calibration curve obtained by this experiment with linearity range, limit of detection and limit of quantification was as 10-100ng mL^{-1}, 5.28ng mL^{-1} and 17.62 ng mL^{-1}, respectively. The advantageous features of the proposed method are their sensitivity, selectivity and reproducibility to easily determine Pb^{2+} in onion samples in presence of other heavy metal ions.



Keywords: Au@Agbimetallic nanoparticles, lead ions, colorimetric sensor.

OP-3

Basic and advanced logical concept derived from surface enhanced infrared spectroscopy (SEIRS) as sensing probe for analysis of chemical species: A brief review

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Infrared spectroscopy is an immensely important technique whose major concern is to measure vibrational frequency in any molecule and especially specific functional groups present. Surface enhanced infrared spectroscopy (SEIRS) is an appreciable advancement of Infrared spectroscopy used to obtain the spectrum of absorption of a solid, liquid and gas. Its emergence facilitated the increase of speed and accuracy of the conventional technique by replacing the use of traditional prism and grating monochromators with an interferometer. It is used for the determination of variety of analytes in environmental and biological samples as its high sensitivity allows to detect the analyte at trace levels. Furthermore, it is commonly used for the characterization and monitoring of organic and some cases of inorganic pollutants on the basis of molecular structure and chemical bonding. Though various chromatographic, fluorimetric and phosphorimetric techniques have been traditionally used for such monitoring and characterizations, FTIR proves out to be an appealingly good alternative due to its remarkable characteristics such as little sample preparation, rapid analysis, better signal-to-noise (SNR) ratio and minimized use of hazardous solvents. This review aims to compile the miscellaneous features of SEIRS favouring its use as a sensing probe for the analysis of chemical species.

Keywords: Infrared Spectroscopy; SEIRS; sensing probe; chemical species; characterization.

OP-4

Reaction mechanism of γ-rays irradiated PMMA using Spectroscopic techniques

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Polymers are an important class of materials having different applications in various fields of science and technology, particularly in optics, electronics, biotechnology, photonics and space research. The study of changes in the properties of polymer material under the effect of ionizing radiation (electron and ion beam, x-ray and gamma radiation) has great importance due to its use in hard radiation environments such as particle accelerator, nuclear power plants, spacecrafts etc. Reaction mechanisms of product formation due to γ-irradiation (with total dose 570 kGy at a dose rate of 1.707 kGy/hr) in Polymethyl methacrylate (PMMA) have been studied by using Fourier transform infrared (FTIR), UV-Vis spectroscopic and x-ray diffraction (XRD) techniques. Gamma radiation is done at UGC-DAE CSR Kolkata centre, WB India. Results show that there are dose dependent changes like chemical and structural nature, formation of color centre, chain scission and cross-linking etc) observed in the polymer. Reaction mechanisms of product formation have been investigated.

OP-5

Synthesis and Characterization of 5-Methylisoxazole Derivatives by LCMASS & ^{1}H-NMR Technique and Its Potentials Application

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The present disclosure of the invention presents a novel 5-methylisoxazole derivative & method of preparation thereof. These newly synthesized compounds were characterization and confirmation by LCMASS and 1H-NMR Spectroscopy. These 5-methylisoxazole derivatives showing antibacterial, antifungal and antimalarial activity, against the STD drugs. These compounds would be of better use in drug development to combat bacterial infections and as anti-malarial agents.

OP-6

Dual fluorometric detection of Cu2+ and Ni2+ ions via excimer quenching of quinoline moiety of quinoline-appended glucopyranose derivative

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Among the various biologically important metals, copper is the third most plentiful element in living organisms and essential to many fundamental physiological processes [1]. On the other hand, Ni^{2+} is an important metal ion in biological processes and exists in the active sites of several enzymes and coenzymes for biosynthesis and metabolism of microorganisms and plants [2]. Both Cu^{2+} and Ni^{2+} ions are crucial trace elements in biological systems but they also act as significant environmental pollutants due to their inherent toxicity. In view of that, a simple triazole-linked quinoline-appended fluorescent sensor has been developed from inexpensive D- glucose in one synthetic step. The sugar-based quinoline-appended sensor exhibited excimer and monomer emissions in MeOH/H_2O (7/3, v/v) after excitation at 350 nm. We observed that the excimer emission of quinoline moiety at 481 nm was quenched with the increment of monomer emission at 391 nm in the presence of Cu^{2+} and Ni^{2+} ions in the aqueous methanolic solution [3]. The sensing ability of the sensor towards Cu^{2+} and Ni^{2+} ions was also established by absorption spectroscopy. Based on Job's plot experiment we found sensor exhibited 1:1 stoichiometric ratios for both ions which were further supported by mass spectra of the complexes. The limit of detection (LOD) values of the sensor for Cu^{2+} and Ni^{2+} were determined as 0.025 μM and 0.047 μM respectively. To the best of our knowledge, this is the first example of monoquinoline-based sensor which exhibited excimer quenching in the presence of Cu^{2+} and Ni^{2+} ions.

Keywords: Cu^{2+} and Ni^{2+} ions, quinoline, glucopyranose, excimer, fluorescence

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OP-7

Access & usability of Science kits for promotion of Laboratory skills among school students

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No science instruction is complete without laboratory work. Experimentation is part & parcel of all sciences.

At the same time, taking good care of our environment has become not only imperative in the present rapidly progressive society rather it is an urgent concern of every conscious being in the planet earth. Different branches of science, plays an important role for advancement of all walks of life. For an individual, the journey to become a chemical scientists starts at very early stage of schooling and ends till post-graduation of even after that. In order to practice certain required skills in science, every student is supposed to provide opportunities for development of some certain skills among students. There are numerous reasons they restricts the students to try their hands on practical work. Students are deprived of the laboratory experiments and in turn are unable to develop some certain skills those are very important in their lives. In order to fulfil the requirements related to laboratory facilities schools are provided support from various organisations including NCERT. NCERT not only develops the science kits, but provides the hands on experiences & training to the teachers to use these kits in the real class room situations.

In the present paper an attempt has been made to find out the status of access & usability of science kits in the schools of western states of India. It is found that all the schools do not have the access of the science kits in their schools. Some schools where these kits are available, are also not in position to make best use of these kits in the interest of the learners. The paper also attempts to analyse the reasons for neglecting the experimental work in Indian schools which otherwise is the back bone of all higher level experiments and researches in science

OP-8

Removal of phenol from wastewater using industrial wastes as adsorbents: A step towards circular economy

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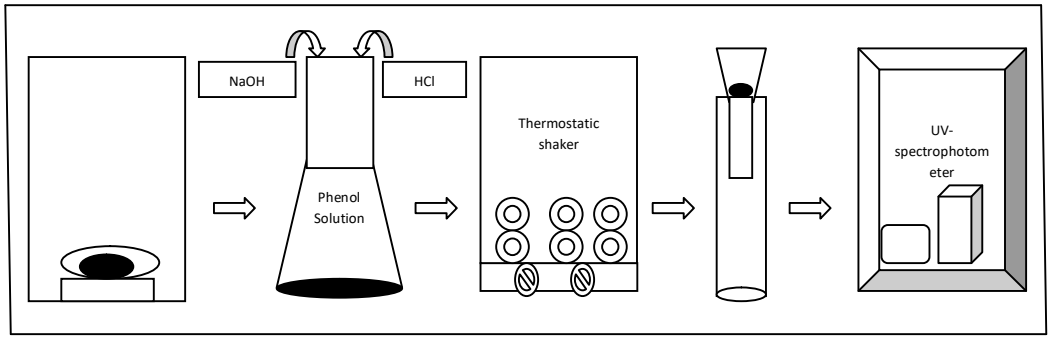
The wastewater containing phenol needs to be treated suitably as it is toxic. There are several techniques developed for this; however adsorption seems to be very effective due to its simplicity and low-cost. In this study three industrial wastes viz., rice husk ash, red mud and clarified sludge from basic oxygen furnace have been used as adsorbents. These waste materials usually do not have any economic value and are therefore discarded from their generating plants. Initially the adsorbent characterizations were performed by SEM, XRD, FTIR and BET analyzers. Thereafter the adsorbent potential of each adsorbent was examined at different process conditions i.e., initial phenol content, initial pH, adsorbent quantity, contact time and temperature. The maximum phenol removal percentage was found to be 95%, 87.5% and 63% for rice husk ash, red mud and clarified sludge respectively at optimum process condition. The experimental results were then verified for kinetic study using several models like pseudo-first order, pseudo-second order, Elovich, Reichenberg, Fick, Boyd and Furusawa-Smith models. The isotherm study was carried out using Langmuir, Freundlich, Temkin and Dubinin-Radushkevich models. The thermodynamic study was performed using the outcomes at different temperatures. The regeneration, safe disposal and scale-up design were deliberated for testing their commercial applications. Finally the innovative prediction analysis was conducted using MLR modeling. The adsorption experiments were also repeated with the real industrial wastewater collected from a coke-oven plant. The study established that these industrial wastes are effective for phenol removal from wastewater and can thus be considered as valuable contributors towards circular economy in the third world countries.

Keywords: Phenol, Wastewater, Adsorption, Industrial wastes, Rice husk ash, Red mud, Clarified sludge



Poster Presentation

PP-1

Structural studies of chemical Constituents - Apigenin 6-C-β-D-(2''-O-β-D-glucopyranosyl) from Bark of Pterocarpus marsupium

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Natural product is considerd as remedial resource for many diseases. Pterocarpus marsupium is very renowned tree which is known as its potential therapeutic applicability. Pterocarpus marsupium is also known as Indian kino tree because this is native to India. It is used to cure many diseases like elephantiasis, leprosy, leucoderma, diabetes, opthalmopathy, greyness of hair and asthma etc. Many chemical consituents from Pterocarpus marsupium have been isolated as- C glucoside, 1-(2', 6'-dihydroxyphenyl)-β-D-glucopyranoside, 7-Hydroxy-6, 8-dimethyl flavanone-7-O-alpha-L-arabinopyranoside and 7,8,4'- trihydroxy-3', 5'-dimethoxy flavanone-4'-O-beta-Dglucopyranoside etc. A new compound Apigenin 6-C-β-D-(2''-O-β-D-glucopyranosyl) has been isolated from the bark of Pterocarpus marsupium. The structure of new isolated compound has been confirmed with the help of MS, 13 C NMR, IR, UV, 1 H NMR, synthesis and Chemical degradation.

PP-2

Novel strategy for optical chemical sensing of nerve agent simulants

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The extreme toxicity, facile production, easy accessibility compare to conventional weapons, there is always possibilities to use of nerve agents by terrorist organization & military regimes which dictates the requirement to develop selective & sensitive detection system for them[1]. Various detection methods based on electrochemistry[2], ion mobility spectrometry[3], surface acoustic wave (SAW) devices[4], biosensors[5], etc were developed. However, these detection methods have at least one of the limitations like limited selectivity, poor sensitivity, operational complexity, low portability etc. As an alternative, optical chemical sensors including chromogenic and fluorogenic sensors have gained great importance as they are portable, cheap and enable neked eye detection of analyte. However, reported chromogenic and fluorogenic detection methods for CW agents and their simulants suffer from poor selectivity due to the involvement of single non-specific nucleophilic-electrophilic interaction between chemical sensor molecule and analyte as similar interaction with non- toxic molecules can give rise to false positive alarms. We, herein, describe a novel strategy for selective detection of nerve agent simulants which involves sequential interactions between the sensing system and analyte's reactive sub units. These multiple interactions modulate the overall optical properties of the sensing system which is specific to the nerve agent simulants. This novel strategy was found to be selective for the detection of nerve agent simulants and did not give response in presence of other common interferences including phosphorus derivatives, acid and anions.

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PP-3

Fluorescent Carbon Quantum Dots as Sensing Probe for Selective and Sensitive Detection of Hg^{2+} in Water Samples

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Carbon quantum dots (CQDs) are promising fluorescent sensing probe for applications in metal ion detection, biosensing and bioimagining. Herein, we have synthesized carbon quantum dots (CQDs) by simple microwave assisted technique for Hg^{2+} detection in water samples via.fluorescence quenching and FT-IR spectroscopic approach. The morphology and chemical structure of synthesized CQDs was characterized by TEM, FT-IR, ^{13}C-NMR, fluorescence and UV-vis spectroscopic technique. The resultant CQDs bears spherical morphology with an average size of 2-4 nm. The binding parameters, as Stern-Volmer quenching constant (K_{sv}) and binding constant (K_a) for CQDs-Hg^{2+} system was investigated by fluorescence method, whereas UV-vis techniques was employed for determination of thermodynamic parameters, as Gibb's free energy (ΔG), enthalpy (ΔH) and entropy (ΔS) at three different temperature (295, 298 and 305 K). Moreover, selectivity assay for Hg^{2+} detection has been studied in presence of other metal ions by FT-IR as well as fluorescence spectroscopy. Analytical assay was also successfully applied for Hg^{2+} in spiked water samples collected from different areas of Chhattisgarh.

Keywords: Carbon quantum dots; FT-IR; fluorescence; UV-vis; mercury; chemical sensor.

PP-4

Comparative Study ofPalladium(II) Extraction Using EBIMTT and DMABIMTTExtractants

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Comparative study of extraction of Palladium (II) was carried out using two different sulphur containing extractants namely EBIMTT (4-(4-ethylbenzylideneimino)-5-methyl-4H-1,2,4-triazole-3-thiol,Extractant 1) and DMABIMTT (4-(4-dimethylaminobenzylideneimino)-5-methyl-4H-1, 2, 4-triazole-3-thiol, Extractant 2) in a Chloroform diluent. Also various parameters such as shaking time, diluent used, concentration of extractants, and concentration of HCl were studied. Extractant 1 could also be used for extraction of Pd ion but extractant 2 was found more efficient than extractant 1 for Pd (II) recovery. In addition Pd(II) was stripped from organic phase, thus enabling the reuse of extractants.

Chemical Engineering & Green Technology Section

Award Presentation

Award Oral

AO-1

Selective production of aromatic compound from the waste plastics by using porous carbonaceous material as catalyst

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The global production of plastics is increasing rapidly because of their vital role in today's daily activities. Plastics are widely used because of its advantages such as cheapness, endurance, lightness, hygiene and design adaptability. The sharp rise and mass consumption of plastics produce a great quantity of wastes, which poses a formidable challenge for waste management. Domestic waste generally contain many kind of waste plastics, including polyethylene, polypropylene and polyvinyl chloride,which is 70% of total was tea sper L l etal. 2001. Approximately 10-20 million tons of plastics end up in the oceans each year as per Tranksali et al. Thus, it is becoming increasingly challenging to manage and control the use of plastics due to their adverse environmental effects. The landfill deposition of municipal waste plastics (MWP) may cause environmental problems and is becoming more expensive. Due to increasing volume of MWP and decreasing landfill capacity for disposal, landfill becomes more challenging. In addition, landfill can release hazardous sub-stances and plastic wastes take long time to degrade. In this paper we focus on the production of clean fuel from waste plastics by catalytic pyrolysis. Catalytic pyrolysis is a novel high efficient technology on recycling of waste plastic and it is environment friendly also. It can also stabilize global need of fossil fuel which tends to be crisis. Pyrolysis of different waste plastics such as polyethylene, polypropylene, polystyrene and polyvinyl chloride was achieved at abenchscale to produce clean fuel of required calorific values or chemical feedstock. Combination of pyrolysis with catalytic up gradation process can prove significant economic and economical option in conversion of e-waste plastic. Herein, we conducted the pyrolysis by utilizing the porous waste carbonaceous material as catalyst. Study the effect of catalytic temperature, residence time and plastic waste component on the production of Aromatic compound. The entire process is undertaken in closed reactor vessel followed by condensation, if required. Waste plastics while heating up to 500 to 900 ^{o} C convert into liquid-vapour state, which is collected in condensation chamber in the form of liquid fuel. Further optimize by soft computing techniques.

Keywords: Waste plastics; Aromatic production; Catalytic thermochemical conversion

AO-2

Porous Organic Molecules to Porous Organic Polymers: Potential Catalysts for CO_2 Fixation

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All-organic nanoporous materials, e.g., organic cages, porous organic polymers (POPs), have attracted significant attention in the last few years for their potential applications in catalysis owing to the functional tunability, high porosity, and outstanding hydrothermal stability.[1] Catalytic fixation of CO_2 with epoxide for the synthesis of cyclic carbonates has drawn a great deal of interest because it provides a viable route to minimize the production cost of various materials derived from cyclic carbonates using easily available, renewable raw material, CO_2, as one-carbon building block.[2] The high atom economy, as well as the versatile utility of the cyclic organic carbonates, make the conversion of CO_2 to cyclic carbonates an industrially relevant reaction.[2]Our group has focused on the importance of the 'nanoconfinement' effect in the aforementioned catalytic process.[3] In this presentation, I shall discuss the

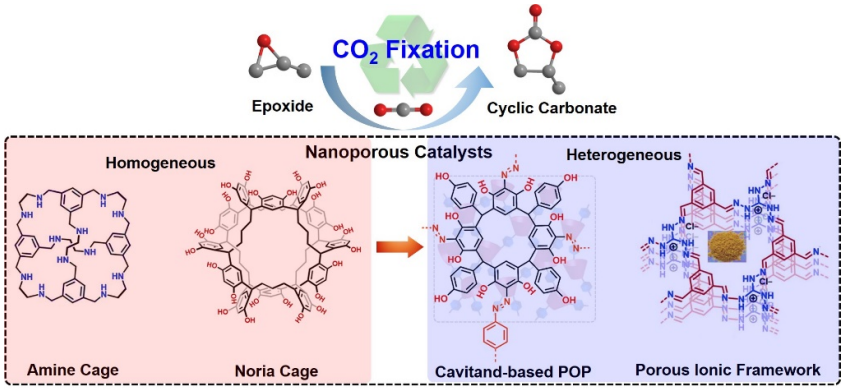

Figure: Pictorial representation depicting the nanoporouscatalysts from cage to frameworks for catalytic fixation of $CO_2$to cyclic carbonates.

nanoporous organic amine cage, and noria as homogeneous catalytic platform for CO_2 fixation.[4a] Addressing the recyclability issue, I will switch to the heterogeneous catalytic platform discussing the use of recently developed cavitand-based POPs,[4b,4c] and N-rich triaminoguanidinium-based ionic frameworks for the efficient CO_2 fixation into cyclic organic carbonates.[4d]

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AO-3

Fabrication of Gold Nano-Ink as Electrochemical Sensor for Glucose Detection

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To the best of our knowledge, the inkjet-printed paper electrode (PPE) with gold nanoparticles (AuNPs)-ink as a non-enzymatic electrochemical sensor for detection glucosein blood samples is reported for the first time. In this work, a green method is used for the synthesis of aqueous AuNPs-ink and has been fabricated on the paper substrate using office desktop inkjet-printer.PPE with AuNPs is sintered at 100º C for 30 min to obtain a conductive film. The prepared AuNPs-PPE is employed as a working electrode in cyclic voltammetry (CV) for the sensitive measurementof glucose in blood samples. The fabricated AuNPs-PPE demonstrated an excellent electrochemical activity and rapid electron transfer kinetics towards the oxidation of glucose. A wide linear range, 0.05-35 mM with a limit of detection, 10 µM is observed for the determination of glucose. The advantages of using AuNPs-PPE in the electrochemical measurements are flexible, user-friendly, biodegradable, economic and enzyme-free with respect to the commercially available electrochemical sensors.

Keywords: AuNPs, electrochemical sensor, glucose, bloodsamples.

AO-4

Single and mixed micelle as catalyst in promoted organic transformation

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Growing concern for environmental issues has compelled synthetic organic chemists to adopt sustainable way towards green synthesis [1]. Catalytic organic transformation in aqueous medium is indeed a green modification in the field of synthetic organic chemistry [2]. To perform organic reaction in water micelle plays a dominating role by solubilising nonpolar organic compound in water and catalysing a chemical transformation [3]. Presently different types of organic reactions are regenerated in micellar medium [4-7]. Here oxidation of aliphatic alcohol is presented. Oxidation dynamics of alcohol oxidation was achieved by aqueous chromic acid under pseudo 1st order condition. The reaction was catalysed by single micelle and mixed anionic-nonionic micelle. Mixed micelles are of low cost and found to be beneficial for industry. Further use of heteroaromatic bases enhanced the rate of reaction. Combined effect of micelle and promoter completes the reaction almost instantly. The product of reaction was characterized by different spectroscopic methods. Formation of mixed micelle and encapsulation of alcohol in micellar core is established by NMR study [2].

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AO-5

Screening Of Ethnomedicinal Plant On B16 Melanoma Cells Using Cell Viability Assay: In Vitro Study

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Skin cancers are often resistant to conventional chemotherapy. Nanomedicine plays an important role in developing alternative and more effective treatment strategies for cancer theranostics. In this present study, we focused on the Green synthesis of metallic nanoparticles, which is a cost-effective environment-friendly technique. *Plumbago zeylanica L.* has ethnomedicinal values. With this background in this study, the plant extract of *Plumbago zeylanica L.* was used to fabricate silver nanoparticles. The biophysical analysis revealed the formation of spherical nanoparticles with a diameter of less than 30 nm affirmed by SEM analysis. The FTIR results prove that the biological components present in the *Plumbago zeylanica L.* had reduced the silver ions to synthesis silver nanoparticles. Significant cytotoxic potentials of the nanoformulation were determined by MTT assay on B16 melanoma cells. There is a significant reduction in several viable melanoma cells were observed in AgNPs treated cells compared to the control cells. The reduction of viable melanoma cells was in a dose-dependent manner. Our results authentically prove the biosynthesized AgNPs induces apoptosis in melanoma cells and it possesses the anticancer property.

Keyword: Nanomedicine, *Plumbago zeylanica L,* Anticancer, Cytotoxicity.

AO-6

Mechanistic Insights into the Pathways of Phenol Hydrogenation on Pd Nanostructures

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Product selectivity in aqueous phase phenol hydrogenation on well-defined supported Pd nanostructures (spheres, cubes, and octahedra) was studied using defined experiments and density functional theory (DFT) simulations. On Pd spheres and octahedra, the reaction initially showed high selectivity (in the first 3 h, at 363 K and 5 bar H_2 pressure) toward the partially hydrogenated product cyclohexanone. On prolonged operation (>20 h of reaction time), a shift in the product selectivity (up to 100%) toward the completely hydrogenated product cyclohexanol was observed on Pd spheres and octahedra. In contrast, the reaction on Pd cubes, which only had {100} facets, showed a high selectivity (~90%) toward the product cyclohexanone even after 40 h, at the same reaction conditions. Since the {111} facets are expected to be the majority sites on a spherical particle, we attribute the selectivity trend observed on spherical Pd particles to be primarily controlled by the selectivity trend on the Pd{111} facets. This observation was further confirmed on performing the hydrogenation reaction on a mixture of Pd cube and Pd octahedron particles in a ratio of 25:75 (representing the site ratio of a spherical particle). DFT simulations provided a mechanistic insight into the reactivity of the two different facets ({100} and {111}) toward phenol hydrogenation. The calculations revealed that the selectivity significantly depended on the activation barriers involved in cyclohexanone hydrogenation on the Pd{111} facets (77 and 57 kJ/mol) as compared to those on the Pd{100} facets (97 and 101 kJ/mol).

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Keyword: Phenol hydrogenation, facet-dependent reactivity, cyclohexanol, cyclohexanone

General Presentation

OP-1

Oral Presentation

Development of Fly Ash Based Geopolymer Concrete Using Nano-Silica

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With the growing infrastructure development all around the world demand of Portland cement are increases day by day. The huge production of cement is associated with releases of CO_2 causing global warming issues. Therefore several efforts are in progress to reduce the use of Portland cement in concrete. These include the utilization of supplementary cementing materials such as Fly ash, Silica fume, Ground granulated blast furnace slag, Rice-husk ash and Metakaolin etc.

The concept of sustainability of structures is touching new heights and many green building materials are tried and tested as partial or complete replacement for the cement. In this respect, the geo-polymer technology shows considerable prospect for application in concrete industry as an alternative binder to the Portland cement. Development of geo-polymer concrete using class F fly ash brings many advantages like; enhancing workability, durability, better strength as well as lowering the price.

Nowadays, Nano Technology is also gaining prominence in the field of construction industries. In this study an attempt is made to find the effect for addition of Nano silica in geo-polymer concrete .The geoploymer concrete cubes were prepared using different percentage of nano silica. Experimental procedures are presented in Fig. 1,2 & 3. Respectively.

Figure-1. Casting of Concrete Cubes

Figure-2. Curing of Concrete Cubes

Figure-3. Compressive Strength of Concrete Cubes

After finalizing the mixed design, the compressive strength were determined. The experimental study will also be carried out for durability aspects under different aggressive environment. The results obtained so far shows that geo-polymer concrete with nano silica addition exhibit good strength. The beneficial effects

of nano silica in improving the workability, microstructure and strength qualities have also been established experimentally. The results so far obtained for compressive strength are presented in fig.4.

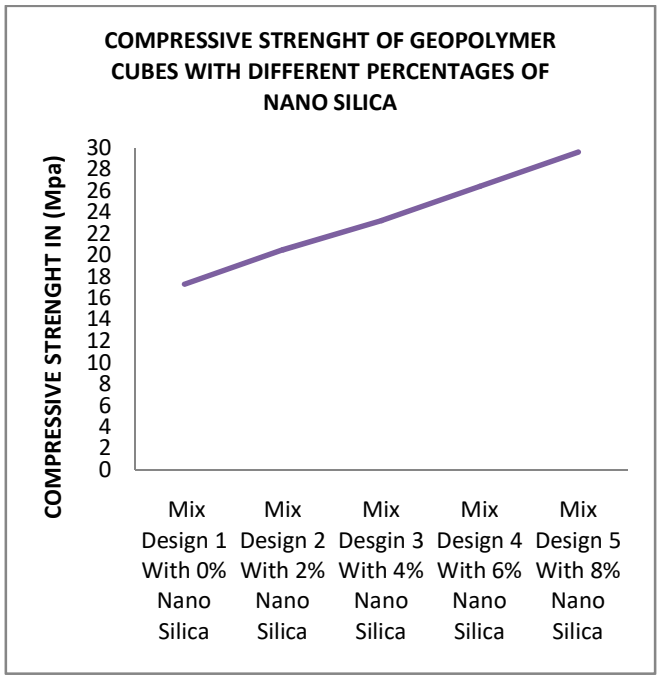

Figure-4. Compressive Strength Results.

OP-2

Band gap engineering of Cu@Zn-3PTZ Metal–organic framework composites

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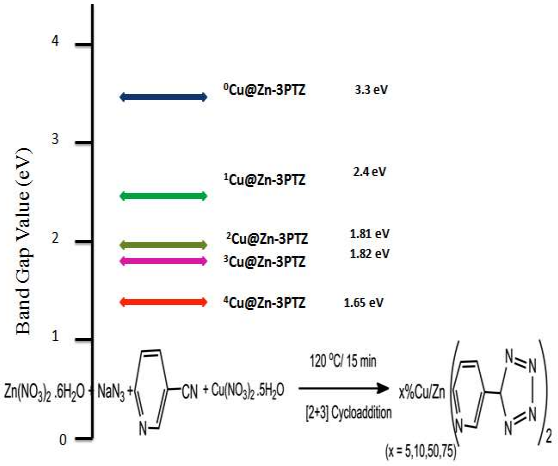
Visible light-induced photocatalysis is a potential method due to the proficient use of solar energy for environmental remediation. Investigations on metal-organic framework (MOF) compounds have attracted the researchers due to large surface area of MOF, well-ordered porous structure, and tuneable architecture with a tailorable competence to absorb light. In this paper, synthesis of Zn (II) and 3-pyridyltetrazolate based MOFs using microwave assisted hydrothermal process has been discussed. Synthesized MOF was used as host-matrix for in-situ loading of Cu^{2+} ion, and subsequently copper loaded luminescent composites were finally synthesized. FTIR, XRD, SEM, TGA, CHN analysis were carried out to confirm the structure, crystallinity, stability, and elemental composition of MOFs. With different input concentrations (5%, 10%, 50%, 75%) of doped Cu ions, the band gap of Zn-3PTZ {PTZ =5-(pyridyl) tetrazolate} (3.3 eV) can be reduced to 1.65 eV, which can be directly excited by visible light. From the analysis of the results, it can be concluded that these materials have huge photocatalytic activity, stability and exceptional recyclability for techno-economically viable applications in the field of sustainable energy.



OP-3

A thermodynamic analysis on liquid-crystal phase transition in supercooled SW-Silicon

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The silicon is mostly exist in the liquid, amorphous and crystal state. The cyrstal and amorhphous silicon are extensively used in the electronic chips and solar cells industries. Interestingly, the amorphous form of the silicon (hereafter referred to as low density amorphous phase or LDA phase) is not a glass, i.e., it does not represent a frozen state of silicon melt (which we will refere to as high density liquid phase or HDL phase). This is evident from the fact that there are important differences between the HDL and the LDA phases. Since the interfacial energy (γ) plays an important role in the dynamics of such phase transition because of high activation energy according to the homogeneous nucleation theory. Therefore, to understand the phase behavior in real silicon, we have studied the liquid-crystal interfacial free energy (γlc) of silicon at the transition point by using cleaving wall method. This is a unique method to compute the interfacial free energy acurately at or near the transition temperature. In this work, we have performed NVT-MC simulation technique in the interfacial free energy calculations to understand the thermodynamics of liquid-crystal transition of silicon modeled by an empirical potential known as the Stillinger-Weber (SW) potentials.

OP-4

A Review On Photochemical Technology For Removal Of Pesticides

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In recent years, where in daily life pesticides play a critical role, also water pollution and pesticide residues in the food chain have become a serious environmental and health hazard problem. Excessive use of such chemicals is a higher risk for plants, animals and humans which have from time to time been studied. Apart from the biological degradation, an effective technology is essential for complete mineralization of pesticides to non-toxic forms. In this short review paper discuss the removal depends on different factors such as a solution pH, catalyst charge, initial pesticide concentration, catalyst support or suspended catalyst, light strength.. This review is also summarizing the existing studies used for the degradation of pesticides; the need to mitigate the contamination issues associated with pesticides is seemingly the photochemical technology.

Keywords: Photo catalyst, Pesticide, Operating parameters, advanced oxidation process

PP-1

Poster Presentation

Understanding The Properties Of Different Types Of Chitosan And Their Value Addition

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Chitosan is derived from chitin which is the 2nd most plentiful bio-polymer on earth after cellulose.In view of this, it is very important to develop an efficient and environmentally benign method to valorize chitosan.In past few decades, researchers have put efforts for the conversion of lignocellulosic biomass but very less attention has been paid on valorization of animal biomass. In the literature, mineral acids and bases, supported metal catalysts under very high hydrogen pressure, high temperature is used for the conversion of chitosan and chitin. These methods have several drawbacks such as corrosion, difficulty in catalyst separation, recyclability etc. In this study, we have done detailed characterization of seven different chitosan using IR, ^{13}C NMR, XRD, TG-DTA, SEM, CHNS elemental analysis, ICP-OES analysis, Viscosity measurement to understand the physical and chemical properties. It is found that viscosity, molecular weight, morphology etc. are different in same type of sample from different company. Solid acid catalyzed valorization of chitosan to value added chemicals is done in this study. Hydrothermally stable catalysts are synthesized to study their effect on chitosan depolymerization. Effect of different solid acid catalysts are studied under inert atmosphere and comparatively low temperature. HPLC and LC-MS analysis confirms that chitosan is getting converted during reaction to form different products.

Keywords: Chitosan, characterization, solid acid catalyst, valorization

Environmental Chemistry Section

Award Presentation

Award Oral

AO-1

Removal of Brilliant Green Dye from Aqueous Solution using Sludge Produced from Common Effluence Treatment Plant

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Dyes are color organic compounds which are discharge in sewage water from many industries such as leather, fabric, textile, paper, printing and cosmetics. Annually, a huge amount of dyes and pigments (over 7X105 tons) are being produced throughout the world and 90% of this production in used in textile industry. In the present study, Sludge (CETP) was employed to develop an effective adsorbent for the removal of brilliant green dye from wastewater. The characteristics of sludge were studied viaby XRF, SEM, XRD and FTIR. Batch studies were carried out to study the effect of pH, adsorbent doses, adsorbate concentration, and temperature and contact time. The results of batch studies revealed that the adsorption of brilliant green was strongly pH dependent and the maximum removal efficiency was found 95% with initiated dye concentrationat equilibrium pH of 5.0. Optimum adsorbent dose and contact time were found to be 15 g/l within4 hours respectively. Kinetic studies have been being performed to have an idea of the mechanistic aspects of the process. The result also shows that adsorption increases with increase in temperature thereby showing the process endothermic in nature. Adsorption data have also been correlated with both Langmuir and Freundlich isotherm models. Thermodynamic parameters were also determined.

Keywords: Brilliant green dye, sludge(CETP), Adsorption, Isotherm models and kinetics.

AO-2

Physico-chemical and Toxic Heavy Metal Analysis of Groundwater aroundLancoAmarkantak Power Plant Areas in Korba District, Chhattisgarh, India

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Recently on increasing the contamination of aquatic environment by domestic sewage and industrial effluents has focused attention on the behaviour and interaction of many rare and neglected elements in the biosphere. Bioaccumulation of heavy metals in living organisms occurs due to their property of persistence and non-degradability of the complex organic compounds. This paper studied the physico-chemical properties and toxic heavy metals in groundwater. The present study focuses on the characteristics of ground water samples collected from around LancoAmarkantak Power Plant Areas in the Korba District during the premonsoon, monsoon and postmonsoon seasons of 2019-20. A total of 16 groundwater samples were analyzed for important parameters of physico-chemical and toxic heavy metals. Comparing the findings against drinking water quality requirements set by Indian standards for maximum acceptable level of drinking water quality (BIS), ICMR, USEPA, and WHO; some samples were found not to be portable for human consumption.

Keywords:- Groundwater, Contamination, Heavy metal, Power plant, Drinking water

AO-3

L-cysteine Functionalized Silver Nanoparticles For Selective and Sensitive Colorimetric Detection of Vitamin B1 in Food and Environmental Water Samples

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Here, we report the use of L-cysteine modified silver nanoparticles (Cys-capped AgNPs) as a colorimetric probe for determination of vitamin B1 (thiamine). This method is based on the measurement of red shift of localized surface plasmon resonance (LSPR) band of Cys-capped AgNPs in the region of 200-800 nm. The color of Cys-capped AgNPs was changed from yellow to colorless by the addition of vitamin B1. The mechanism for detection of vitamin B1 is based on the electrostatic interaction between positively charged vitamin B1, which causes the red shift of LSPR band from 390 nm to 580 nm. The interaction between Cys-capped AgNPs and vitamin B1 was theoretically explored by density function theory (DFT) using LANL2DZ basis sets with help of Gaussian 09 (C.01) program. The morphology, size distribution and optical properties of Cys-capped AgNPs were characterized by transmission electron microscope (TEM), UV-Visible spectrophotometry, Fourier transform infrared spectroscopy (FTIR) and dynamic light scattering (DLS) techniques. The method is linear in the range of 25-500 µg mL^{-1} with correlation coefficient (R^2) 0.992 and limit of detection of 7.0 µg mL^{-1}. The advantages of using Cys-capped AgNPs as a chemical sensor in colorimetry assay are being simple, low cost and selective for detection of vitamin B1 from food (peas, grapes and tomato) and environmental (river, sewage and pond) water samples.

Carbon Dioxide Adsorption And Its Chemical Fixation By Chitosan -Graphene Oxide And Arginine Based Composites

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Carbon dioxide (CO_2) gas is the main greenhouse gas in the atmosphere which is primarily responsible for global warming and climate change. The most pressing challenge is contemporary environmental research is to reduce and control the amount of anthropogenic CO_2 gas inthe atmosphere by developing an effective and efficient materials and methods. Herein we have introduced composites materials of chitosan with graphene oxide and arginine and which was characterized by fourier transformation infrared spectroscopy (FTIR), X-ray diffraction (XRD) and scanning electron microscope (SEM) techniques. In FTIR spectrum, characteristic peaks around 3100-3300 $cm^{-1}$and 1740 cm^{-1} almost vanishes in resulting compounds indicates successful grafting of graphene oxide and arginine in CS matrix, XRD peaks shows crystal structure turns into amorphous nature and SEM analysis indicates the porous structure of resulting compounds in comparison to starting materials. This chitosan composite was used for the CO_2 adsorption and the adsorptioncapacity of CO_2 gas was measured by TGA method on its solid surface. The CO_2 gas adsorption was found to be 240 mg/g (5.45 $mmolg^{-1}$) at 35°C, hold for 35 min. Thiscomposite show much higher CO_2 capture capacity than thepure chitosan.The conversion of CO_2 gas into valuable organic molecules is underway in our laboratory. Thus, we believe that this study will help toreduce the anthropogenic CO2 gas from the atmosphere.

Keywords: Chitosan, Grpahene oxide, Arginine, Carbon dioxide, Adsorption, Conversion.

AO-5

Cu_2O Nanopetal Architecture as a Superhydrophobic and Antibacterial Surface

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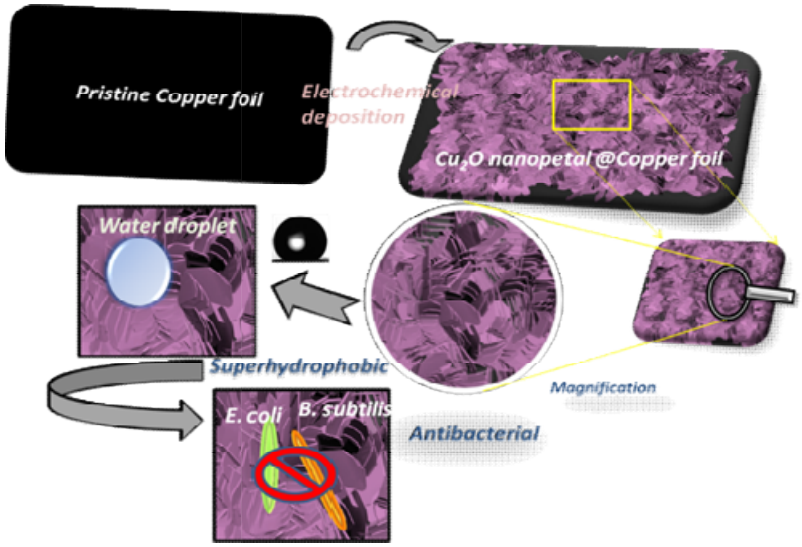
Bacterial infections being sporadic and uncontrollable it demands an urgent paradigm shift in the development of novel antibacterial agents. This work involves the fabrication of Cu_2O nanopetals over copper foil that shows superlative antibacterial and superhydrophobic properties. A superhydrophobic surface has been fabricated using the electrochemical deposition (ECD) method. Here, it is aimed to establish the superior antibacterial activity as an outcome of the inherent superhydrophobic property of the as-fabricated nanostructures. The present study finds that the elevated value of water contact angle (154±0.6) does not allow proper bacterial adhesion, and it is impugn from the possibility of biofouling. Specifically, two kinds of bacterial strains have been tested and the time response of the antibacterial activity has been studied over a period of 12 hours, taking DH5α *E. coli* as a gram-negative model and *B. subtilis* as a gram-positive model. Higher antibacterial effects were observed for gram negative model (*E. coli*) owing to its simplistic cell wall structure which facilitates the easy diffusion of Cu^{+1} ions into the bacterial membrane. The simplicity of the developed method of fabrication along with the supercilious superhydrophobic nature and excellent antibacterial property of the material, owing to its synergistic biophysical and biochemical modes of biocidal action, establishes its viability in tons of applications.



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Suvani Subhadarshini, Rashika Singh, Dipak K. Goswami, Amit K. Das, Narayan Ch. as.Electrodeposited Cu_2O Nanopetal Architecture as a Superhydrophobic and Antibacterial Surface*Langmuir* **2019**, 35, 52, 17166–17176.

Keywords: antibacterial, superhydrophobic, Cu_2O, nanopetals

AO-6

Room Temperature Self-healable and Mechanically Robust Polymeric Materials for Sustainable Society

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Polymeric materials are used in nearly all areas, from daily life-to-constructions of human body parts. However, these polymeric materials may have possibilities of damages during the course of use and are therefore required to replace with similar materials. Introduction of polymeric materials, which have ability to repair itself from the damages or cracks referred as self-healing materials, will be useful to enhance the safety index, long-term durability, minimizing the system breakdown and allows us to reuse. One of the most significant feature of living organisms is their self-healing ability after suffering from the damage; for example, self-recovery of our damaged skin, autonomous healing of the bone fracture, etc. Mimicking the self-healing features from nature, synthetic polymeric materials are highly demanding for sustainable self-life and prevention of cracks at the micro-level. The utilization of self-healing in a specific polymeric system for a particular application such as aeronautics, aerospace, self-stratifying coating, flexible electronics or battery, films, paints, soft robotics or xenobiotic, 3D/4D printing, neural prostheses, implantable biosensors, structural similarity towards the biological tissues, artificial skin is the key concern. This work presents an ionically crosslinked, mechanically robust, efficient, and multiple times self-healing polymeric hydrogel involving polymeric cationic and polyanion having a dual interpenetrating network of hydrogen bonding and ionic interactions. Fine-tuning of polymeric cation and anion allows achieving tailormade hydrogel exceptional mechanical properties such as very high tensile strength (30 MPa), a superior toughness (43 MJ/m^3) and high fracture energy (4300 J/m^2) and ultra-stretchable (5400%). These hydrogels show rapid and repeated self-healing instantly, without any external stimuli providing ~90% of healing efficiency at room temperature. Additionally, the hydrogel exhibits transparency, flexibility, fire resistance and shows good conductivity. This new generation of self-healing polymeric materials having emerging physical, thermal, mechanical, electrochemical properties may further open the doors to exciting domains towards a sustainable society.

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AO-7

A Novel Agro Waste (*ArtocarpusHeterophyllus*) Adsorbent For Pb(II) Ions Sequestration From Wastewater

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There is a demand to develop more effective agricultural agro-waste adsorbents to remove heavy metal ions from various aqueous media. the main target of the present research was focused on the selection of novel agricultural waste material. For this Purpose, Jackfruits leaves (*Artocarpusheterophyllus*) was chosen as a suitable adsorbent material for Pb (II) ion removal from synthetic or wastewater. Jackfruit leaves were naturally occurring and cost-effective agro waste material. To enhance the adsorption performance of Pb (II) ion on JFLP adsorbent, surface modification is preferred by using suitable reagents. Batch Adsorption experiments were carried out to investigate the varying parameters like initial Pb (II) ion concentration (12.5-100) ppm, pH (2-6), and exposure time (180) on Pb (II) adsorption and also studied the effect of Adsorbent dosages on Pb (II) adsorption. The chemically modified adsorbents were also pointed out by its morphological and characterization techniques using Fourier transform infrared spectroscopy (FT-IR), FESEM with EDX, FTIR, N_2 adsorption-desorption and surface area analysis by BET method and also the pore size and pore volume study by BJH method.

The aim of the present work is to investigate the compatible adsorption behavior and identify the adsorption capacity of the all chemically modified adsorbents.

Keywords: Adsorption, agro waste adsorbents, chemical modification, adsorption capacity, Pb(II).

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AO-8

Environment friendly flexible paper-based electrodes towards electrochemical biosensing application

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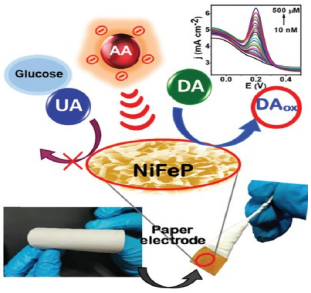
The advancement in research mainly covers cost reduction, waste management, and the well-being of a human. In this context, rapid diagnosis of diseases at their initial stage is life-threatening for the medical industry and is especially meaningful for disease diagnosis in promoting general public health and regulating physiological activity.[1] However, an abnormal level of biomolecules causes several disorders. Over decades, numerous devices have been developed for detecting biomolecules; amongst these techniques, electrochemical sensors have gained a dominating role in clinical diagnostics due to advantages such as rapid response, simplicity, high sensitivity, and low cost. Nodaway's, considering the inexpensive, portable, easily disposable, lightweight, reduction of waste materials, more attention is given towards the design of a flexible sensor for a wide range of applications as they are adaptable for modification with a variety of functional groups for performing biomolecule detection.[2] Also, considerable improvements have been made in developing efficient electrochemical material for biosensing applications. Herein, we have designed environment-friendly paper-based flexible material for electrochemical biosensing of biomolecules, mainly dopamine, cholesterol, and glucose.[3] Additionally, due to the existence of specific biomolecules in human blood serum, real-time analysis hasbeen performed as the confirmation of a related disease.



Scheme 1. Schematic representation of DA detection with NiFeP.

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AO-9

Designing electrolytes for next-generation, safe and energy-dense lithium metal based batteries

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Ever growing demand for fossil fuels and limited availability along with environmental problems associated with it has motivated researchers to look for alternative and environmental friendly high performance energy conversion and storage systems. In this regard, lithium-ion batteries (LIBs) have gained significant attention owing to its unmatchable combination of high power and energy density along with low self-discharge rate which makes it an ideal candidate for portable energy devices.[1] However, LIBs suffer from low charge capacity and usage of high energy electrodes are restrained due to low-flash point of conventional electrolytes which limits its high energy output. Ionic liquids (ILs) are a promising candidate to solve the problems of flammability, low-flash point and aid in achieving high energy output owing to their tunable properties, high thermal and electrochemical stability as well as non-flammability. Imidazolium based ILs have gained popularity due to their favorable melting point, moisture and temperature stability and ease of tenability. Imparting functionalities to IL in order to minimize their viscosity can enhance its ionic conductivity. Herein, we present imidazolium based ILs bearing ether-ether and ether-siloxane functionalities over both sides of imidazolium ring to control their thermo physical properties.[2]

Keywords: Lithium-ion batteries, ionic liquids, imidazolium.

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AO-10

"H_2S" from environment pollutant to new form of energy

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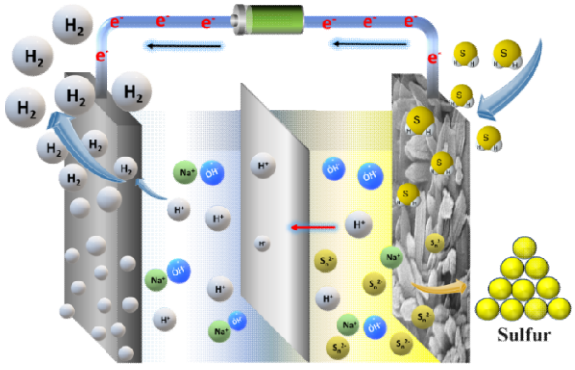
Highly efficient and cost-effective production of hydrogen (H_2) promises to play a vital role in green energy production due to its high energy density, low-pollution,and renewable nature. The electrocatalytic decomposition of H_2O to H_2 and O_2 considered to be a most sustainable method for pure H_2 production, unfortunately it stumble due to potentially uphill and energy-consuming sluggish anodic evolution reaction (OER).[1] Contrary to H_2O isostructural hydrogen sulfide (H_2S) possesses lower bond dissociation energy. Therefore, anodic sulfide oxidation reaction (SOR) will be more energy-efficient than OER. Presently, the Claus process is the most popular industrial technology for removing H_2S, but energy wasted in the form of steam.Therefore, electrochemical conversion of environment pollutant H_2S into H_2 and Sprovide a way to remove pollutant H_2S and also emerges as new energy source.[2] However, the industrialization of such energy-efficient technology never meets the expectation in reality in the absence of cost-effectiveand robustelectrocatalyst. Herein we have designed $CoFeS_2$ based catalyst that exhibited lower onset potential of 0.2 V *vs.* RHE towards SOR, which is 1.27 V lower than OER. Notably, only a 1.2 V commercial battery easily derives H_2S electrolysis, which is impossible for H_2O splitting demonstrating the tremendous future prospective of H_2S for cheaper hydrogen production for a sustainable economy.



Scheme 1. Schematic representation of H_2S electrolysis into cathodic H_2 and anodic S by $CoFeS_2$.

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AO-11

Mesoporous iron gallatenanocomplex for adsorption and degradation oforganic dyes

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The stability and porous nature of a nanocomplex are of importance for the practical utility like in adsorption orcatalytic activities. Mesoporous Iron gallate (Fe-Ga) nanocomplex was fabricated by means of effective, simple, convenient and rapid solvothermal method. These nanocomplexes were then utilized as a catalyst for rapid degradation of cationic (Toluidine Blue (TB)) and anionic (Rose Bengal (RB)) dyes without employing any auxiliary oxidants like Hydrogen Peroxide (H_2O_2), Sodium Borohydride ($NaBH_4$) etc. Analysis of the nanocomplex using various techniques like Powder XRD, N_2 (Nitrogen) adsorption/desorption, UV–vis spectroscopy and electron microscopy revealed mesoporous (pore size = 2.72 nm) structure with high surface area of 90.48 m^2 g^{-1}, uniform sizes of around 15–20 nm and outstanding adsorption and degradation properties. The nanocomplex adsorbed, decolorized and decomposed both the dyes within 10 min. Due to the negative zeta potential (14.6 ± 3.5) the particles preferably adsorb and degrade cationic dye (TB) because of the presence of positively charged amine groups. Furthermore, the catalyst is stable and reusable. Such material releases reactive oxygen species (ROS) such as hydroxyl radicals and primarily responsible for the degradation of dyes at enhanced rate. Such advancement can be extended to othernanocomplexes to efficiently enhance their catalytic activities and hence may be envisaged as a method for removal of dyes for detoxification of waste water.

AP-1

Award Poster

Importance of measurement of CO impurity in high purity nitrogen at high- and lowcylinder pressureby Cavity Ring Down Spectroscopy Technique

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Carbon Monoxide (CO), is often called the "Silent Killer" because of its ability to take lives quickly and quietly. It is not detectable to humansand in highconcentrations it can kill them within minutes.CO is found as one of the impurities in nitrogen and oxygen gas cylinder. A case study on determination of CO as impurity has been done in high purity nitrogen gas cylinders.A high purity Nitrogen (>99.999%) gas is used as a balance gas for preparation of calibration gas mixtures which areused for the calibration of ambient monitoringinstruments and also used in food packaging because it slows food deterioration and improves longevity. Trace gases impurity like moisture (H_2O), methane (CH_4) and carbon monoxide (CO), oxygen (O_2) effectively change composition of standard gas mixtures by reacting with required component gases or by adsorbing on cylinder surface. Cylinder pressure plays an important role in industrial and medical purposes because the concentration of impurities increases when cylinder pressure decreases whichmay be highly dangerous in medical field. A different type of techniquesare used like FTIR, GC-FID, GC-PDHID or CRDSetc for impurities measurements. In which Cavity ring down spectroscopy (CRDS) technique for laser spectroscopy is a relatively recent development and is considered as primary method that measures impurity levels directly without need for calibration gases.In cavity-enhanced absorption spectroscopy, the laser light is guided into an optical cavity with two highly reflective mirrors with a reflectivity greater than 0.999. A light pulse from a tunable pulsed laser enters a cavity and travels back and forth between the mirrors, which increases the absorption length by several orders of magnitude.These profound path lengths provide ppb detection range for analyte gases. Measurement of CO gasin high purity nitrogen gas is done by CRDS analyzer. CO impurityis also determined by gas chromatograph using flame ionization detector which was in agreement with CRDS results. Lowest detection limit of CRDS used is1 ppb for CO measurement. The observed concentration of CO was found to be <1 ppm at high pressure gas cylinder (~200 bar) buta spike change in concentration was observed atlow pressure (~50 bar) i.e. 2-3 ppm. Measurement uncertainty is also evaluated for the analysis.

Key words: Gaseous pollutants, Cavity Ring down Spectroscopy (CRDS), Effect of pressure, Effect of CO in human health, Measurement uncertainty.

General Presentation

OP-1

Oral Presentation

Seasonal Assessment of Ground Water Toxicants from Fatehpur Shekhawati block of Rajasthan

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Water is one of the most important natural resource in the universe and an essential compound for life having its prime uses in drinking and irrigation. The most common problem associated with water is identified with the presence of some toxic ions such as fluoride, nitrate and arsenic.

Ground Water samples were collected from 49 different sites of Fatehpur Shekhawati block of Sikar district Rajasthan from various sources to evaluate some physicochemical parameters such as fluoride, chloride, nitrate, TDS, Alkalinity, pH and hardness. Fluoride, nitrate and chloride content was found in the range from 1.6-11.8, 2.0- 480 and 190-800 mg /L respectively.These results indicate that toxic contents in ground water samples were found beyond the permissible limits governed by WHO and BIS standards which are responsible for negative health and environmental impacts.

Bio-adsorbents have come up as one of the promising substances which can remove or minimize the different type of toxic organic and inorganic pollutants present in industrial waste as well as in Groundwater. For this purpose our research is focusing on peanut shell as agricultural bio waste which is subjected to physical and chemical modification to obtain more advantageous product for water treatment.

Keywords: Ground water, bio-adsorbents, peanut shell.

OP-2

Biodegradationof Textile Dye by Fungal Species Isolated from Contaminated Industrial Sites of Hapur District, Uttar Pradesh

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The presence of dyes in wastewater released from manufacturing units represents a major environment problem. Industries such as textile, paper, printing, plastic and leather etc. are consuming huge amount of dyes to colorize their products. Most of the textile and dye manufacturing industries pours dye contaminants directly into water resources without any treatment which may pollute both ground water and soil. It has been estimated that around 10-15% of the dyes used in the industries are lost in the effluents during the dyeing operations. The physical and chemical methods such as coagulation, chemicaloxidation, membrane separation, ion-exchange, photo-catalysis, reverse osmosis and adsorption have been used to deal with dye pollutants. The major drawback associated with all the above mentioned techniques is high cost of application, intensive energy requirement, complex procedure, unable to completely remove the dyes and generation of sludge which causes secondary pollution.

The present investigation was conducted to evaluate the dye degradation potential of indigenousfungal isolates such as *Aspergillus niger, Aspergillus flavus, Fusarium solani* and *Fusarium oxysporum* collected from contaminated soils of effluent disposal sites of industrial area of Hapur district of western Uttar Pradesh. The effect of different factors viz. pH, temperature, inoculum size, incubation period and dye concentration was studied on the dye degradation process. The results revealed that indigenous fungal species exhibited high dye removal efficiency which significantly decolorized dye contaminated effluent. Further researches are required to develop cost-effective decentralized wastewater treatment system for small or medium scale manufacturing units.

OP-3

Impact of Pesticides on Soybean Plants in Madhya Pradesh

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Madhya Pradesh is a land of agriculture where pesticides, insecticides and varieties of fertilizers are extensively used. The pesticides consumption causes a serious environmental and public health problem. Due to steep competition many farmers make overuse of organophosphate pesticides to increase their agriculture yields.

The Farmers involved in the spraying activities of pesticides in the field get direct exposure of pesticides due to unsafe and no preventive work practices. They do not use safety masks, gloves and other protective gears during the spraying of pesticides which results into the access of pesticides in the blood stream through inhalation and dermal exposure which adversely affect their eyes, skin and the respiratory system. It was observed that the increased rate of pesticide treatment significantly decreased Physiological parameters like rate of photosynthesis transpiration. It has also been observed that this photosynthesis transpiration is significantly decreased with increased concentration of pesticide in soybean plants. The Stomatal conductance has also been found to increase at higher concentration of pesticide T4 in soybean. The impacts of foliar spray of pesticide on growth and metabolism of Soybean has been studied under controlled condition using chlorpyrifos.The study shows that the pesticides can significantly affect the plant growth and yield of soybean. A growing number of soybean producers have begun to incorporate below threshold fungicide, insecticide and pesticide treatments into their management programme in attempt to increase their yield.

OP-4

Strategic Devising of Hydrolytically Robust and Post-Synthetically Modified Metal-Organic Frameworks for Humid condition Capture and Efficient conversion of CO_2 to Chemicals

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Rapid consumption of fossil fuels has increasedthe concentration of carbon dioxide (CO_2) beyond the permissible limit.Consequently, CO_2 capture and sequestration (CCS) is major research goal with specific importance to develop new functional materials for selective capture and catalytic fixation of CO_2.The non-toxic and anthropogenic CO_2 serves as a potential C1 source towards 100% atom-economic conversion of CO_2 to cyclic carbonates, which find enormous applications.The high surface area, compositional diversity and tailorablepore characters in metal-organic frameworks (MOFs) endorsethese porous crystalline frameworks ideal candidates for adsorption of major green-house gas as well asheterogeneous catalysis. In this direction, we have strategically designed Cd(II)-framework Cd1.5(L)2(bpy)(NO_3)]•$_2$DMF•2H_2O (CSMCRI-5) (HL = 4-(4-carboxyphenyl)-1,2,4-triazole, bpy= 4,4′-bipyridine, DMF = Dimethylformamide), by utilising the bifunctional ligand HL. Thefunctionalised and optimum sized poresin this two-fold interpenetrated structure provides ample basic nitrogen sites for highly selective and multicyclic adsorptionof CO_2. In another case, a chemically robust Zr(IV)-based framework (ZrOF) was synthesized, andfurther modified through incorporation of ultra-small Ni-nanoparticles. Despite reduction in surface area, the CO_2 adsorption capacity increased tremendously with a large rise in adsorption enthalpy.The Ni@ZrOF system was utilised as a highly active heterogeneous catalyst towards solvent-free fixation of CO_2 to cyclic carbonates in excellent yield under relatively mild conditions. Both of these materials exhibit remarkablerecurrences towards CO_2 adsorption and catalysis for multiple cycles.

Keywords: Robust metal-organic framework, post-synthetic modification, CO_2 adsorption, cyclic carbonate, mild conditions

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OP-5

Theory of Waste Water From Boil Rice Mill Unit By Concentration

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Above 260 rice mills are obtainable in the Raipur district in Chhattisgarh considering the main supply of this area is paddy which was change within rice, rice mill are need for the activity, the sector like Raipur and Chhattisgarh are too much devoted to with this sector and the mostly human are very focused in per-boiled paddy the summer plants are also devoted to these paddy mills. Water is the most specific element in the before cleaning the paddy and after per-boiling the waste water is manufacture of which the reception is requisite prabhu rice mill Nawapara Rajim was choose for the waste water study from parboiled paddy unit by concentration waste water was composed from two or three samples of the rice mill by seize selection

OP-6

Albumin Protein derivedSustainable Underwater Superoleophobicity

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Fish-Scale inspiredunderwater superoleophobicity is the ability of an interface to repel an oil droplet underwater, that has been widely adapted artificially in the past for diverse applications including oil droplet manipulation underwater, oil/water separation, self-cleaning etc. However, the synthesis of a highly durable bio-inspired underwater superoleophobic coating is of utmost importance for achieving uninterrupted performance at practically relevantand challenging conditions. In the current design, bovine serum albumin (BSA) protein was deposited on a fibrous substrate followed by 'in situ' treatment with glutaraldehyde to achieve a cross-linked imine-based fluorescent coating.[1] The resultant interface displayed uninterrupted underwater oil repellence even after 30 days exposure to highly alkaline (pH 12) water, surfactant-contaminated water, river water and sea water. However, due to accelerated hydrolysis of imine under acidic conditions, the embedded underwater "superoleophobicity'' transformed into "oleophobicity'' on exposure to acidic conditions for 12 h. To combat this challenge, the reductive conversion of imine to secondary amine was adopted in the BSA-derived coating. The resultant coating embedded with underwater superoleophobicity survived different severe physical abrasionsand 30 daysexposure to pH 1, pH 12, seawateretc. Further, such a durable coating was extended for environment friendly separationof the chemically contaminated aqueous phase from both refined oil and crude oil with water collection efficiency above 98 v/v %. Thus, this simple and scalable chemical approach provided a platform for developing a highly sustainable underwater superoleophobic coating, which can perform under challenging scenarios.

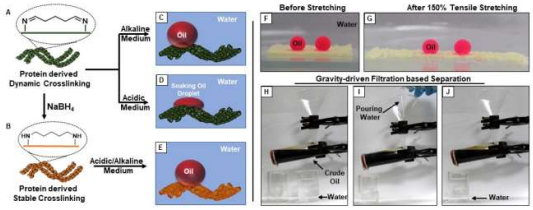

Figure 1. The facile and dynamic cross-linking process between the amine residues of bovine serum albumin protein and glutaraldehyde yielded a fluorescent coating (A) on a fibrous substrate that displayed underwater superoleophobicity in alkaline media (B) but failed to perform in acidic media owing to the hydrolysis of the imine (C). The reduction of the imine bond resulted in a stable cross-linked BSA coating (D) that continued to display unperturbed underwater superoleophobicity in both acidic and alkaline media (E). F-G) The oil repellence underwater remained intact even after 150% tensile stretching of the coating. H-J) The reduced imine based BSA-coated membrane was pre-exposed to crude oil (H), and thereafter, on pouring the water phase through the funnel (I), the added water selectively permeated through the membrane in the gravity-driven filtration-based process (J).

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OP-7

Why Organomercurials are More Neurotoxic

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Methylmercury ($MeHg^{+}$) is a potent neurotoxin that bio-accumulates at high levels in food chains, and thus poses a significant health risk to human.It is known to inhibit several important antioxidant enzymes and also reduce the concentration of endogenous thiols likecysteine and glutathione in tissues, and thereby increases the production of reactive oxygen species which lead to the oxidative damage of biomolecules including DNA and protein.The high potency of $MeHg^{+}$ in producing DNA damage compared to inorganic mercury Hg^{2+} in tissues isoftenrecognized due to its striking ability to easily cross the cellular membranes including the placental and blood-brain barriers.However, contrary to its recognized indirect role on oxidative DNA damage,in this oral presentation for the first time we will show the direct effect of $MeHg^{+}$ on DNA damage, in addition to the oxidative DNA damage, which may account for its highly cytotoxic compared to inorganic mercury.[1,2]

Keywords: Methylmercury, Alkylative DNA Damage, Oxidative DNA Damage.

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OP-8

Statistical interpretation of trend of monthly variation in concentration of ambient air quality parameters in the KMC area

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Trends of monthly variation of concentrations of ambient air quality parameters in the KMC area are analysed during the three years of 2003-2004, 2008-2009 and 2009-2010. Using statistical analysis, Outlier test of monthly concentrations of PM10, SO_2 and NO_2 during the three years shows that 0.42% data is statistically unsatisfactory and 0.16% data is statistically as well as environmentally unconsidered. For PM10, monthly variation of concentration shows similar wavy trends during these three years. This similarity in variation of concentration is supported by the statistical analysis as there exists strong non-linear Spearman correlation for PM10 concentration between the years 2003-2004, 2008-2009 and between the years 2003-2004, 2009-2010. For SO_2, monthly variation of its concentration was observed to show nearly linear trend during the years of 2003-2004, 2008-2009 and 2009-2010. Also, statistical analysis shows that SO_2 concentration of the year 2003-2004 has strong linear Pearson correlation with that during the year 2008-2009 as well as during the year 2009-2010. During the three years, monthly variation of NO_2 concentration shows nearly similar trend. However, contradictory interpretation is observed as NO_2 values has Spearman correlation between the years 2003-2004, 2009-2010 and Pearson correlation is observed between the years 2003-2004 and 2008-2009. Also, paired sample t-test shows correlation in NO_2 concentration between the years 2003-2004 and 2008-2009 only.

OP-9

Anion exchange membranes for eco-friendly and sustainable energy devices

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Incessant exploitation and exhaustion of limited natural energy sources and related technologies pose a threat to the environment and the global economy. Natural energy sources are associated with various environmental implications like pollution and global warming leading to conspicuous climate change. At the same time, 88% of the current energy economy relies on fossil fuels[1]. Despite the outsized share of conventional energy sources to the energy portfolio, it is time to get rid of the era of fossil fuels. But there is no globally accepted benchmark of resource availability for long-term energy planning purposes. Natural energy sources seem to be the solution to this energy constraint or crisis but the intermittent nature and latitude dependency of these sources are the roadblocks to their full employment at the global level.[2] Hydrogen is the most abundant element in the universe with no toxicity, high mass- energy density (39.4 kWh kg^{-1})[3], and high energy efficiency (>70%).[4] Thus, the hydrogen produced from renewable energy sources used as fuel can be considered as a promising replacement for fossil fuels. So, both Electrolyzer and fuel cells together in conjugation with renewable energy sources are recognized as a key technology in the delivery of clean energy with low emission, high efficiency, and scalability[5, 6]. These technologies rely on Ion exchange membranes (IEMs). Alkaline anion exchange membranes (AAEMs) are viable alternatives of proton exchange membranes (PEMs) and are the center of attraction owing to the extra benefit of faster oxygen reduction kinetics (ORR) and the use of non- noble metals. AAEMs based technologies are at their infancy stage and require impactful exploration for commercialization. Here we will discuss per substituted imidazolium based AAEMs which shows appreciable conductivity and alkaline stability.

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OP-10

A Review On Effective Heterogeneous Catalysts For Biodiesel Production

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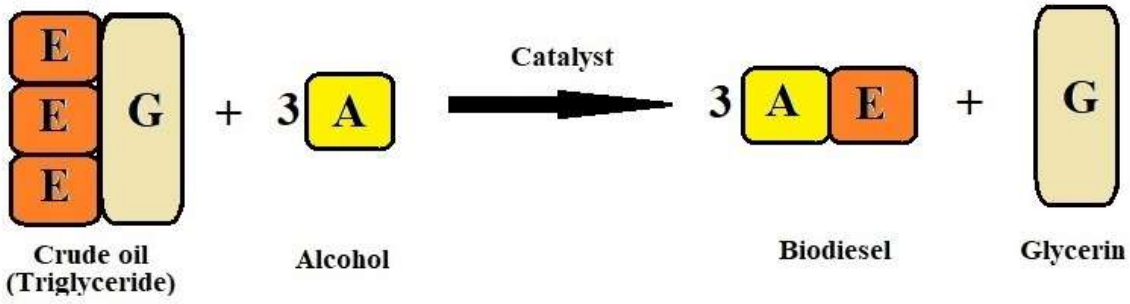
Rising demand for energy and environmental issues associated with depleted fossil fuels have led to the requirement for an alternative source of renewable energy. Generally, biodiesel processing is carried out by the trans esterification reaction process. The production of biodiesel is commonly carried out by trans esterification reactions, catalyzed by homogeneous or heterogeneous catalysts. In the reaction steps, several parameters have been evaluated, such as catalyst quantity, alcohol molar ratio: oil, temperature, agitation speed, and duration of reaction. The trans esterification reaction of several raw materials as sources of feedstock, various alcohols, and heterogeneous catalysts is therefore presented in this review. Optimal conditions have been summarized for each catalyst, as well as its respective mechanisms of reaction.

Keywords: Biodiesel, heterogeneous catalyst, operating parameters, transesterification



OP-11

"Bio Fuels & Green Chemistry- A New Horizon"

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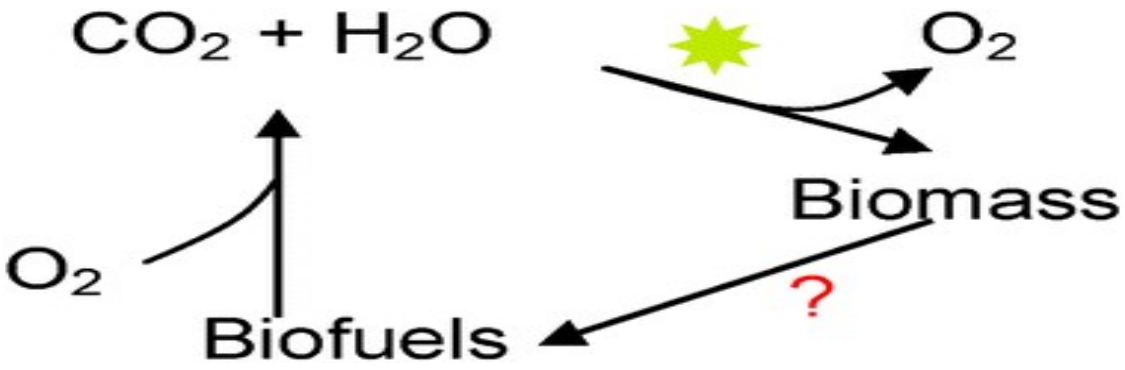
Nature provides a remarkably wide range of renewable raw materials with varying properties and differing chemical compositions. Renewable raw materials are therefore especially interesting as alternatives to fossil resources for energy generation and as starting materials for industrial chemistry. Bio fuels (and bio fuel additives) have been known since ancient times. In fact, more than 100 years ago, the two giants of modern car engine, Henry Ford and Rudolph Diesel, strongly believed in the future of bio fuels, and began with ethanol and vegetable oils to run the Ford Model-T and the diesel engine, respectively. With the significant increase in the importance of oil, the technologies based on the use of bio fuels were set aside. Nowadays there is an urgent need for the reduction of fossil fuels consumption, as already mentioned, but at the same time, innovative chemical production is fundamental for keeping the level of civilization high and opening new job positions.

Keywords: biomass; green chemistry; bio diesel; renewable.



OP-12

One pot synthesis of bicyclic heterocycles Benzothiazepines: Green Approach

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Green chemistry deals with chemical processes that are environmentally sustainable in the long run. The idea of 'going green' is to look at all the processes from source to sink that determine and follow the processes that will reduce the impact of harmful chemicals in the environment. The subject encompasses the resources of raw material, manufacturing techniques and processes, water and energy use in such processes, waste generation and disposal of waste and final product export out of the manufacturing unit. Greener reactions are especially important in organic chemistry, where, due to a huge number of industrial processes with the use of hazardous chemicals and solvents, severe damage to the environment takes place. In organic chemistry, green techniques include reactions of C–H bond activation, fluorous, solid-supported, bio- and asymmetric catalysis and synthesis, use of water and other green solvents in particular, ionic liquids or without any solvent, microwave, ultra sound and ultraviolet (UV)-assisted reactions, and use of flow reactors. Several non-contaminating physical methods, such as microwave heating, ultrasound assisted and hydrothermal processes or ball milling, frequently used in combination with the use of natural precursors.

The endeavor of the research work is to develop more effective synthetic procedure for synthesis of new active benzodiazepine and benzothiazepine derivatives using milder, selective, nonhazardous and inexpensive solvents. One pot synthesis is an approach for the synthesis of 1,5- benzothiazepines with the features like high yield, very short reaction time, no side products, no solvents, does not require critical purification and separation. The methodology employed is most superior over conventional methods of synthesis, since it is convenient, minimizing waste, equipment, energy, eco-friendly and demand of the generation for sustainable development.

OP-13

Multifunctional Arithmetical Processor inside GUMBOS

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To construct future molecular computers, the mimicry of some elementary functions of neurons and electronic computers at the molecular scale has been attracting more and more interest from chemist community. Many life processes, such as chemical synapses of neurons, can operate normally within a very narrow ion window such as Ca^{2+} and H^{+}. This function or behavior can be described as being "off-on-off" or "on-off-on" behavior as a function of ion concentration. Mimicry to this behavior at the molecular scale has been possible for some time with Ca^{2+}, H^{+}, or laser as inputs. These studies are highly important not only for the understanding of complex mechanisms of important life processes but also for the potential application in molecular computing. Presently, we are interested in exploring a single molecular species to execute distinct algebraic operations, even to mimic some elementary functions of neurons by a variety of chemical inputs by exploiting the advantage of GUMBOS-group of uniform materials based on organic salts. Maintaining input ion concentration,depending on the corresponding signals (output), keeping the output above a threshold value we will see definite output signals in UV-Visible regions in the form of two 1 & 0 i.e. ON &OFF respectively. If we get outputs as ON--OFF-ON mode, we can conclude in two input system, if we reverse the inputs the output may be ON-ON-ON mode form this obviously we cannot make any conclusion visually. This is how encryption, coding, decoding molecular systems can be formed.

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OP-14

Low cost adsorbent prepared from waste plant material for removal of congo red dye from wastewater

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The adsorption process is being extensively used for the removal of dyes from synthetic dyehouse effluents. The most widely used adsorbent is commercially available activated carbon. Despite the frequent use of adsorption in wastewater treatment systems, commercially available activated carbon remains an expensive material. The safe and economical methods are required for the treatment of dyehouse effluents. In recent years, researchers are focussing towards the preparation of low cost adsorbents from cheapest sources like waste plant materials. Therefore, in this research paper stems of Prosopis cineraria (Kejri) was used to prepare activated carbon for removal of congo red dye from aqueous solution. The dye adsorption experiments were carried out by using bath procedure. UV-visible absorption spectroscopy was used to record the adsorption behavior. The pH effects, the contact time and the initial dye concentration were changed to obtain the best experimental conditions. The dye adsorption equilibrium was attained after 60 min of contact time.

Keywords: Adsorption, Wastewater, Prosopis cineraria, Congo red dye, Low cost adsorbent.

OP-15

Treatment of Wastewater of Textile Industries Using Photocatalyst

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Uses of photocatalytic techniques for decomposition of azo dyes those are non- biodegradable and persistent in water for longer duration. Complete removal of dye contaminant from water is challenging. This water dye contaminated water is also dangerous for living beings as azo dyes are carcinogenic in nature. Application of photocatalytic techniques for the degradation of these dyes would be beneficial and cheaper than conventional treatment technologies. photocatalyst has great potential of degradation of organic pollutants within a few minutes of treatment. We used the azodye model (commonly used in textile industries) for experimental purposes. We observed successful depredation of sample azo dyes by the photocatalyst.

Keywords: Degradation; Azo dyes; photocatalyst

PP-1

Poster Presentation

Application Of Chemically Modified Di Thiazide- Chitosan For Adsorption Of Industrial Toxic Metal Ions

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In recent decades, acceleration of modern industrial activities have introduced environmental pollution in view of heavy metal ions which has reached at alarming level in aquatic and terrestrial environment and therefore, concerned the contemplationto many researcher groups worldwide due to its adverse effect on human and animal life.

Chitosan is a (Poly-ß-(1,4)-2-amino-2-deoxy-D-glucose which is a nitrogenous (amino base) polysaccharide, Due to unique polycationic nature, controlled biodegradability, biocompatibility, nontoxicity and bioresorbable nature, it has several key properties that make it one of the most promising natural substances in environmental field. Chitosan is highly acquiescent to chemical modification via one of its three reactive functional groups: the amino group as well as both primary and secondary hydroxyl groups. Chemical modification, in particular crosslinking and grafting of these polysaccharides offers vast opportunities to be used as bio adsorbents for pollutants.

Investigation has been done for chemical modification of chitosan through di thiazole compound. Chemically modified chitosan was applied for adsorption of industrial waste effluents through adsorption process. The process was followed by Langmuir and Frendlich isotherm through batch experiments.

Keywords: Chitosan, industrial effluents, adsorption.

PP-2

Study of Change in Physico Chemical Parameters by Treatment of Sludge from Common Effluent Treatment Plant (CETP) with Earthworm

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One of the most vital problems of environmental protection concern is that of solid waste disposal as the inappropriate disposal of CETP's hazardous sludge can cause serious environmental problems. The sludge if sent for land filling may cause ground water contamination, changing the soil fertility parameters as well. The research presented here is carried out to explore the ability of an epigeic earthworm Eudrilus eugeniae to transform the sludge produced from CETP into value added product i.e., vermicompost. In this study, six samples of feed mixture were used with different ratio of CETP sludge, cow dung and saw dust. Physicochemical parameters such as pH, Electrical Conductivity (EC), Volatile Solids (VS), Total Nitrogen (TN), Nitrate Nitrogen (NO^{3-}-N), Ammonium Nitrogen (NH^{4+}-N) were characterized to analyze the quality of the compost formed. All these parameters are in the agreement with recommended standards of the mature compost. The result shows that vermicomposting technique when used epigeic earthworm Eudrilus eugeniae can work as a favorable alternative solution for disposal of CETP sludge.

Keywords: Common effluent treatment plant sludge, Eudrilus eugeniae, vermicompost, cow dung, saw dust, pH, Electrical Conductivity (EC), Total Nitrogen, Phosphorus.

PP-3

Bacterial Biofilms Based Bioaccumulation of Lead and Conversion of Chromium

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Due to high cost of culture media used for microbial growth is creating complications in the scaling-up of biological processes in wastewater treatment. The experiment is designed to find a beneficial, inexpensive and effortlessly available alternative source for culture growth and removal of heavy metals and present work highlights the use of bark material of Azadirachta Indica (neem), Psidium Guajava (guava), Vachellia Nilotica (acacia) and Saccharum Officinarum waste (bagasse) for biofilm preparation and used as Cr(VI) and Pb reduction. In this experiment an indigenous heavy metals reducing bacterial strain P8 isolated from Motha River, Kakasaheb Gadgil Bridge, Deccan, Pune, Maharashtra and identified as Bacillus subtilis strain JCM 1465 MN749805.1 on the basis of 16S rRNA gene sequencing. Selected isolate is not even accumulate the lead but also capable for conversion and accumulation of 8 mM solution of hexavalent chromium into 0.35 mM trivalent chromium. Based on maximum fixation capacities of lead and chromium, bark materials could be arranged as Saccharum Officinarum>Psidium Guajava>Azadirachta Indica>Vachellia Nilotica. The performance of different biofilms prepared by identified bacterium in lead accumulation is Saccharum Officinarum>Vachellia Nilotica>Psidium Guajava>Azadirachta Indica. Similar biofilms performance in chromium bioaccumulation is as Vachellia Nilotica>Saccharum Officinarum>Psidium Guajava>Azadirachta Indica.

PP-4

Optimization of Different Organic Solvents For The Fabrication of Uniform Graphene Oxide Thin Films Through Langmuir-Blodgett (LB) Technique

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The main focus of the work has been to optimize the organic solvent for the utilization in Langmuir-Blodgett (LB) technique to synthesize uniform graphene oxide thin films and the study of the fabricated thin films through Atomic Force Microscopy (AFM). Graphene Oxide has been synthesized through Modified Hummer's method and characterized through UV-Visible Spectroscopy, Fourier Transform Infrared (FTIR) Spectroscopy, X-Ray Diffraction (XRD) Spectrum, Raman Spectrum, and Zeta Potential Distribution. As-prepared Graphene Oxide has been dispersed in THF (Tetrahydrofuran), *N*-methyl-2-pyrrolidone (NMP) with Cyclohexane and Water: Methanol mixture in varying ratios and volumes and their Pressure (π)-Area Isotherm have been recorded through Langmuir-Blodgett (LB) system. Although THF and NMP with Cyclohexane gave satisfactory isotherm results but Water: Methanol mixture accounted for the suitable Pressure (π)-Area Isotherm for the deposition of Graphene Oxide thin films. Films of all three solvent mixtures have been collected on glass and silicon substrate through Langmuir-Blodgett trough and studied under AFM, that showed although, THF and NMP with Cyclohexane gave graphene oxide films on the substrates but not that much uniformity has been found as it has been in the case ofWater: Methanol mixture. Further, 1:5 Water: Methanol mixture has been utilized to form more films and studied under AFM.

Keywords: Langmuir-Blodgett (LB) Technique, Graphene Oxide, Atomic Force Microscopy(AFM).

PP-5

Determination of traces of toluene by simple chemical oxidation method

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Toluene is an aromatic hydrocarbon commonly used as octane – boosting component in gasoline blending, raw material in the production of other chemicals (benzoic acid, toluene diisocyanate), as a solvent in paints & coatings, inks, adhesives, pharmaceuticals. Toluene exposure occurs especially in occupations such as printing or painting where toluene is used as a solvent. Inadvertent sources include emissions from motor vehicles & aircraft exhaust, losses during gasoline marketing activities, chemical spills & cigarette smoke. It is a member of the BTEX group of pollutants that are exerting influence on global environmental problems. In the presence of sunlight and oxides of nitrogen in the atmosphere, toluene is considered as precursors for ground level ozone and secondary organic aerosol formation. EPA has labeled toluene as hazardous air pollutant (HAP) and a toxic substance. Inhalation of toluene in low to moderate levels can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, loss of appetite, hearing loss, and color vision loss. Current methods for analyzing BTEX are via gas chromatograph equipped with flame ionization detector (FID), photo ionization detector (PD-HID), and solid–phase microextraction (SPME) followed by GC- MS. Disadvantages of these methods include elaborate sampling and advanced instrumentation. So, our present study includes the development of a chemical method for toluene estimation. On this account, pure toluene was oxidized by $KMnO_4$ in a basic medium that converts into potassium benzoate which is analyzed by UV-Spectrophotometer, and % age of conversion is determined. Different concentrations of potassium benzoate obtained by applying reaction on different amounts of toluene is analyzed that gives wavelength maxima at 223.5nm (same as that of pure potassium benzoate purchased from Merck), the exact amount of toluene in the sample can be quantified. Limit of detection for this method is 0.1ml/87mg toluene. It gives estimation of toluene in sewage water disposal, which provides very high sensitivity and accuracy that would be ideal for this kind of analysis.

Keywords: Toluene sources and effects, BTEX analysis, oxidation of aromatic compounds, UV-Spectrophotometer

Industrial & Applied Chemistry Section

Award Presentation

AO-1

Award Oral

Synthesis of Polymer Coated MCM-41 Nanohybrid And Its Application In Antibacterial, Antioxidant And Drug Delivery

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Mesoporous silica nanoparticles (MSNs) and chitosan are biocompatible due to their unique properties and also made outstanding achievements in the field of biomedical applications. In the present work, thiolated chitosan (organic polymer) was coated on 3-(trimethoxysilyl)-1-propane thiol (TMSP) modified MCM-41 (inorganic silica) through disulfide bond by oxidation process or oxidative coupling. The synthesis of chitosan-silica based hybrid material was confirmed by FTIR, XRD, SEM, TGA and NMR techniques. FTIR spectra peaks at 545cm^{-1} corresponds to disulfide linkage and thiol groups peaks at 1258cm^{-1} (S-C bond) and 2580cm^{-1} (H-S bond). The SEM images exhibits change in the surface morphology of hybrid which confirm the successful coating of polymer onto silica surface and XRD patterns of MSNs at 2θ=2.5° corresponds to differaction peaks of hexagonal mesoporous structure. The antibacterial properties observed that gram-negative (E. coli) bacteria exhibit better inhibition zone (2.8, 2.4, 2.0, and 1.8 cm) than gram-positive (B. subtilis) bacteria (2.4, 2.1, 1.6 and 1.4cm). The DPPH scavenging capability of synthesized hybrid was found to be 67.48%. The drug (quercetin) encapsulation efficiency of hybrid material was calculated to be 92.14% and more drug releases in acidic medium than that of pH7.4, so we can conclude that hybrid material shows pH-dependent drug releasing behavior. The results show that synthesized hybrid materials possess good antibacterial and antioxidant activities and also a good nanocarrier for drug delivery application.

Keywords: Mesoporous silica nanoparticles (MSNs), Chitosan, disulfide bond, oxidative coupling.

AO-2

Multifunctional Silver Prussian Blue Nanoparticles for Biomedical Applications

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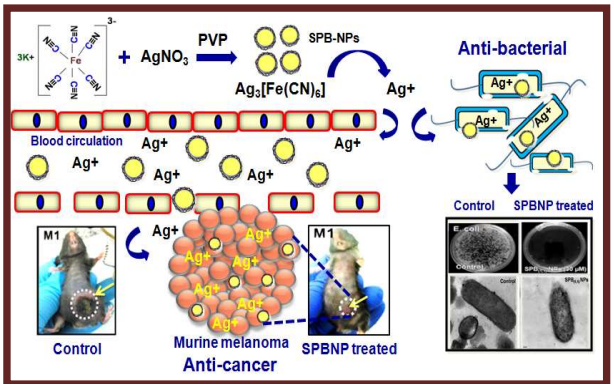
In the currentstudy, Prussian blue (PB) and silver salts (silver nitrate) were incorporatedin the presence of PVP [poly(N-vinyl-2-pyrrolidone)]to producestable silver hexacyanoferrate nanoparticles (silver Prussian blue analogue: $Ag_3[Fe(CN)_6]$ abbreviated as SPBANPs)[1-2]. It is an innovative nanoparticle formulated with an intention for an effective as well as safer approach of treatment strategy (2-in-1) for both cancer and bacterial infections. The characterization of the biocompatible and stable nanoparticles was done through several available techniques.The nanoparticles on application over cancer cells MCF-7, A549, B16F10and SK-OV-3) *in vitro* displayedestimable inhibition property. Moreover, when the only nanoparticles without any drug was injected in the aggressive murine melanoma model: B16F10 (C57BL6/J mouse) intraperitonially it disclosed relative inhibition of tumor growth as compared to control. Further, the SPBANPs demonstratedclear antibacterial activity in many Gram-positive and Gram-negative bacteria. The beauty of this current nanoformulation is that it itself functionsfor drug delivery, as anticancer as well as an antibacterial agent. All the performed experiments (both *in vitro* and *in vivo*) collectively exhibit that this biocompatible SPBANPs devoid of any antibiotic and anticancer drug could be explored for the advancement as a multifunctional therapeutic molecule (2-in-1) for treatingcancer along with bacterial infections in the forthcomingperiods.



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AO-3

Hydrocarbon Class Type Data on Petroleum Resids by TLC-FID and Open Column Chromatography Techniques For Increased Predictability of FCC Modelling Software

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Fluid catalytic cracking (FCC) is one of the most important conversion processes used in refineries. This process converts heavy petroleum fractions into lighter, higher-value products, such as gasoline, propylene and others. FCC units (FCCUs) have the flexibility to process a wide range of feedstocks, and at varying severities, to optimize refinery profitability. Some of the feed stocks being processed at Indian oil refineries include SRVGO, VGO, Hydrotreated VGO, Vacuum Resids and theirblends.

In any refining processes including FCC, modeling and simulation have critical importance for process development, control, and optimization. In COVID-19 pandemic times, because of decline in gasoline demand growth, forward-looking refinersare exploring new revenue options and shifting to petrochemical-oriented operations. Refineries are turning their FCC units towards maximization of propylene and ethylene production to maintain their competitiveness. However, the simulation software for any refinery process used to optimize refinery conditions have prerequisite of precise input of analytical data onfeed.

In this work, two different methods; TLC-FID based IP 469 method and open column liquid chromatography have been used to give the precise composition of hydrocarbon classes namely - Saturates, Aromatics, Resins and Asphaltene in different kind of High boiling Petroleum Resids. To further confirm the precision of data, repeat analysis were carried by TLC-FID on each sample. The repeatability data show that standard deviations are less than 3% in estimation of each class. The data was also generated under slightly different analytical conditions of gas flow rates and change of stationary phase sets that is chromarods to check the robustness of TLC-FID based data.

Keywords : TLC-FID, FCC, Hydrocarbon class

AO-4

First-Principlesbased Theoretical Investigation Of Impact Of Polyolefin Structure On Photo-Oxidation Behaviour

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Degradation of polyolefins is a serious issue with economic and environmental implications, and therefore we have focused on understanding the changes that occur at the molecular level during the photo-oxidation. However, polyolefins on longtermexposure to ultraviolet (UV) radiation or high-temperature conditions or erosion undergo degradation and generatemicroplastics.The microplastics generated after the degradation of these polyolefins are hazardous for the ecosystem. We have carried outDFT studies to investigate the photodegradation of sixdifferent polyolefinsranging from polyethylene to polydecene. Herein, we have investigatedphoto-oxidized derivatives of different polyolefins and analyzed theirrelative stability, conformations, UV-visible spectral behaviourand carbonyl index.The TD-DFT analysis confirms thatphoto-oxidizedproductsshow absorption peak in IR and visible region, acting as light-absorbing species.The computed results suggest that polyolefins in their pristine state are stable towards photo-oxidation,but chemical impurities like carbonyl groupsmake them proneto undergo photo-oxidation,a fundamental process leading to generation of microplastics.Our results clearly demonstrate that lower polyolefinsi.e polyethylene and polypropylene, which are the highest produced polymers globally, are more susceptible to photo-oxidation than higher polyolefins that could be the leading cause of the generation of more microplastic in the ecosystem.

AO-5

β-Cyclodextrin Based Highly Efficient Selective Flocculant Towards Beneficiation Of Iron Ore Slime

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Iron is the backbone of our civilised society. The source of iron is the conventional mines. During mining of iron ore, a huge number of fine particles are generating, which are known as slime. The slime is not used for steelmaking as it contains considerable amount of impurities. Therefore, the beneficiation of slime may be a worthy approach for better quality of iron ore. Herein, a functionalized β-cyclodextrin (β-CD) based flocculant has been developed. The developed material is composed of β CD methacrylate, polyacrylamide and poly (acrylic acid). It has been found that the developed material has promising selectivity towards the hematite particles and also demonstrates very fast settling of hematite particles. The developed material has been found to be an excellent material towards the iron ore beneficiation than that of the conventional flocculant starch.

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AO-6

Recovery of high purity chlorine from industrial waste HCl via electrolysis

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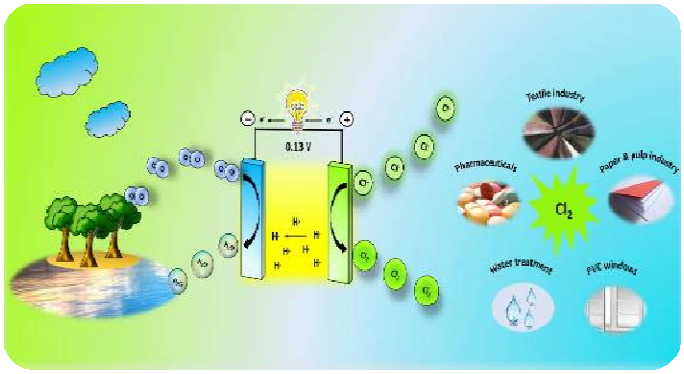
HCl is a fundamental chemical reagent used frequently in industries for polyvinyl chloride (PVC) production. Synthesis of polyurethanes and polycarbonates produce an excess amount of HCl as a by-product out of which only 15-20% is recycled back to chlorine, leaving behind excess waste HCl which cannot be completely employed for PVC production. An energy efficient route for valorization of waste HCl towards chlorine production is electrolysis, which involves hydrogen evolving cathode and chlorine evolving anode with cell potential of -1.36 V, accounting for high power and energy consumption along with safety hazards imposed due to H_2 evolution during uncontrolled shutdown. This can be overcome by replacement of cathode with oxygen depolarized cathode decreasing the cell potential to -0.13 V wherein development of highly active, stable and inexpensive electrocatalyst is need of the hour. We have developed a Cu-doped Fe_2O_3 catalyst incorporated in nitrogen containing carbon matrix via one step pyrolysis of precursor premeditating reduced cost and eliminating complicated procedures for carbon synthesis. A superior activity with current density of 92.1 mA cm^{-2} is observed at anode and a comparable activity to state of art catalyst is witnessed at cathode underlining the potential of electrocatalyst for HCl valorization towards chlorine production.



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AO-7

Effects of nano materials on bioactive glass ceramics

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Bioactive glass ceramics (BGC) have been widely used to restoration, implants and filling defects of dental and bone.Glass ceramics can attach directly to the bone tissue via forming a biologically active hydroxycarbonate apatite (HCA) layer due to their biocompatibility, Osteoconductivity and antibacterial activity properties. HCA layer is chemically and structurally equivalent to the mineral phase of bone. BGC is a special type of biomaterials, which has the ability to form an interfacial bond to the bone through the formation of HCA layer on the surface of samples when they are implanted in the human body or in the simulated body fluid (SBF).The addition of nano particle e.g., Nano SiO_2, Nano Al_2O_3 etc. to the BGC enhances the bioactivity and mechanical properties. In the present work the synthesis, phase composition, crystallization behavior, surface morphology of bioactive glass ceramics containing (38-*X*) normal-SiO_2-28CaO-18Al_2O_3-12CaF_2-4P_2O_5-*X*nano-SiO_2 (mol%) glass-ceramics (where X = 0, 19, and 38) have been investigated. The glass ceramics were synthesised using simple melt-quench method. The microhardness value, cutting energy, and the machinability parameter havebeen determined. The *in-vitro* study has also been investigated by immersion in the sample in SBF solution. HCA layer was developed after 28 days of immersing in the SBF. The addition of SiO_2nano particlesin the specimens showed an increase in Vicker's hardness, density, and acid-base resistivity.

Keywords: Bioactivity, *in vitro* study, FTIR, Hydroxycarbonate apatite, simulated body fluide.

AP-1

Award Poster

Microwave Assisted Synthesis Of Cellulose Derived Chelating Ion-Exchange Resin For Determination Of Distribution Co- Efficient (Dg- Value) Of Manganese

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Microwave assisted synthesis of cellulose after its cross linking with triazine has been used for the preparation of new chelating resin incorporating methyl orange.The resin has been characterized through, moisture content, bulk density, bulk volume FT-IR, NMR, Mass Spectroscopy, SEM and EDX.The amount of metal ions retained by these resins at equilibrium was determined in terms of distribution coefficient values (Dg). The metal exchange capacity of resins at different pH wasconsidered in a batch equilibrium study on the chelation of Mn(II) metal ion. The adsorption study of Mn (II) showed maximum adsorption at pH 4.94, the value of distribution coefficient of derivative for Mn (II) at pH of maximum adsorption was 1410.25.

Keywords: cellulose, Microwave Assisted Synthesis, SEM, EDX, distribution coefficient values (Dg)

General Presentation

OP-1

Oral Presentation

Today's Chitosan Based Biopackaging For Foods In Digitalized World

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Recent time digitalization in every aspects of our life has been a thrust phenomena. The purpose of it may be considered from economy, marketing, environment, cleaniness and many more. As a chemist, we can think over on it & take this challenges to your profession also. Nowadays the online purchase may be taken as one of the issues on this aspect. The purchased articles are being sent with robust packaging with considering its environmental implications aslo. The packaging materials should not be the source of junk for adverse impact on environment. From that point of views, the biopackaging has been considered as a great relief, particularly for food packaging applications. Chitosan-the active biomolecule and its derivatives have a significant and very fast development in food application area because of its biodegradability, biocompatibility, antimicrobial activity, non-toxicity and versatile chemical and physical properties along with different forms of shapes like fibers, films, gels, sponges, beads or nanoparticles. The present paper will discuss on chitosan films/coating as a biopackaging material for the quality preservation and shelf life of a variety of foods and for clean environment in randomized digitalized world.

Keywords: Chitosan, antimicrobial activity, biopackaging, food application, environment, digitalized marketing

OP-2

Indian Academicians Seed, Harvest, Germinate & Cultivate The Buddingpharmacists To Serve For Mankind Because Service To Human Is The Service To God

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Outlook: Before you pray for life: Believe on Pharmacist Before you speak to doctor: Listen to Pharmacist Before you spend money for medication: Earn the trust on Pharmacist Before you write your consent: Think over Pharmacist's devotion Before you quit from life: Try to feel Pharmacist's noble profession Before you die: Live with Pharmacist's oath.TEACH & LEARN both are five-man army in the fieldof pedagogy. Actually T-EACH & L-EARN is the focusto EACH and every person to EARN something afterimplementation of basic knowledge which has beengrasped through the diploma [DPharm] or baccalaureate [BPharm] or postbaccalaureate [MPharm] or in doctoralcourse [PhD] in pharmaceutical science. Pharmacy is avast subject totally embedded into the application oftherapy through medication by proper nursing.Pedagogy is the discipline that deals with the theory andpractice of teaching that informs teaching strategies,teacher actions and teacher judgments and decisions bytaking into consideration theories of learning, understandings of students and their needs and thebackgrounds and interests of individual students. Pedagogy includes how the teacher interacts withstudents and the social and intellectual environment theteacher seeks to establish. A true academician is a personwho has grasping power of subject expertise and Gateway of basic knowledge has to be focused on traffic personalization. Pharmacy is subject which runs on it's two legs: chemistry & biology. An academician is a person who can correlate these two basic subjects with compilationto give best outcome of cream to the global domain byfar-sight. Reflection of elements of periodic table in pharmaceutical science through correlation approach offar-sight of pharmacy which is the vision of pharmacy (phar-sight) in globalization in past and currentmillennium. Indian pharmaceutical academician is the best contributor of basic knowledge to pharmacy practicethroughout the nation.

Pharmacists, also known as chemists (Commonwealth English) or druggists (North American and archaically,Commonwealth English), are healthcare professionalswho practice in pharmacy, the field of health sciencesfocusing on safe and effective medication use. Apharmacist is a member of the health care team directlyinvolved with patient care. Pharmacists undergouniversity-level education to understand the biochemicalmechanisms and actions of drugs, drug uses, therapeuticroles, side effects, potential drug interactions andmonitoring parameters. This is mated to anatomy, physiology and pathophysiology. Pharmacists interpretand communicate this specialized knowledge to patients, physicians and other health care providers. Among otherlicensing requirements, different countries requirepharmacists to hold a Bachelor of Pharmacy (B.Pharm.), Master of Pharmacy (M.Pharm.), or Doctor of Pharmacy(Pharm.D.) degree. The most common pharmacistpositions are that of a community pharmacist (alsoreferred to as a retail pharmacist, first-line pharmacist ordispensing chemist), or a hospital pharmacist, where theyinstruct and counsel on the proper use and adverseeffects of medically prescribed drugs and medicines. Inmost

countries, the profession is subject to professionalregulation. Depending on the legal scope of practice, pharmacists may contribute to prescribing (also referredto as "pharmacist prescriber") and administering certainmedications (e.g., immunizations) in some jurisdictions.Pharmacists may also practice in a variety of othersettings, including industry, wholesaling, research,academia, military and government.

Reference:

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OP-3

New ^{1}H NMR method for quality control and to differentiate genuine and spurious hand sanitizers for COVID-19

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In light of rapidly evolving COVID-19 pandemic and demand for hand sanitizers in global and Indian markets, many companies are manufacturing alcohol-based hand sanitizers and selling in the market. Though genuine manufactures produce and supply hand sanitizers as per guidelines by World Health Organization (WHO), due to sudden demand, inferior and cheaper quality spurious sanitizers are also available in the market and not meeting the guidelines of WHO. Considering public health, there is a need for quick and reliable method to analyze the alcohol-based hand sanitizers by analytical technique for their quality. There is no single method available for estimation of all four components viz. alcohol, glycerol, hydrogen peroxide and water in the hand sanitizer formulation as per guidelines of WHO.

A quick and reliable ^{1}H NMR method was developed for quality control and to differentiate genuine and spurious hand sanitizers for COVID-19 based on proton NMR technique which can estimate all four components in WHO-recommended Handrub formulations without using any organic chemicals. Further, this method can able to identify various other toxic components present in sanitizers like methanol. In this method, hydrogen peroxide peaks were successfully separated in presence of water and alcohols. The experiment parameters were designed and the equations were derived so that all four components can be quantified without using any organic solvent in just 15 minutes in WHO-recommended Handrub formulations.

Some sanitizer manufacturers clearly mention the name and concentration of alcohol on the bottle, but some do not mention the concentration and name of the alcohol. Many commercial samples of hand sanitizers were analyzed qualitatively & quantitatively by the newly developed ^{1}H NMR based method in order to check the compliance of these samples w.r.t WHO guidelines. It was found that one locally procured sample contains toxic methanol (~ 71%) while others contains much lesser amount of isopropyl alcohol (~33%). It was also found that approximately 60 % commercial samples analyzed by this method do not meet WHO guidelines. IOCL has come up with “IOC Clean”, an ethyl alcohol based hand rub solution to sanitize hands in a bid to strengthen efforts to fight the coronavirus.

Keywords: Covid-19, Handrub formulations, Sanitizer, ^{1}H NMR

OP-4

Synthesis, Characterization and Applications of Highly Reactive Polyisobutylene

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Fuel and oil additive industry in general use polyisobutylene based dispersants, due to their exclusive properties of cleaner burning, high shear stability, tackiness, water and oxidation resistance, and cohesive strength. Furthermore, PIB based dispersants possess a variety of other value-added advantage including less char formation at high temperature performance conditions and ability to improve final lubricant and fuel performance. Low molecular weight highly reactive polyisobutylene (HR-PIB) is a vital precursor in the preparation of polyisobutenylsuccinimides, which are used as motor oil and fuel additives. The widely used traditional process to prepare HR-PIB is based on boron trifluoride catalyst system. The traditional process utilizes an alcohol or ether nucleophile at temperatures below -30°C. The requirement of low temperatures and highly purified feed make the process expensive. Recently, researchers studied metal halide complexes; however, their poor solubility in the preferred nonpolar solvents imposed a serious limitation for industrial application.

Authors have developed a fully hydrocarbon soluble catalyst that produce HR-PIB with quantitative yields, ~95 % and up to 85% exo-olefin end-functionality at 0-10°C. We have investigated effect of temperature, method of catalyst dosage, catalyst to additive ratio, catalyst concentration, etc., as the part of process development enabling HR-PIB suitable for post-polymerization modification.

OP-5

Estimation of Ethers Generated Through Conversion Of Lower Branched Olefins In Light Cut Naphtha (LCN) using GC-MS and NMR Technique

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In the etherification process, C5/C6 iso-olefin presents in light cut naphtha (LCN) react with methanol in the presence of acid catalyst to produce C5+ ethers which have high octane number. These lower molecular weight unsymmetrical ethers, such as methyl t-butyl ether (MTBE) and t-amyl methyl ether (TAME) can be added to C5 -C10 hydrocarbon-containing gasoline products to increase gasoline octane performance without the addition of deleterious components such as tetraethyl lead and benzene. GC coupled with mass spectrometry (GC-MS).method was developed for monitoring the etherification process by characterizing the products completely and correlated the components with NMR method.

Since light cut naphtha is a mixture of C2 - C6 olefins, monitoring of selectively conversion of C5 olefins (isoamylenes) to tert-amyl methyl ether (TAME) and branched ethers in the presence of other hydrocarbons is very difficult. Therefore, a separation scheme using appropriate capillary column was devised to separate TAME, MTBE and other ethers generated during the etherification process in the presence of olefin isomers. The depletion of isoamylenes in light cut naphtha (LCN) feed and corresponding product was also monitored using GC-MS technique. The generated ethers were identified by Mass Spectrometry (MS) using NIST library and quantification was done using the internal standard method. The data obtained for total ether content (TAME and MTBE) was validated with NMR technique. A good correlation was found between GC and NMR spectral results (correlation coefficient R^2 = 0.995).

Keywords: Gas chromatography, Mass spectrometry, NMR, Etherification, Isoamylenes.

OP-6

Quick and Simultaneous Estimation of Oxygenates, Octane Booster, Hydrogen Content and Hydrocarbon Types in High Octane Gasoline by q-^{1}H NMR Spectroscopy

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Fuels with higher octane rating are considered more premium as they have better resistance to knocking. Standard gasoline has an octane rating of 91 which is being used for most standard vehicles. However with high performance luxury vehicles, it is advisable to use fuels with higher octane ratings to ensure better health of the engines. Additionally in order to mitigate harmful emissions and to meet environmental considerations use of high octane gasoline is known to be more effective. Towards that end premium quality gasoline with greater than 99 octane rating is being promoted by OMCs throughout the country. Blending of suitable oxygenates and octane boosters to BS-VI gasoline are done to formulate these premium quality fuels. Estimation of various parameters, like % of oxygenates, octane booster, hydrogen content as well as hydrocarbon types, such and aromatics, olefins are imperative for the formulation of such products. Oxygenate such as ethanol, methanol and hydrocarbon types [Paraffin, olefin, naphthene and aromatic (PONA)] can be estimated by standard GC methods. Estimation of octane booster by GC has been found to be challenging as poor peak separation characteristic for octane booster was observed. Moreover standard GC method may not be applicable for PONA analysis as the presence of octane booster may affect overall estimation. Estimation of oxygenates and octane booster can be done by IR. However simultaneous estimation of all the above mentioned parameter cannot be done by any such technique. Herein we report a new quantitative ^{1}H NMR based method for the estimation of oxygenate , octane booster, hydrogen content as well as PONA in high octane gasoline. The method uses Hexamethyldisiloxane (HMDSO) as the internal quantitative reference standard with respect to which the % age of oxygenates, octane booster, hydrogen content, H/C and O/C ratio have been estimated. Application of the principal group molecular weight (GMWt) on the same spectrum provides the PONA analysis. Results of the study along with comparable data for oxygenate and octane booster obtained by IR analysis will be presented.

Keywords: Quantitative ^{1}H-NMR spectroscopy, High Octane Gasoline, Octane Booster, PONA.

OP-7

Facile synthesis of PANI/SnO2 and PANI/SnO_2 /rGO ternary composites for high performance chemi-resistive gas sensors applications

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PANI/SnO_2 and PANI/SnO_2/rGO ternary composites have been synthesized by by facile one step hydrothermal approach and followed by polymerization method. To explore the structural, optical, morphological and elemental composition of the composites, it has been characterized by XRD,TEM, EDAX, FTIR and EPR techniques. XRD indicates that the tetragonal rutile phase with the with nanocrystallite size range from 25-35 nm. The N_2 adsorption-desorption measurement showed that ternary PANI/SnO_2/rGO composite showed huge specific surface area (114.51 m^2/g) and pore size (17-21 nm), which is higher than the bare SnO_2 (surface area=83.51 m^2/g; pore size=33-37 nm).The chemiresistive type gas sensor was fabricated and the gas sensing properties of designed sensors were examined towards different gases (ethanol, methanol, carbon monoxide, oxygen, H_2S and NH_3). The results exposed that that ternary PANI/SnO_2/rGO showed better sensor sensitivity. It showshigh sensing response (56 %), fast response (35 s) and recovery time (40 s) towards H_2S gas than other gases. The improved gas sensing mechanism was also proposed.

OP-8

Ability of Numerous Recent Chemical and Physical approaches for the Elimination of Wastewater Dye

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Dye effluents emitted from a variety of dye-use industries are toxic to the atmosphere and to living things. As a consequence, the presence of dye effluent in environmental water sources is becoming an increasing issue. Environmentalists and the civilian community a long-term sustainable and effective method of treatment of dye effluents should be developed to resolve this problem. Until publication, dye wastewater should be processed first to mitigate the negative waste water impacts on the atmosphere and on living organisms. However, due to a lack of knowledge on efficient dye removal methods, it is difficult to settle on a single technique to address the prevailing dye effluent problem. Accordingly, this paper examines current study papers on different molecular, chemical and physical dye removal approaches in order to find their effectiveness by a percentage of dye removal. While there are several tried and tested current and the methods evaluated for the removal of pigment, most of which have a common drawback in the production of secondary emissions to the atmosphere. This paper illustrates, adsorption (physical) dye removal is considered as one of the most effective dye removal techniques. This paper also recommends the use of a mixed adsorbent, since it is envisaged that this approach would be more effective and would be able to extract dyes at a quicker rate.

Keywords: Dye effluents, wastewater, adsorbent,chemical and physical method

OP-9

Chemical Recycling of Waste Plastic into Hydrocarbon Oil via Pyrolysis

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Plastic in modern society make an important contribution to all major daily activities and their global production and utilization has grown rapidly over the last few decades. Plastic are highly durable, versatile, light weight, do not rust and low production cost, which makes them ideal choice for wide varieties of applications in industry as well as in domestic areas. Due to the increased use of plastics, the waste generated from their production, transportation and consumption has created various environmental problems. Plastics, designed to be resistant to biological degradation, remain in the ecosystem for many years. The huge and ever increasing amount of plastic waste is thus a burning issue throughout the globe, as nature cannot handle it. Management of waste plastic through sustainable recycling routes is need of the hour.

The present study describes the value addition of various waste polyolefins like high density polyolefins (HDPE), linear low density polyolefins (LLDPE), polypropylene (PP) into valuable hydrocarbon oils via catalytic pyrolysis process. The yield and nature of the product was found to vary with feed and the catalyst. The major portion of the liquid product is in the range of C6-C16.The obtained liquid product is free from sulfur compounds.

OP-10

Bioprospecting of Alkaliphilic Nesterenkonia Lacusekhoensis In Decolorization of Azo Dye For Its Application In Treatment of Highly Alkaline Textile Effluent

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Azo dyes are one of the recalcitrant organic pollutants known to have diverse toxic effects on the environment, thus its remediation from the environment using sustainable mean is of utmost necessity. The severity of the pollutant further aggravates if it is present in an alkaline environment like in textile-originated wastewater. To remediate dye from this alkaline system, there is a requirement for dye degrading alkaliphilic microbes. In the present study, potential azo-dye methyl red (MR) decolorizing microbial strains were isolated from the alkaline textile effluent (pH 13). Among four isolated strains, Nesterenkonia lacusekhoensis EMLA3, found to grow at alkaline pH (pH 11.5) and simultaneously remediate high level (200 mgL^{-1}) of MR from alkaline medium was selected for detailed studies. Interestingly, dye decolorization was also observed in presence of high salinity levels (20-120 gL^{-1} NaCl). Formation of low molecular weight metabolites identified through GC-MS studies inferred biodegradation to be responsible for dye decolorization. The strain was also applied for treatment of real textile effluent having high alkaline pH and salinity, wherein efficient decolorization of effluent after 96 h of treatment was successfully attained. The merit of the bacterium is that the initial pH (13) of the effluent got reduced to 8.6 after the treatment along with COD reduction. Thus N. lacusekhoensis EMLA3 could be effectively used for bioremediation of dye-containing textile effluents.

Keywords: Nesterenkonia lacusekhoensis EMLA3; alkaline pH; Azo dye; Methyl red; textile effluent; Bioremediation.

OP-11

Thiol-tethered Nanocomposites as Future Materials

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Thiol is an important group and is present widely in natural products. Also, the strong chelating property of thiol is used to treat poisoning by heavy metals. Therefore, herein we developed a process for thiomers from polysaccharide via an innovative green approach using innocuous low- cost thiourea reagent. Subsequently, the synthesized thiomer were used as reducing agents to synthesize nanocomposites. The detailed structural characterization results supported the uniformity of modification, which ultimately resulted good control for the size and shape in nanocomposites. The controlled size and shape are important in nanocomposites for exception capabilities in applications. Rather, the synthesized nano-composited confirmed exception results for heavy metal ions and in antimicrobial applications. Overall the applied protocols are simple, green and less-energy intensive, and which also have scale up potential. Also, the materials have prospective to be an alternative to the conventional materials.

Keywords: Thiomer, Nano-composites, Heavy-metals, Antimicrobial

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OP-12

Comparative Study of Poly(acrylate-co-maleic anhydride)amides of Hindered Phenolic Schiff Base Amine For Lubricant Applications

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Automobile industries require a significant amount of lubricants, especially the engine oil, and comprise up to half of the total lubricant demand. The foremost aim of the lubricant is to prolong the engine's service life under harsh operating conditions. Several specialty additives have been used in the base oil to improve the engine oil's effectiveness and efficiency. A finished lubricant performs several critical functions, including oxidation inhibition, cleaning, suspending the generated sludge, protection from corrosion, and high friction due to metallic surface asperities. Two essential properties of a lubricant are; good low-temperature property and good high viscosity index, i.e., minimum variation in viscosity with varying temperature, which is generally incorporated by blending the viscosity index improvers and pour point depressants. It is a matter of great concern if an efficient multifunctional additive could be developed possessing these important characteristics. In view of this, four poly(acrylate-co-maleic anhydride)amides of hindered phenolic Schiff base amine were synthesized, having varying alkyl chains. The molecular characterization was done using various spectroscopic techniques. A comparative performance study of these synthesized additives was done in polyol reference base oil to investigate the effect of long alkyl chain on VI, pour point depressant, detergent-dispersant, and anti-oxidant additive properties. Poly(acrylate-co-maleic anhydride)amides of the C18 alkyl chain showed the best results enhancing the viscosity index of base oil from 178 to 195 at 5000 ppm additive dose. A maximum oxidation inhibition of 41 % and a significant enhancement of 35 % in detergency/dispersancy was observed at this dose.

OP-13

Catalytic Intervention for Tailoring Gasoline Composition for Octane Barrel Improvement

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Fluid Catalytic Cracking (FCC) process is a major secondary refining operation that caters approximately 40-50 % of total gasoline pool. ZSM-5 catalyst additive finds widespread usage in a FCCU for both light olefin production and gasoline octane improvement. Conventional ZSM-5 system cracks gasoline to LPG and propylene components and consequently leads to lower gasoline yields. However, with increased demand for gasoline, refiners prefer to enhance olefin yield without or minimum loss of gasoline.

To increase octane number/octane barrel with minimum loss of gasoline yields tailoring of catalyst to generate selective hydrocarbon composition with enhanced octane contributing molecule is required. A customized catalyst additive formulation with tailored zeolite system having enhanced selectivity to high octane molecule and an active matrix component to crack heavier fraction is discussed.

This additive prepared using similar procedure reported in US Pat. No. US 75718271B22009 & IN 201921040347 is characterized for different physico-chemical properties such as Apparent Bulk Density (ABD), Attrition Index (AI), X-ray Diffraction (XRD), Surface Area (SA) and Particle Size Distribution. Performance of tailored additive prepared at lab and commercial scale evaluated in ACE R+ unit is discussed in the paper along with its commercial plant trial performance in a commercial FCC unit.

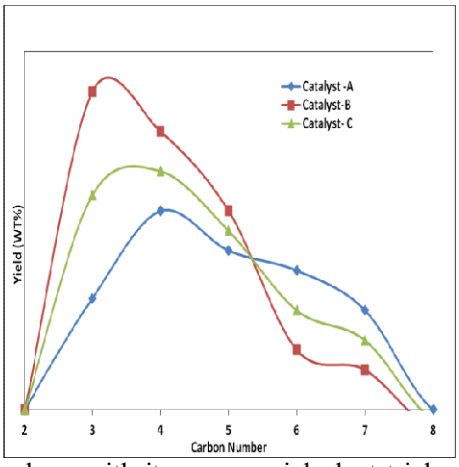

Fig.1: Shift of molecular compositional distribution with catalyst (Catalyst- A= FCC Catalyst (Zeolite Y Based), Catalyst- B= FCC Catalyst + Conventional ZSM-5 Catalyst, Catalyst- C= FCC Catalyst + Tailored Catalyst)

Keywords: Octane boosting additive, Gasoline Octane, RON improvement, FCC operation

OP-14

Xrf-Xrd Analysis of Turbine Deposits: Problems And Solutions

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Steam turbines are commonly used to convert the heat energy of steam to finally generate electricity, propulsion for ships, airplane etc. There may be series of specially designed blades inside turbine which capture the steam and a rotational force is generated. In general, steam from a water boiler is pressurized into turbine which propels spinning motion of turbine blades. During operations, various materials may deposit on the turbine blades and affect the efficiency of turbine. Deposits on turbine blades may restrict steam flow, corrode the turbine blades and cause imbalance in motion of turbine blades in addition to reduction of turbine efficiency and MW generating capacity, and malfunction of valves and seals.

The determination of elemental and phase composition of these deposits is important for prevention of deposit formation on the blades and also for cleaning of deposits on the blades. In this study, deposit samples on turbine blades from IOCL refinery have been characterized using X-ray diffraction (XRD) and X-ray fluorescence spectroscopy (XRF). Elemental analysis of deposit samples by XRF shows presence of Si, Na, Cl as major elements which appear in different phase composition including Silica, Sodium silicate, Sodium carbonate, Sodium chloride etc as indicated by XRD. It takes only few hours of a chemical upset such as leak or boiler carryover to build up deposits on the turbine blades, but it takes thousands of hours of operation with pure steam to remove these deposits. In this regard, techniques such as XRD and XRF have proved to be vital analytical tools for understanding root cause of deposits on the turbine blades. Based on the data, source of these contaminates can be traced and preventive measure can be taken to avoid shut down and to identify suitable reagent to clean these deposits.

Keywords : Turbine deposit, Elemental composition, Phase analysis, XRF, XRD

OP-15

Toxic Effect And Risk of Disease Among Nail Artists of Bhopal, Due To Toxic Trio – Toluene, Dibutyl Pthalate And Formaldehyde.

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Modern day nail polishes have the formulations, which contains highly toxic chemicals toluene, dibutyl pthalate and formaldehyde. These products affect the health of workers engaged in saloon, particularly in nail salons. Workers breathe in harmful vapors, dusts and mists, and are exposed to those products on skin and eyes, or even sallow sometimes accidently through food. This exposure is intensified on the use of varieties of other nail products during their longer duration of work. Acetone contains leads to headache, dizziness, and irritation to eyes, skin and throat, causing various breathing problems.

- Long term exposure to dibutyl phthalate causes nausea and irritation to eyes, skin and throat.
- Formaldehyde causes difficulty in breathing including coughing, asthma like attacks, wheezing, it can also cause cancer on prolonged exposure.
- Toluene makes skin dry, causes headache and dizziness, irritation to eyes and nose.

The present study aims to investigate the toxic effects of above potentially hazardous chemicals on health of nail artists of Bhopal and investigates the impact of long term exposure of various nail products on the nail artists. It has been found that these workers developed, the symptoms of nausea, breathlessness and asthmatic problems, on continuous exposure to these toxic chemicals.

After a survey of two months and after detailed study on this problem, some preventive measures have been suggested to reduce the hazardousness of this problem.

The measure suggestion include, absorption spill of nail products and scrubbing the area with detergents. Proper ventilation of working area, use of safety glass, gloves and aprons. The suggestion, was found to be effective, when adopted by concerned nail artists.

OP-16

Amelioration of Cadmium Induced Vascular Endothelium Damage by Pro-Angiogenic Europium Hydroxide Nanorods (EHN)

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Environmental and industrial heavy metal (arsenic, lead, cadmium etc.) pollution is one of the major reasons for humans to become susceptible to various health hazards. Cadmium (Cd) is a common heavy metal among all that causes major environmental pollution with adverse effects on the human health and functioning. The fundamental mechanism of Cd induced vascular toxicity is through inhibiting angiogenesis via reduction of nitric oxide (NO) bioavailability and induction of apoptosis. Several approaches were attempted to treat Cd-induced toxicity such as the use of anti-oxidants and chelating agents. However, these approaches are associated with their own limitations. In this context, there is a critical need for the development of alternate treatment strategies to address the Cd intoxication. One such novel approach is therapeutic angiogenesis which could be an ideal option to recover from the toxicity. Our group already demonstrated the biocompatible europium hydroxide nanorods (EHN) which exhibited excellent pro-angiogenic properties through enhancement of intracellular nitric oxide (NO). In the present study, we have evaluated the effect of EHN on Cd induced toxicity in EA.hy926 (hybrid endothelial cell line) using various in vitro and in vivo assays. EHN improved the viability of EA.hy926 cells pretreated with Cd, reduced apoptotic cell population, increased NO production and promoted blood vasculature development in chick embryo model. Down-regulation of p53 and up-regulation of Bcl-XL along with enhancement of NO was found to be the plausible molecular mechanisms underlying the retrieval of Cd induced vascular toxicity by EHN. Henceforward, we strongly hope that the EHN could be developed as potential alternative therapeutic nanoparticle for overcoming Cd induced toxicity and associated diseases.

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OP-17

Antifungal Activity of New Series of Some Synthesized Pyrimidine Derivatives

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Pyrimidine pharmacophore is an important and integral part of nucleic acid and play an essential role in several biological processes and occupy an important place in the therapeutic area. Pyrimidines derivatives were found to possess a wide range of diverse activities such as anti-inflammatory and analgesic, antimicrobial, anti-avian influenza virus (H5N1), against herpes simplex virus type-1 (HSV-1) and hepatitis-A virus (HAV), serotonin 5-HT6 receptor antagonist, anti-arrhythmic agents. Pyrimidine analogs have been already demonstrated as platelet aggregation inhibitors, antagonists, anti-conceptive and antiparkinsonism agents. The pyrimidine core is a structural constituent of critically important drugs like fluorouracil, etravirine, risperidone, iclaprim, avanafil, and rosuvastatin. Keeping in view the importance of pyrimidine ring in various therapeutic agents and our continuous work to design and synthesis of novel pyrimidines based new chemical entities of biological significance, recently, we have designed and synthesized the new series of multifunctionalised halogenated pyrimidines and their antimicotic activities were evaluated in vitro against five human pahtopathogenic fungi using ketoconazole as standard reference. In this presentation, the detailed synthetic procedure, biological screening profiles and characterizations of the synthesized compounds by their spectral data (^{1}H NMR, ^{13}C NMR, EIMS, UV and IR) analysis will be discussed.

OP-18

Future Aspects of Flame-Retardant Polyurethanes

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Indeed, as I have studied on retardant compounds for polymers as collaboration works with Indian university [1-4],"Materials and Chemistry of Flame-Retardant Polyurethanes" may be one of the important remand from the viewpoint of social safety of fire accidents.

In 2017, for example, a fire broke out from a three-story building in Yoyogi 5-chome, Shibuya-ku, Tokyo, and burned to the roof of the second car of the regular train (8-car train) from Honatsugi to Shinjuku that stopped between Sangubashi and Yoyogi-Hachiman on the Odakyu Odawara Line. According to the Tokyo Fire Department and Odakyu Electric Railway, about 300 passengers got off the railroad tracks and evacuated, and no one was injured. The roof of train (Figure) was made of polyurethane materials.

In this talk, I will briefly review characteristic of polyurethane and known features of its retardant, and I will discuss expected fire considering "Future Aspects" such as low concentration of oxygen and non-gravity conditions assuming marine or space life of human being.

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OP-19

Methods and Practices for Disposal of Municipal Solid Waste (MSW):A step towards immaculateness

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Solid waste is the useless, unwanted and discarded material resulting from day to day activities. Waste disposal includes the practices required to manage waste from its inception to final disposal. This includes various methods from transport to treatment and disposal of waste. The present study deals with the solid waste management methods and practices. The main focus is on the municipal solid waste. Various methods have been described to manage the solid waste.

Keywords: Waste management, Treatment, Disposal, Reuse, Recycling,

OP-20

Fading of Rhodamine B using CdS quantum dots under solar light

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Cadmium sulfide (CdS) quantum dots (QDs) were prepared by chemical precipitation method by using β-cyclodextrin as reducing agent. Optical property of CdS is investigated using ultra violet visible-diffused reflectance spectroscopy and photoluminescencespectroscopy. The absorption band edge emission of this particle was 469 nm which is considerably blue shifted compared to those of the bulk CdS. The calculated band gap of CdS quantum dot is 2.62 eV showed a difference of 0.2 eV energy greater than that of bulk, indicating quantum size effect. The formation of CdS quantum dots were confirmed by the structural characterization using XRD. The synthesized quantum dot has size in the range of 3.5nm with zinc blende crystallite structure. The morphology and molecular confirmation were studied using SEM and FTIR. The different magnification of SEM images clearly indicates the formation of plates like nanocluster. Photocatalysis based on semiconductor quantum dots, which utilize the solar energy can be used for the elimination of pollutants from aqueous media and applied for water purification. The photocatalytic activity of cadmium sulfide quantum dot was tested for degradation of rhodamine B dye under solar light. Effect of weight of catalyst, concentration of dye, pH of solution and reusability of catalyst were investigated. Existence of isosbestic point observation of high intense absorbance peak at 550 nm at 300 min in different matrix circumstances confirms the formation of leuco Rh B.

Keywords: Cadmium sulphidequantum dots, β-cyclodextrin, photocatalysis, Rhodamine B, solar light

OP-21

A greener approach towards fabrication of flexible carbon cloth electrode for water splitting

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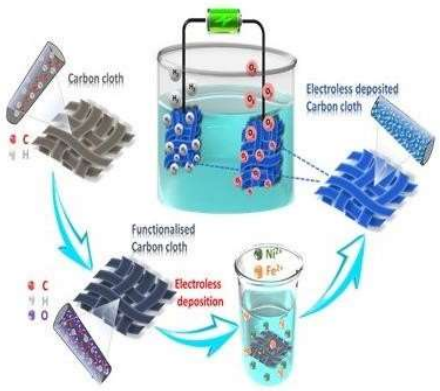
Development of cost-effective electrodes for efficient electrochemical water splitting with industrial applicability is of great importance. Mostly electrodes are fabricated by powder casting on a rigid substrate with insulating binder impeding the ion transport and hence lowering the overall efficiency. In that respect, self-standing binder-free electrodes are an innovative approach possessing an increased density of exposed active sites to accomplish faster mass transport, providing excellent adhesion between catalyst and substrate. Self- supported carbon cloth based flexible electrodes has advantages of high activity, light weight and eco-friendly nature favouring industrial applications. Electroless deposition is most probably the simplest approach for electrode preparation, but still underexplored due to use of expensive sensitizer and activator. Herein, we manifested a cost-effective and greener approach to design self-supported flexible electrode depositing NiFeS and NiFeP over carbon cloth by proficient electroless deposition, eliminating traditionally expensive sensitizer and activator. As prepared, NiFeS@OCC and NiFeP@OCC demonstrate good bifunctional activity and require a low overpotential of 220 & 270 mV during OER, 223 & 300 mV during HER to reach 10 mA cm^{-2} which are comparable to that of state of art catalyst. The promising bifunctional activity and stability of these flexible



electrodes under full cell conditions for overall water splitting signify great potential for their practical implementation in industries.

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OP-22

Effect of transition metal oxide dopant on corrosion protecting behavior of polypyrrole

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Conducting polymers are the organic polymersand various applications of conducting polymers can be increased by doping with other functional materials to form polymer composites. Here, in present research work, effect of doping of titanium dioxide has been studied on corrosion protecting behavior of polypyrrole.

Polypyrrole and polypyrrole composites of titanium dioxide of 5%, 10% concentrations are electropolymerized on the surface of stainless steel by cyclic voltammetry technique. The corrosion protecting behavior of polypyrrole and polypyrrole-titanium dioxide composites of different concentrations in 1M HCl was evaluated by Electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization techniques. From the EIS measurement, it is observed that the charge transfer resistance (Rct) value i.e. reactions intensity at coating/metal interface of Polypyrrole-TiO_2compositesof different concentrations is higher than pure polypyrrole. The double layer capacitance (Cdl) of all composites is lower than pure polypyrrole. So corrosion protection efficiency of Polypyrrole-TiO_2 of different concentrations are better than pure polypyrrole on stainless steel surface. The higher values of Rct for Polypyrrole-TiO_2 composites can be explained by the building up of a primary protective passive layer. From the polarization analysis, it was observed that pure polypyrrole coated steel possessed a lower Ecorr and higher Icorr value than polypyrrole-TiO_2 composites which indicated that polypyrrole composites give better corrosion protection on the stainless steel surface.From the EIS and polarization analysis, it was confirmed that polypyrrole-TiO_2 composites give better corrosion protection on stainless steel surface than pure polypyrrole coating.

Keywords: Corrosion,Electrochemical impedance spectroscopy, Stainless steel, Polypyrrole, Titanium dioxide

OP-23

Chicken Eggshell as Low-cost Calcium Source in the Synthesis of Bioactive Glass and Glass-ceramics

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Bioactive glass ceramics have come up as an important class of biomaterials. Many products based on these biomaterials have found extensive use in biomedical applications - bone implant and bone graft, drug delivery, tissue engineering, etc. are some examples and many new applications are coming up [1-3]. Bioactive glasses are primarily composed of a three dimensional silica network with other compounds incorporated in the structure. One of the primary constituents is calcium oxide (CaO) and it is used in most of the commercial bioactive glass and glass ceramics products. Composition of CaO can range from 10 to 45 wt % and in glass manufacture commercial $CaCO_3$ is primarily used as the source for CaO. Chicken eggshell, which is generated worldwide in huge quantities as solid waste, contains ~ 88% of CaO. Although some of it is used in agriculture, even in the developed countries some 30% is still discarded [5,6]. This can be utilized as an economical source of CaO in glass composition. The present work examines the suitability of chicken eggshell as the candidate for calcium source in the composition of bioactive glass. Three glass samples were synthesised – all having the 45S5 Bioglass® composition (45% SiO_2, 24.5% CaO, 24.5% Na_2O and 6.0% P_2O_5, all in wt%). Three separate calcium sources – commercial $CaCO_3$ powder for glass 1, CaO powder derived from eggshell for glass 2 and powdered raw eggshell for glass 3. Chicken eggshells were cleaned and then calcined at 900°C for 3 hours for obtaining CaO powder. The 3 glasses had bulk densities of 2.460, 2.316 and 2.515. FTIR spectra of the glasses showed the characteristic Si-O-Si glass network and the XRD data showed the amorphous nature of all 3 glass samples. Vickers Hardness (5 measurements average) of the 3 glasses was 5.074 GPa, 5.536 GPa and 5.746 GPa, respectively, showing the similar mechanical strengths for the glasses. The in-vitro bioactivity of the 3 glasses was tested by soaking in SBF solution for 7 days and then performing SEM, FTIR and XRD studies to confirm the formation of surface hydroxyapatite layer. Very good bioactivity was exhibited by all the glass samples. Toxicity assessment was done by using chicken red blood cells which confirmed that all glass samples were non-toxic in nature. So, CaO obtained from chicken eggshell and raw eggshell itself can be considered as economical alternative calcium source for bioactive glass and glass ceramics manufacture.

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PP-1

Poster Presentation

A novel method of nitriding of steel (AISI-SAE 52xx) using melamine derived from urea

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Urea on heating under normal pressure yield melamine at about 275 degree Celsius and reaches equilibrim at about 325 degree Celsius[1] in 6 hours according to the chemical reaction

$$6NH_2CONH_2=(NH_2CN)_3(\text{melamine})+6NH_3+3CO_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Along with biurate, cyanuric acid and water insoluble intermediates but yield of melamine is 99.4%.

Melamine, on the other hand, is widely used as a fire retardant due to the fact that at an elevated temperature (above 500 deg Cel) it produces nitrogen gas.

We have made use of this chemical reactions to nitride medium carbon steel (AiSI-SAE:52xx) sample and nitrided samples are characterized by powder XRD, metallurgical microscopy and scanning electron microscopy. TheVicker hardness of the steel samples in creased manifold.Extent of corrosion resistace power, particularly in saline condition, was further enhanced as evidenced from cyclic voltammogram of nitrided and un-nitrided steelsamples.

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PP-2

Defluoridation of ground water by chemically modified maize husk as an adsorbent

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The defluoridation of ground water concerned one of most noticeable attention among the world community. The present investigation deals with effective removal of toxicants presents in ground water using bio adsorbents from agricultural waste. Research has been probed for successful removal of fluoride ions by chemically modified maize husk as adsorbents. Fluoride containing ground water samples were collected from Gadra road region of Thar desert of Rajasthan. Batch experiments were conducted to establish the optimal conditions like pH, dose of the adsorbent, and contact time. The prepared biosorbents were applied on these collected samples under optimized conditions and found to be effective with removal efficiency ranging from 79 to 83 %. The adsorption process obeyed Langmuir adsorptionmodel.

Keywords: ground water, maize husk, batch experimen

PP-3

Compatibilized Blends of Polypropylene And Polyethylenimineand Its Potential Application In Carbon Dioxide Sequestration

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Hyperbranched polymers (HBPs) or dendrimers have been used as additives for thermoplastics. Incorporation of HBPs or dendrimers in commodity thermoplastics, such as, polypropylene (PP) have proven to increase its toughening properties, nucleating efficiency, processability etc. Here, we report Polyethyleneimine (PEI), a hyperbranched polymer as a nucleating agent for PP in the presence of a compatibilizer - maleic anhydride grafted polypropylene (PP-g-MA). The compatibilized PP-PEI blends displayed significant improvement in the crystallization behaviour as well as mechanical and morphological properties as compared to the non-compatibilized blends. Decrease in crystallization time for PP/PP-g-MA/PEI blends was further confirmed by isothermal (Avrami analysis) and non-isothermal crystallization kinetics (through Jeziorni as well as Mo models). In addition, PP-PEI blends were examined for their ability to capture carbon dioxide (CO_2) through thermogravimetric analysis (TGA). PEI contains primary and secondary amine groups that can chemically react with carbon dioxide. In this case also, compatibilized blends showed remarkable increase in CO_2 absorption efficiency as compared to the non-compatibilized blends.

PP-4

Lab Scale MEC Determination of Fire Supression Agents

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Minimum Extinguishing Concentration (MEC) of gaseous or liquid fire extinguishing agents is the measurement of their fire extinguishing capability to extinguish flammable and combustible fuel fire. It is an important parameter to calculate design concentration of fire suppression agent for their fire protection system development. The Cup-burner test method has been established as standard method for MEC determination of fire suppression agents. This study investigated the lab scale method for MEC determination of newly developed fire suppression agents and their screening for futuristic applications as in-kind halon alternatives. This experimental tool consists of specifically designed Combustion tube having provision for introduction of air/agent mixture in upper part and properly fitted methane/hydrogen fuel burner in lower part. Flame Ionization Detector has been used for flame extinguishment detection. The MEC value of Halon 1301 and newly developed perfluorinated liquid fire suppressing agents were determined using very small quantity (approx. 1-3g). The experimental results were found in good agreement i.e. exhibited good reproducibility and repeatability based on average of five replicate experimental determinations.

PP-5

Impact of Biojet Blending on Jet A1 Fuel Properties

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Aviation turbine fuel (ATF), kerosene type, Jet A-1 fuel consists of predominantly refined hydrocarbon derived from conventional sources such as crude oil, natural gas liquid condensates, heavy oil, oil shale and oil sands. The use of laboratory synthesized hydrocarbons from renewable new sources is beyond the scope of conventional ATF, kerosene type Jet A1 fuel specification. However, usage of synthesized fuel components from renewable sources is envisaged to decrease carbon footprints.

The stringent specifications of ATF are aligned with international aviation fuel standards like British Ministry of Defense Specification DEF STAN 91-091 and ASTM 1655 specification to meet the ATF quality standards and facilitate aircraft refueling in different countries. The ASTM specifications (D7566) is designed for using biojet fuels derived from renewable source in Jet A1 fuels which is in line with international specifications. Bureau of Indian Standard (BIS) has also issued later specification IS 17081: 2019 for use of biojet fuel components from renewable sources in Jet A1 fuel.

Biojet fuels can be blended with conventional Jet A1 fuel according to ASTM D7566 or IS 17081 specifications limits and biojet blended Jet A1 fuel has to meet IS 1571 specifications also. A study was carried out by using two different types of biojet fuels i.e. SPK-HEFAs (Synthesized paraffinic kerosene derived from hydrogenation and deoxygenation of fatty acid esters and free fatty acids) and ATJ-SPK (hydro-processed synthesized paraffinic kerosene derived from ethanol or isobutanol) and blended in conventional Jet A1 fuel at different ratios. The properties of biojet-Jet A1 blends significantly influenced are sulfur content, lubricity and aromatics. Detail impact on properties of biojet-Jet A1 blends vis-a-vis properties of jet A1 fuel as per specifications will be discussed in the full paper.

Key words: Biojet, FT-SPK and ATJ-SPK, thermal stability, Jet A1 fuel

PP-6

Doping engineering through Vanadium and Nitrogen dopent in MoS_2 enhance the catalytic performance towards HER in acidic and alkaline medium

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With the growing civilization the eager of fossil fuels are increasing gradually. Hydrogen energy is come out to be sustainable and never ending energy source to resolve the energy crises. Hydrogen has highest gravimetric energy density (120 kJg^{-1}) than all the other conventional energy resources[1]. Hydrogen evolution reaction (HER) through electrocatalytic pathway is emerging as contemporary green technology to combat with the modern energy crises scenario. In this connection, selection of suitable electrocatalyst plays a vital role to get the highest faradic efficiency in HER process. Interestingly, Volcano plot suggest that MoS_2 is one of the most promising electrocatalyst towards HER. However, the 2D MoS_2 semiconductor has some definite drawbacks over its performance for HER. In this aspect, numerous modification techniques were applied to enhance the catalytic performance of the MoS_2. Among them doping engineering emerges as promising technique to enhance the catalytic efficiency of the MoS_2. Here in, we have tune the MoS_2 catalytic activity by doping with different foreign element like Vanadium (V) and Nitrogen (N) into the layer 2D MoS_2 crystal lattice. The catalytic performance of MoS_2 in acidic and alkaline pH got augmented on incorporation of the V and N over MoS_2. The observed overpotential in acidic and alkaline medium after doping with V (194 & 206 mV) and N (109 & 141 mV) were found to be less than pure MoS_2. This findings provides a novel route to enhance the catalytic activity of MoS_2.

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Inorganic Chemistry Section

Award Presentation

AO-1

Award Oral

Exploration of Electrical Conductivity of 1D Coordination Polymers (CPs): Recent Trends in Design strategy and Controlling factors

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The key revolution in material science has been presented on its prospective applications in electrical energy storage, semiconductor devices, new energy resource generation and sensitive switches etc. Numerous organic and inorganic compounds have been synthesized and utilized for progression of electrical and electronic material research. However, in recent consequence, the hybrid materials (i.e. composed of inorganic metal ions and inorganic ligands) mainly coordination polymers (CPs) have been proven to be attractive in laboratory to land applications.Scientists have taken the opportunity of this hybrid nature and designed the requisite materials in order to improve the electrical and optoelectrical.To overcome the energy crisis situation, these CPs may be employed to resolve the issue owing to their outstanding structural diversity and chemical stability. Therefore, judicious selection of structural components of CPs is directly valued the energy-related applications. Here, the rational designing strategy and structural factors that affect the charge transport properties as well as electrical conductivity will be discussed (**Figure 1**).

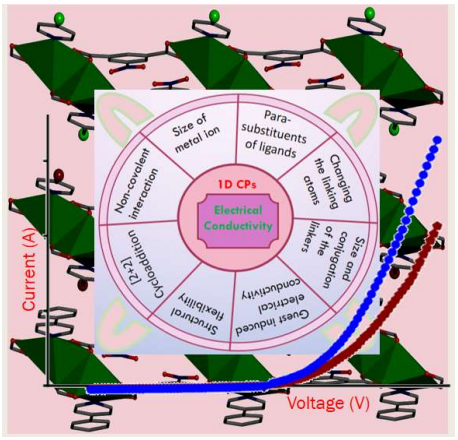

Figure 1. Designing strategy and structural factors that affect the electrical conductivity of 1D CPs.

Selenium Enriched NiSe/NiO Hollow Nano Architecture as a Binder-Free Battery-Type Cathode for High Performance Pouch-Type Hybrid Supercapacitors

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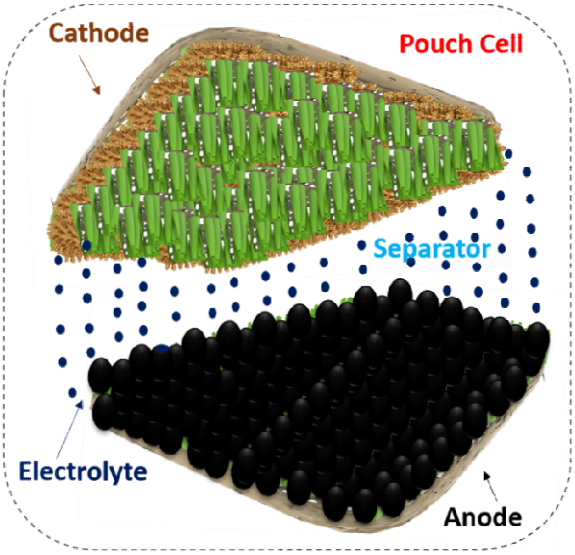
NiSe-Se@NiO nanostructures were supported on highly conductive nickel foam. They were synthesized using facile chemical bath deposition technique. The densely grown nanostructure, with its large number of electroactive sites, facilitated rapid diffusion and charge transport. The NiSe-Se@NiO@Ni foam electrode, exhibited a superior specific capacitance value of 2704 F g^{-1} at a current density value of 4 mV s^{-1} in a 1 M aqueous KOH electrolyte. Furthermore, a high-energy-density pouch-type hybrid supercapacitor (HSC) device was fabricated using the proposed battery-type NiSe-Se@NiO@Ni foam as the positive electrode, activated carbon on Ni foam as the negative electrode, and a filter paper separator soaked in a 1 M KOH electrolyte solution. The HSC delivered a specific capacitance of 91.68 F g^{-1} at a current density of 6 mA cm^{-2} with an energy density of 0.52mWh/cm^2 at a power density of 22.9mW/cm^2 for an extended operating voltage window of 1.6 V. In addition, the HSC exhibited excellent cycling stability with a capacitance retention of 93.87% after 5000 cycles, highlighting its excellent potential for use in the hands-on applications. The real-life practicality of the HSC was tested by using it to power a red light-emitting diode, a toy motor fan and a PC cooler fan.

Keywords: hybrid, supercapacitor, nickel oxide, nickel selenide, nanostructure, conductive, electrode



AO-3

Efficient Water Oxidation Catalyzed by Single-Site Ruthenium(III) Complex with a Redox-Non-Innocent Ligand Framework

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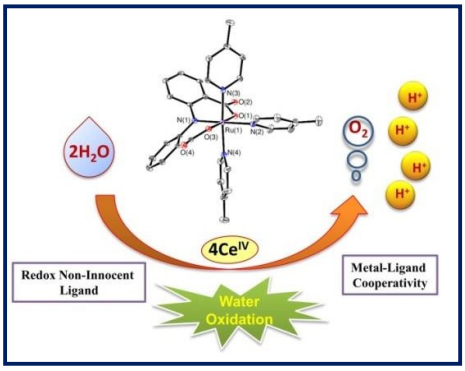
This work describes catalytic water oxidation activity of a mononuclear ruthenium(III) complex $[Ru(L)(pic)_3]$ (H_3L = 2,2'-iminodibenzoic acid, pic = 4- methylpyridine), using Ce(IV) as an oxidant in pH 1. The detail mechanistic investigations of water oxidation have been carried out by the use of spectroscopy, electrochemistry, kinetic analysis and computational studies. Electrochemical study suggests that water oxidation proceeds via formal high-valent Ru^{VII} species. The capability of accessing such a high valent state is derived from the non-innocent behavior of the anionic-tridentate ligand framework which helps in accumulation of oxidative equivalents in cooperation with metal center. This metal-ligand cooperation is important to facilitate the multi-electron oxidation of water. Mechanistic investigation reveals water oxidation at single-site of Ru where O-O bond formation takes place via



radical-radical coupling pathway between the oxygen atom of ruthenium-oxo species and the oxygen atom of hydroxocerium(IV) ion. This is an important observation from the viewpoint of natural oxygen evolution reaction in Mn_4CaO_5 cluster where the O−O bond formation was proposed to take place through the heterometallic reaction between Mn^{V}=O species and Ca^{II}–OH species.

Keywords: Non-innocent Ligand, Ruthenium Complex, Water Oxidation, Catalysis.

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AO-4

Geometry-Driven Iminosemiquinone Radical To Cu(II) Electron Transfer And Stabilization Of An Elusive Five-Coordinate Cu(I) Complex

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The non-innocent ligand[1-4] H_2LAP(Ph) contained a bulky phenyl substituent at the ortho- position to the aniline moiety. The ligand reacted with 0.5 equivalent of $CuCl_2$•$2H_2O$ in the presence of Et_3N under air and provided the corresponding Cu(II)-bis(imonosemiquinone) complex (**1**). The complex upon oxidation by stoichiometric amount of ferrocenium hexafluorophosphate ($FcPF_6$) yielded the four-coordinate [Cu(II)-(imonosemiquinone)(iminoquinone)]PF_6 complex (**3**), while the oxidation by an equivalent amount of $CuCl_2$•$2H_2O$ produced the five-coordinate Cu(I)-bis(iminoquinone)Cl complex (**2**). Thus, a ligand-based oxidation followed by ligand-to-metal electron-transfer was realized for the latter oxidation process[5]. Removal of the Cl^- ion from complex **2** rendered four-coordinate complex 4. The oxidation state of both Cu(I) and iminoquinone moieties remained unaltered upon the change in the coordination number.

All the complexes were characterized by X-ray crystallography. Complexes 2, 3, and 4 were diamagnetic with a St = 0 ground state as evident by EPR and ^{1}H-NMR measurements. The UV-Vis-NIR spectra of all the complexes were dominated by charge-transfer transitions. Two oxidations and two reductions waves were noticed in the cyclic voltammogram (CV) of complex **1**.[6] Complex 2 and complex 3 underwent one oxidation and three reductions. Unlike complex 3, which experienced ligand-based oxidation, in complex 2 the oxidation was metal-centered [oxidation of Cu(I)-to-Cu(II)] [7]. UV-Vis-NIR spectral changes during the fixed-potential coulometric one-electron oxidation and thereafter, EPR analysis consolidated the metal-based oxidation in complex **2**. Complex **2** was air stable; however, it oxidized KO2 to oxygen molecule and complex 1 was formed in due course as evident by UV-Vis-NIR spectral changes and EPR measurement[8]. TD-DFT calculations have been incorporated to assign the transitions appeared in the UV-Vis-NIR spectra of the complexes.

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Crystallographic Characterization and Biological Study of One Thiocyanato Bridged Copper (II) Polymeric Complex Derived From Substituted Thiosemicarbazone Schiff Base

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Transition metal complexes have been studied extensively for their use as anti-cancer drugs because of their diverse spectral, chemical and electrochemical properties. A number of low molecular weight molecules, as well as synthetic and natural products can recognize DNA. The interaction of metal complexes with DNA is now a day's one of the main active area of research at the interface of chemistry and biology. Earlier, platinum based drugs were already in use in clinical application for more than three decades. In this respect, one polymeric copper (II) complex has been synthesized using substituted thiosemicarbazone Schiff base ligand. The synthesized Cu(II) complex was characterized by various physico-chemical studies and single crystal x-ray diffraction. Some biological study of the synthesized complex was also evaluated. DNA binding ability of Cu(II) complex was investigated using UV-Vis and fluorescence spectroscopic, viscosity studies as well as by cyclic voltammetry measurements. The binding constant (K_b) value of the synthesized complex was determined from the absorption spectrum and from the fluorescence spectrum, the Sterm-Volmer constant (K_{sv}) value was determined. From the above K_b and K_{sv} values, the binding of the complex to CT-DNA is revealed to be through partial intercalative mode. The protein (BSA and HSA) binding studies were determined with the help of UV-Vis as well as fluorescence spectral methods. Theoretical molecular docking studies were also carried out to ascertain the interaction pattern of copper (II) complex with duplex DNA. The cytotoxicity profile of the titled copper (II) complex with AGS and A549 cancer cell lines have also been investigated.

Molecular Memory Device Based on a Tetranuclear Organotin Sulfide Cage

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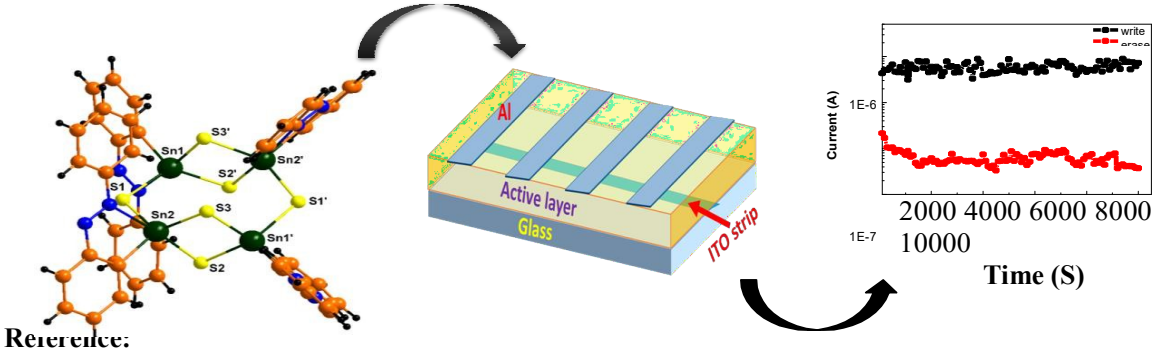
To overcome the problem of data storage and data handling various electronic devices at molecular level are being explored continuously. Molecular organometallic complexes have been considered as the potential candidates for the molecular materials to be used in these devices for their ease of processing, flexibility, being light weight, solubility, stability, and versatility to design.[1] Azoaromatic compounds are known to show switching behaviour[2,3] which encouraged us design a tetranuclear monoorganotin sulfide cage $[(RSn^{IV})4(\mu\text{-}S)_6]\cdot 2CHCl_3\cdot 4H_2O$ (**1**) (R = 2-phenylazophenyl) exploiting the intramolecular N→Sn coordination. It consists of an interesting Sn_4S_6 double decker cage like core in which Sn centers are bridged through μ2-S units. The single crystal x-ray diffraction analysis revealed that it contains four identical Sn possessing distorted trigonal bipyramidal geometry. The complex **1** is further explored as active material for the fabrication of solution-processable resistive memory switching device. I-V characteristics of the device showed an excellent memory behaviour with low write voltage i.e., -1.4 V. The device showed a good ON/OFF ratio of 10^3 with retention time of 10000s.[4] The complex **1** is the first organotin complex to exhibit the memristive behaviour.



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Ni(II) Tethered Coordination Compounds As Effective Growth Inhibitors of A Drug Resistant Bacterial Pathogen MRSA

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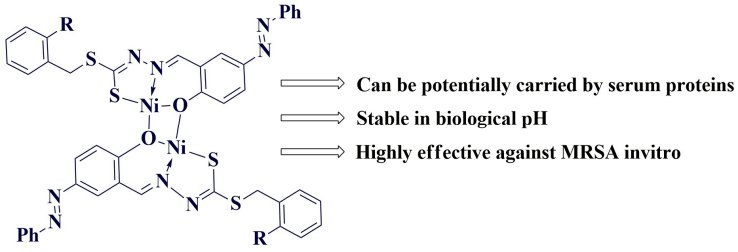
Research and development in the field of medicinal chemistry for designing new and sustainable drugs is very crucial due to the expanding population of superbugs and drug resistant pathogens. Medicinal inorganic chemistry or metallotherapy is one of the multifarious approaches to tackle such health challenges. To contribute in this direction, we have developed two potentially bioactive nickel complexeswith a ONS donor Schiff base ligand backbone. The complexes have been characterized with the help of analytical techniques such as IR, EDAX, CHNS, ^{1}H-NMR and ^{13}C-NMR. The solution behavior of compounds in acidic and basic pH conditions were tested and their interaction with a serum carrier protein BSA was evaluated which deliberated that the compounds are quite stable over biological pH conditions and bind protein carriers effectively. Further, the compounds were screened for their inhibitory action against a group of bacterial and fungal species. Interestingly, they exhibited excellent growth inhibitory action against methicillin-resistant *staphylococcus aureus* (MRSA) bacterial species. Further studies to confirm their activity, efficacy and mechanism of action will be done in due course. However, preliminary studies suggest that these complexes hold great potential to act as drug candidates for treating infections by MRSA.



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AO-8

Directed highly ordered mesoporous nitrogen-rich g-C3N4.5 nanosheets for sustainable visible-light hydrogen evolution with prominent quantum efficiency.

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It is desirable yet challenging to synthesize a highly ordered holey carbon nitride material with excess nitrogen atoms for a sustainable solar H_2 evolution. Herein, we report the development of directed highly ordered nitrogen-rich honeycomb-like mesoporous carbon nitride nanosheets by using a novel synthetic approach for this purpose. The unique formation route, surface structure and charge carrier dynamics of the two dimensional holey nanosheets are comprehensively monitored and confirmed by SAXS, HRTEM, AFM, BET, XPS and TRPL analyses. Non-stoichiometric high nitrogen content mesoporous nanosheets with the final stoichiometry of g-C3N4.5 acquiring a high specific surface area (382 m^2 g^{-1}), remarkable pore size (7.2 nm) and sheet thickness ~ 5–6 nm are realized in this first report. This elegant material possesses unique low band-gap energy (2.42 eV). Remarkably, the as-synthesized g-C3N4.5 NSs exhibit a record high photocatalytic H_2 evolution rate of 8180 mmol g^{-1} h^{-1} under the present light irradiation ($420 \leq \lambda \leq 510$ nm) condition. The apparent quantum efficiency is found to be as high as 27.14% at 420 nm and retains its photocatalytic activity for longer consecutive catalytic cycles. Bigger pore size and pore volume, and thin walls leading to shortening of the path length of exciton pairs, efficient charge separation and the prolonged average life time of the charge carriers, and lone electron pairs associated with the excess nitrogen content are found to be the reasons behind the excellent visible light driven water splitting reaction.

Keywords: Mesoporous, photocatalytic, H_2 evolution, exciton.

AP-1

Award Poster

A Short Review on Cyclometalated Iridium (III) Phenyl pyridine Complexes

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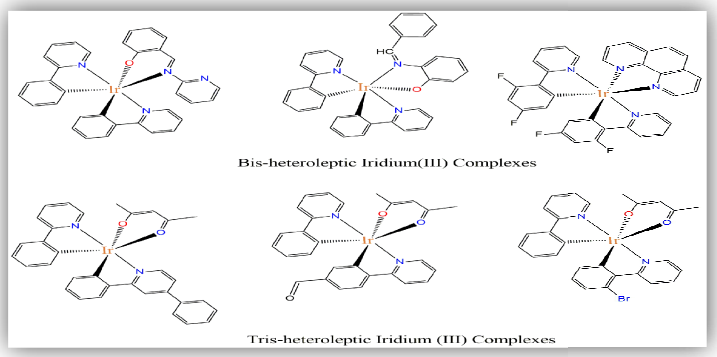
Cyclometallated Ir(III) complexes as phosphorescence emitters have gained widespread interest as attractive candidates for use in organic light emitting diodes (OLEDs), bioimaging probes[1], oxygen sensors, anticancer agents, photo redox catalysts, pH sensors, and so on because of their remarkable optoelectronic properties. To date, numerous examples of Iridium complexes have been prepared[2] and most of them can be categorized as IrL_3, IrL_2L', IrL_2A, and IrL_2A' where L and L′ are different cyclometallating ligands that chelate to an Ir(III) ion via carbon and hetero atoms, 'A' depicts a symmetric ancillary ligand that binds to Ir(III) via two hetero atoms, and A′ represents a non symmetric ancillary ligand.



Tris-heterolepticIr(III) complexes containing an Ir(III) ion with three different cyclometallating ligands (IrLL′L″) or a combination of two different cyclometallating ligands and one ancillary ligand (IrLL′A or IrLL′A′) represent new classes of highly functionalized Ir(III) complexes, which may open new avenues for the finetuning of their photochemical and electrochemical properties and could fill a function gap between a series of the homoleptic and bis-heteroleptic Ir(III) complexes.

The Phenyl Pyridine and related derivatives have attracted interest as precursors to highly fluorescent metal complexes of possible value as organic light emitting diodes (OLEDs). In all cases, complexation of the metal with the nitrogen donor and metallation at an ortho-position of the phenyl ring gives rise to a five-membered chelate ring.

Now a days the studies on iridium complexes are being designed with heteroleptic iridium complexes composed of phenyl pyridine, substituted phenyl pyridine and ancillary ligands and thus obtained iridium complexes expected to act as phosphors. Each combination of ligands would give rise to HOMO-LUMO separation which would reflect in luminescence behaviour of new complexes. In other words, tuning of emission colour could be achieved through subtle changes in the structure of phenyl pyridine, it's derivatives and ancillary ligands.

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AP-2

A Novel Piperidine Based Schiff Base Sensor for Zn(II) ion with the Formation of Binuclear Zn Complex Having Specific Al(III) Detection Ability in Aqueous Medium and Live Cell Images

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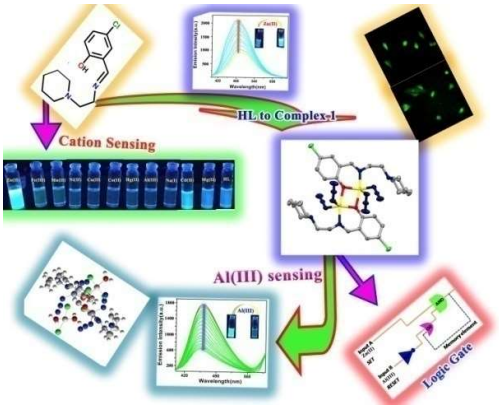
A fluorescent Zn(II) sensor **HL** [4-chloro-(((2-(piperidine-1-yl)imino)methyl)phenol] based on piperidine platform have been constructed and properly identified by using various spectroscopic techniques. This organic fluorescence probe **HL** can selectively detect Zn(II) among several analytes This sensing phenomena is convinced by using optical, UV and fluorescence changes of **HL** after adding Zn(II). Dduring conduction of a reaction between **HL** and $ZnCl_2$ sodium azide has been used to form multinuclear complex and as a result of which one Zn complex $[Zn_2(\mathbf{HL})_2(N_3)_4]$ (complex **1**) employing azide as the secondary anionic residue instead of bridging is produced. The single crystal structure of the complex unveils the unique protonation of the piperidine N during the crystallization of the dinuclear motif of the complex. Furthermore due to the presence of remarkable luminescence property the complex **1** have been reutilized to sense Al(III) ion as metalloreceptor in HEPES buffer solution via turn of fluorescence with high fluorescence quenching constant. The DFT study suggests the formation of bimetal complex during sensing of Al(III) with complex **1** as metalloreceptor. The in vitro cell imaging study gives a authentic hints for in vivo biomedical application of **HL** as a Zn(II) sensor. The two step sensing phenomena of **HL** and Zn complex is further established by advanced molecular logic gate formation.



AP-3

Fluorescent Metal–Organic Framework for Trace Quantity Detection of Inorganic Phosphate as $H_2PO_4^-$

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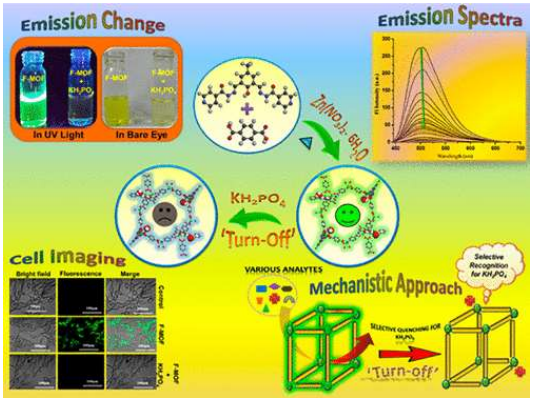

Drinking water quality management and sustainable environment to water bodies are a major concern to public health engineering departments. Inorganic phosphate (Pi), one of the major inorganic pollutants, is addressed for the last two decades regarding trace quantity detection. Over the past few years, a large number of fluorescent metal–organic frameworks (F-MOFs) have been studied to explore the desirable method for selective water analysis. In this article, a Zn(II) 3D F-MOF, {[Zn_2(PCDF-INH)$(BDC)_2$]·(H_2O)}n (**1**) (H_2BDC = 1,4-benzenedicarboxylic acid, and PCDF-INH = *N*,*N*′-diisonicotinoyl-2-hydroxy-5-methyl-isophthalaldehyde dihydrazone), is used for selective recognition of $H_2PO_4^-$ anion by a "turn-off" fluorescent sensing technique. Single-crystal X-ray analysis accounts that the asymmetric unit is constituted of two different Zn(II) centers by PCDF-INH, and the bridging group BDC^{2-} ions are responsible for the generation of the helical polymer and the biporous structures (14.807 × 13.096 $Å^2$ and 24.905 × 24.932 $Å^2$). The compound, **1**, exhibits strong emission at 505 nm in CH_3OH–H_2O solution and is "turn-off" upon the addition of $H_2PO_4^-$. The selectivity and specificity for $H_2PO_4^-$ have been checked in the presence of 15 different anions, including different phosphates (PO_4^{3-}, HPO_4^{2-}, $P_2O_7^{4-}$). The entire sensing activity of **1** is examined by spectrofluorometric method,^{1}H NMR titration, PXRD analysis, and bioimaging study, and the limit of detection is 3.903 μM. However, in vitro biosensing analysis confers that F-MOF (**1**) is sensable toward the $H_2PO_4^-$ ion at a trace level in the human lung fibroblast cells and human liver cancer cell line Hep G2.

General Presentation

OP-1

Oral Presentation

Green protocol for Synthesis, Characterization and Biological Studies of Transition Metal Complexes of N4-diubstituted Thiosemicarbazones

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Complexes of transition metal ions with N-4-disubstituted thiosemicarbazones were synthesized. Salicylidene N-4-substituted thiosemicarbazones were prepared through condensation of salicylaldehyde and N-4-substituted thiosemicarbazides by sonication method. The characterization of newly formed compounds was carried out by ^{1}H-NMR, FTIR spectroscopy, elemental analysis, molar conductance. In addition, the structure of the complex has been determined by X-ray diffraction method.

IR spectrum of ligand and the metal complexes indicate the existence of tridentate nature of ligand which undergo coordination to metal ions with ONS donor atom sets. The ligand and its metal complexes were also tested for biological activities.

Keywords: N-4-substituted thiosemicarbazones by sonication, biological studies.

OP-2

Insights into Transition Metal Mediated Generations of NO and H_2S

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While NO and H_2S are historically known as potent toxins, both the gaseous molecules have recently gained remarkable research interests because of their involvements as gasotransmitters in a diverse array of physiological processes including vasodilation, immune response, and neurotransmission. As a consequence, the generations and utilizations of NO and H_2S in the biological milieu are very tightly regulated through complex chemical pathways. Our research aims tohighlightthe molecular level insights into a number of unique routes leading to the generations of NO and H_2S.

Owing to our interest in disclosing the molecular mechanisms of NO generation from relatively stable NO_x^- anions, we employ a number of isolated nitrate and nitrite complexesbound to copper(II) site. A detailed kinetic study outlines thatphenols are capable of reducing NO_2^-($NO_2^- + 2H^+ + e^- \rightarrow NO + H_2O$) at copper(II) through proton-coupled-electron-transfer (PCET). Intriguingly, the protonation of a proton-responsive secondary coordination sphere leads to a switchover of the underlying mechanism for the phenol mediated nitrite reduction. Notably, the alternative mechanism involving the nitrito-copper (II) hosted by the protonated cryptand discloses an unusual anaerobic route for phenol nitration. While phenol is not capable of reducing nitrate at copper (II) site, hydrazine reacts with copper (II)-nitrate complex to yield NO.

In parallel to the recognition of new NO releasing pathways, this talk will brieflydemonstrate the mechanism of H_2S releasing pathway from CS_2 / COS through the hydrolase activity of a dinuclear zinc (II)-aqua complex. These findings offer a new possible H_2S generating route from CS_2/ COS metabolism mediated by dinuclear hydrolase enzymes.

Keywords: Bioinorganic chemistry • Nitrogen-oxides •PCET •Second-coordination sphere•Hydrogen sulfide

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OP-3

Bioinspired Models of the [FeFe] Hydrogenase Enzyme Using 2-Mercaptobenzimidazole Ligand: Synthesis and electrocatalytic Proton Reduction

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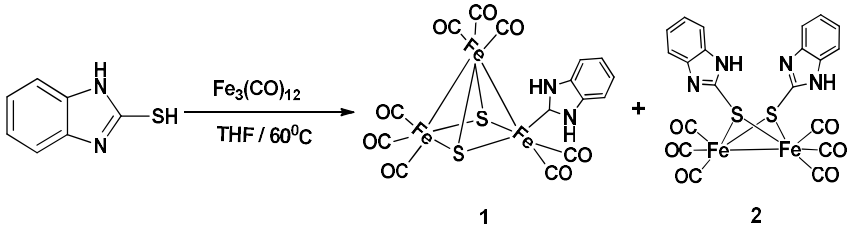
Nucleophilic N-heterocyclic carbene ligands (NHCs) are an important class of ligands as they are bulkier and more basic than the ubiquitous phosphines. In order to investigate electrocatalysis for complexes with NHCs, two new iron sulphur complexes,triiron carbonyl cluster $[Fe_3(C_7H_6N_2)(\mu_3\text{-}S)_2(CO)_8]$ **1** and diiron complex $[Fe_2(\mu\text{-}2\text{-mercaptobenzimidazole})_2(CO)_6]$**2** were synthesized. Both the complexes were obtained from the reaction between $Fe_3(CO)_{12}$ and 2-mercaptobenzimidazole. Complex **1** was the major product of the reaction while complex **2** was produced in only minor quantity. The complexes were characterized by various spectroscopic techniques, elemental analysis and mass spectrometry.[1-3] In the triiron carbonyl cluster $[Fe_3(C_7H_6N_2)(\mu_3\text{-}S)_2(CO)_8]$ **1**, the carbene ligand is attached to one of the metal centers, as is also observed from the X-ray structure analysis.Electrochemical studies were also performed on the complexes in the absence and presence of acids. Based on cyclic voltammetric measurements, complex **1** was found to catalyze the reduction of trifluoroacetic acid to produce hydrogen at -1.73 V vs. Fc/Fc^+.[4-8]



Keywords: Electrocatalysis, [FeFe] hydrogenases, Hydrogen, N-based thiolate linkers, organometallic complexes

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OP-4

Nontransition Metal Complexes Of Azoheterocycles: Structures And Photochromic Behaviour

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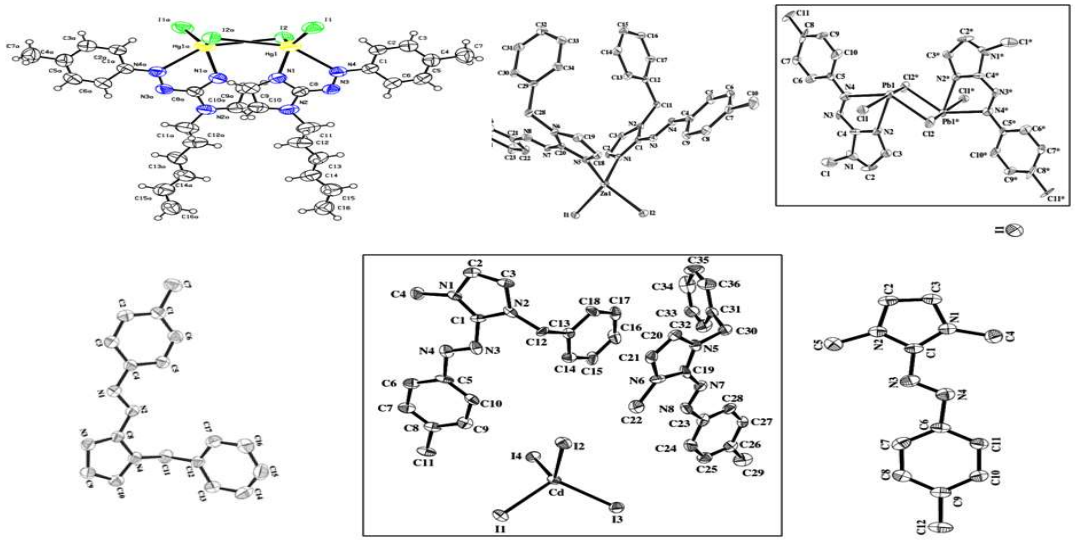
Synthesis and characterisation of some nontransition metal compounds of 1-alkyl-2-(arylazo)imidazoles and 1,3-dialkyl-2-(arylazo)imidazolium ions will be presented. Photochromism of arylazoimidazoles will be discused. The coordination chemistry of Zn(II), Cd(II), Hg(II), Pb(II) and Bi(III) with 1-alkyl-2-(arylazo) imidazoles will be presented along with their photochromic properties in some cases. The complexes are characterized by spectral studies (IR, UV-Vis and ^{1}H NMR) and the structural confirmation has been carried out in representative cases by single crystal X-ray diffraction studies. The electronic properties and photochromic efficiency of the compounds will be explained on the basis of DFT and TD-DFT calculations in some cases.



OP-5

A greener Approach: Oxidation of Fatty Aldehyde In Aqueous Medium

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Oxidation of long chain aldehydes is truly tough in aqueous medium. So, an attempt has been made to oxidise octanal, a fatty aldehyde, by Cr(VI) in acidic aqueous media with the assistance of surfactants. The detailed kinetics of this successful micellar oxidation reaction has been studied spectrophotometrically under pseudo1st order condition at 25°C (± 0.1°C). In promoting the oxidation reaction three hetero-aromatic bases i.e. 1, 10 – phenanthroline (Phen), 2-picolonic acid (PA) and 2, 2' – bipyridine (Bpy) have been used in combination with the surfactants. Mixture of SDS and Bpy has come out to be the most effective among the others to enhance the oxidation rate maximum. Necessary spectral analysis and thermodynamic facts have also been produced in support of the whole process.

OP-6

Amorphous Zeolites for CO_2 to Fuel and Plastic to Chemical Transformation

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In this work, we report the synthesis and application of a new class of material, called "Amorphous Zeolites (AmZe)"[1], which possesses Brønsted acidic sites like in zeolites and textural properties like ASAs. This was achieved by controlling the hydrolysis and condensation reaction kinetics between silica (tetraethyl orthosilicate) [2,3] and alumina (aluminum acetylacetonate) precursors in a bicontinuous microemulsion template [4-7]. The synergy between strong acidity and accessibility was reflected in the fact that AmZe catalyzed eight different catalytic processes (styrene oxide ring-opening, vesidryl synthesis, Friedel−Crafts alkylation, jasminaldehyde synthesis, m-xylene isomerization and cumene cracking) which all require strong acidic sites and larger pore sizes, with better performance than state-of-the-art zeolites and amorphous aluminosilicates (Figure 1). Notably, AmZe efficiently converted a range of waste plastics to hydrocarbons at significantly lower temperatures. A Cu-Zn-Al/AmZe hybrid showed excellent performance for CO_2 to fuel conversion with 79% selectivity for dimethyl ether. Performance of AmZe for plastic degradation and CO_2 conversion was found to be superior to conventional zeolites. The catalytic activity and selectivity of AmZe was then investigated by conventional and DNP- enhanced solid-state NMR to provide molecular-level understanding of the distinctive Brønsted acidic sites of these materials. Due to their unique combination of strong acidity and accessibility, AmZe will be a potential alternative to hierarchical zeolites.

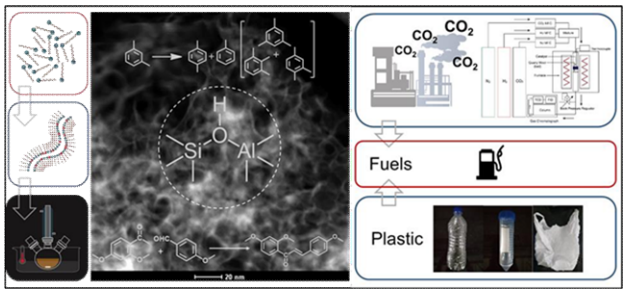

Figure 1. Synthetic Scheme and application of Amorphous Zeolites (AmZe) in CO2 to fuel and plastic to chemical conversion.

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OP-7

Easily Extraction of Arsenical Ferrihydrite from Water at Varied pH By Zinc Acetate and Consequent of Mineralization

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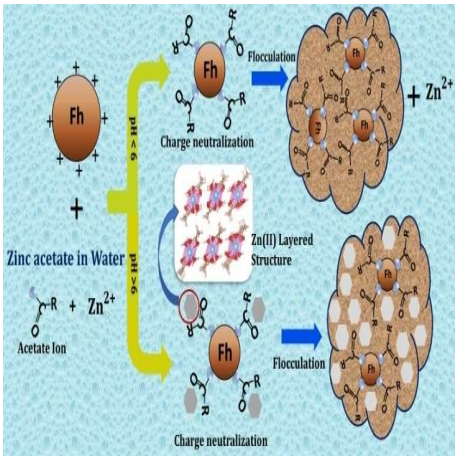
Natural iron oxyhydroxide nanoclusters in water, broadly named as ferrihydrite (Fh), has a serious role in water remediation as Fh is known to form inner sphere complexes with many inorganic contaminants, thereby acting as an efficient adsorbent of Arsenic and heavy metals. However, difficulty lies in extracting such clusters from water at low concentrations and varied ranges of pH other than the pH of their respective point-of-zero-charge (PZC) because repulsive forces between their charged surfaces keep the clusters as stable colloidal suspension. Therefore, the only possible methods of removal seem to be microfiltration or sweep flocculation creating large amount of unstable toxic sludge. Here we show that, it is indeed possible to extract these 'soluble' nanoclusters out of water by charge neutralization, if effective coagulants of opposite surface charges are applied. This is achieved here by simply adding a limited amount of commercial zinc acetate salt. Ferrihydrite is a crucial sequester of arsenic, but leaching of arsenic (As^{3+}, As^{5+}) is one of the fatal drawbacks of Fh.The present study tries to explore an alternative pathway for formation of tooeleite-like mineral staring from arsenical ferrihydrite, which is the only known mineral containing Fe(III) and As(III) and can ensure safe disposal of As(III).



OP-8

Pore-Functionalized and Ultralight Charged MOF with Color Tunable Emission for Anticounterfeiting Applications *via* Specific Tb^{3+} Sensitization

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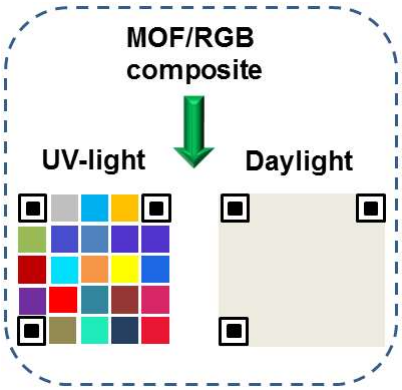
Counterfeiting is a long standingglobal problem that poses threats to the safeguard of individuals' data and creates huge negative impact on the development of global economy.[1] Among various anticounterfeiting protocols, fluorescent materials such as carbon dots, perovskite nanocrystals, and cadmium chalcogenide quantum dots are widely utilized owing to their high photoluminescence (PL) intensity/efficacy and tunableexcitation/emission wavelength. But,due to several disadvantages of these materials; [2] modern anticounterfeiting techniques demand fabrication of advanced composite material with tunable photoluminescence quantum yield, where lanthanide based luminescent materials are specifically important owing to their unparalleled spectroscopic attributes.[3] Such most anticipated composite system has been realized in an ultralight, anionic metal-organic framework (MOF)**CSMCRI-4**, constructed from Li^{+} ion and 4,4',4''-tricarboxytriphenylamine (H_3TCA) ligand.[4] Benefitting frompore-occluded dimethylammonium ions, the framework provides an opportunity to selectively exchange these cations with Tb^{3+} ions, which are stabilized inside the MOF cavity through binding with the free oxygen atoms at the inner surface of pore. Interestingly, Tb^{3+} is sensitized through antenna effect and modulates the pristine bright blue emission of the MOF to green. Such dichromatic emission modulation has been efficiently harnessed in developing anticounterfeiting label for potential anti-forgery applications over multiple platforms.



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OP-9

Facile Synthesis and Characterization of Heteroatom Doped Graphene Quantum Dots

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Doping of graphene quantum dots (GQDs) with heteroatom effectively alters its electronic and optical properties. Herein, we report a facile bottom up method for synthesis of boron doped GQDs (BGQDs) and nitrogen, sulphur co doped GQDs (NS-GQDs). The characterization was done by UV-vis, fluorescence and FTIR spectroscopic techniques. The stable fluorescence of heteroatom doped GQDs indicates that they can be used as biosensor for clinical and medical studies, as imaging and sensing. FTIR spectra confirm the presence of different functional groups and effective doping onto the surface of GQDs. The effect of pH has also been studied which indicates that particle size distribution increases with increasing of pH.

OP-10

Hetero Bimetallic Anion Radical Complexes of Azobispyridine

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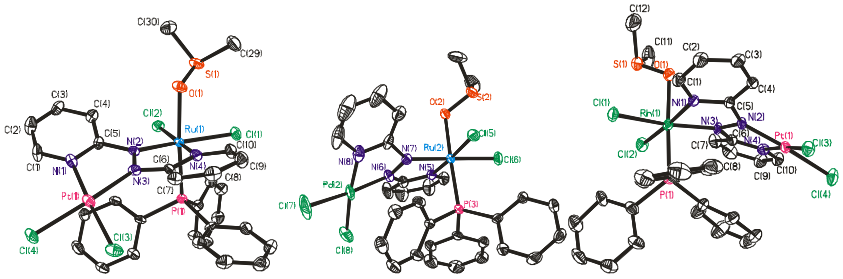
Coordination induced spin state conversion from the $^3O_2$ to $^1O_2$ and the electron transfer from the metal ion to $^1O_2$ are significant phenomena in the bioactivity of the O_2 molecule. Upon coordination, O_2 molecule is transformed to superoxide in hemoglobin and myoglobin, to peroxide in hemocyanine and p-450, to hydroperoxide in hemerythrin. Thus, the coordination induced electron transfer from the metal ion to the coordinated molecule is a subject of investigation in chemistry. $^3O_2$ molecule is a weaker ligand due to its stabilized σ orbitals and occupied π* orbitals and exhibits poor synergistic effect. Formation and stabilization of azo anion and diimine anion radicals in the complexes of transition metal ions were documented in literature. In this report, the coordination induced electron transfer from a t_{2g} level of ruthenium(II) and rhodium (II) ion to -N=N- fragment, when both the N atoms coordinate the metal ions. Bimetallic complex of Ru-Pd, Ru-Pt and Rh-Pt are most important in the synthetic and chemical point of view. These hetero bimetallic complexes show the lower region band due to metal to metal (intravalent charge transfer) transition band.



Ru-Pt **Ru-Pd** **Rh-Pt**

OP-11

A Smarter Approach towards Environmental Remediation: Strategic Construction of Functionalized MOFs for CO_2Scavenging and Ultra-Sensitive Detection of Multifarious Aqueous Pollutants

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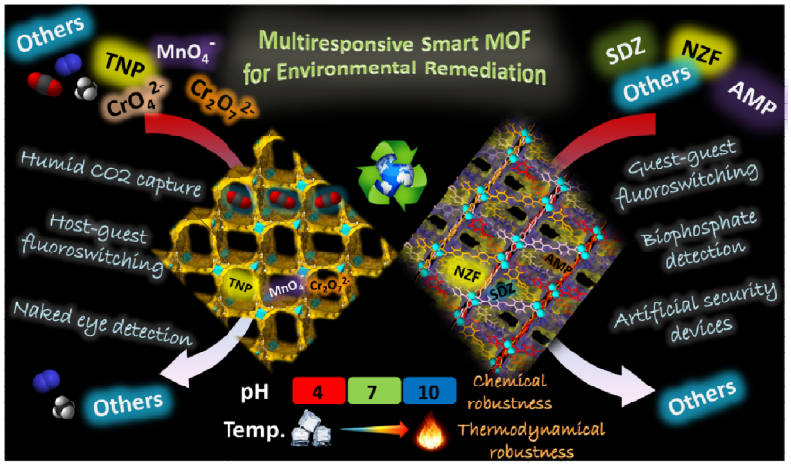
Metal–organic frameworks (MOFs) show distinctive superiority for carbon dioxide (CO_2) capture and luminescent sensing of toxic pollutants over other materials, where combination of both of these properties together with improvement of hydrolytic stability and pore functionality is critical to environmental remediation applications.[1,2] In view of these facts we strategically synthesized the dual functionalized MOF,**CSMCRI-2** thatfeatures unique analyte-responsive turn "on–off–on" fluorescent switching towards toxic sulfadiazine (SDZ) and nitrofurazone (NZF) antibiotics[3] with nano-molar limit of detection (LOD). This MOF further shows exceptional "turn-on" detection of adenosine monophosphate (AMP) (~14 fold) in concurrent presence of interfering biophosphates, with 10 nM LOD. Importance of pillar functionalization in such unique fluorescence alteration is explicitly validated by density functional theory (DFT) calculations that provide proof-of-concept to the sensing mechanism.Alternatively,the cationic and chemically robust Ni(II)–organic framework (**CSMCRI-3**), with nitrogen rich pore surface benefits moisture tolerant CO_2 capture with exceptional selectivity over other gases (CO_2/N_2 :292.5) alongside remarkable muticyclic usability. Owing to the hydrolytic stability, this mixed-linker MOF exhibits ultra-low detection of nitro-explosive (Picric acid) and toxic oxo-anions (chromate, dichromate and manganate) in water with sharp colorimetric changes in highly selective and regenerative manner.[4]



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OP-12

Enhanced Stability of Curcumin in Presence of Cu^{2+} ion : A HPLC Study and Its Biological Attributes on Bacterial Strains

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In an attempt to overcome limitations of Curcumin in biology and medicine, a monomeric complex of $Cu^{II}[(Cur)(OCOCH_3)(H_2O)]$ was prepared. Using HPLC, it could be realized, under physiological conditions Curcumin is not a "single-unit" either in aqueous solution or in cellular medium. Hence, to understand things better it became essential to identify fragments actually responsible for the reported efficacy of Curcumin (or to have it in solution as a "single-unit". Hence, to prevent Curcumin from degrading (verified by HPLC) before it interacts with a biological target and to improve bio-availability a complex of it with Cu(II) was attempted. Metal bound Curcumin remains a "single-unit". Besides, presence of a metal ion might assist in cellular uptake or address issues related to solubility. Antibacterial efficacy of Curcumin and its Cu(II) complex were explored against clinically significant bacterial strains *Staphylococcus aureus* and *Escherichia coli*. Cu(II) complex was more effective than Curcumin that may be considered an attribute of complex formation The complex being membrane targeting was able to permeabilize the cytoplasmic membrane of *Staphylococcus aureus* that makes it a better bactericidal agent than curcumin. Toxicity studies revealed Cu(Cur) had very little side effects on mammalian cells making it relatively safe as an antimicrobial agent for the host. The study is also an effort to realize the increased stability and efficacy of a non-toxic Cu(Cur) on *Staphylococcus aureus* over that of Curcumin.

OP-13

Preparation of Metal Complexes with Picramic Acid

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There are various of metal complexes form various ligands which have been known since long time and synthesis and their and their application of new ligand are always being tried in order to prepare varieties of complexes. In this way, picramic acid, ($C_6H_5N_3O_5$) which is 2-Amino-4-6- dinitrophenol has been prepared in this laboratory and its complexes with copper (II), mercury(II) and $UO2^{2+}$ has been prepared. The characterization of these complexes has been done in terms of elemental analysis, IR and UV-Spectra and melting points. Dehydrated $CuCl_2$ was treated with alcoholic solution of picramic acid and the solution of picramic acid and the solution was refluxed to give deep blue crystal (mpt.=135°c). Alcoholic solution of picramic acid was treated with dry uranyl nitrate then deep blue crystal were obtained (mpt.=162°c). Deep brown crystals were obtained when mercury chloride was refluxed with alcoholic solution of picramic acid (mpt.=158°c).

OP-14

Synthesis, Characterization And Antimicrobial Studies Of Co (II) Complexes Of Bidentate Schiff Base Ligand 2-(Benzylideneamino) Pyrimidine-4, 6-Diol

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The transition metal complexes of Co (II) were prepared from bidentate Schiff base. The Schiff base ligand synthesized from the condensation of Benzaldehyde and 2- amino-4, 6- dihydroxypyrimidine (L) in alcohol medium. The metal complex was characterized on the basis of their micro analytical data, molar conductance, magnetic susceptibility, IR, UV-Vis, ^{1}H NMR, X-ray diffraction, thermogravimetric analysis. The ligand and their metal complexes were screened for fungicidal activity against various fungi like Aspergillusniger, Penicilliumchrysogenum, Fusariummoneliforme and Aspergllusflavus.and antibacterial activity against various bacteria likes Escherichia coli, Salmonellatyphi, Staphylococcus aurious, B.subtilis. The result indicated that the complexes exhibited good antifungal and antibacterial activities.

Keywords: Schiff bases, Transition metal complexes, Thermal analysis, Powder X-ray diffraction, Antimicrobial activity.

OP-15

PdSn Hollow Alloy Nanostructure Prepared by Low Cost Hydrothermal Approach and Auto Galvanic Replacement Process for Robust Electrocatalysis Towards Hydrogen Evolution Reaction

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Nanostructured hollow PdSn alloy system introduced as highly efficient electrocatalyst for hydrogen generation using electrocatalytic water splitting reaction. Hollow $Pd_{1-x}Sn_x$ (x=0.0–1.0) alloy with different composition having large electrochemically active surface area for producing hydrogen in 1M H_2SO_4 electrolyte solution. Due to different redox potentials of Pd and Sn and in-situ galvanic replacement process hollow PdSn alloy nanoparticles generated. The as-synthesized alloy nanoparticles have fcc crystal structure exposed with {111} facets. Among various compositions $Pd_{0.6}Sn_{0.4}$ exhibits excellent catalytic activity towards hydrogen evolution reaction to reach an overpotential of 68 mV to attain current density of 10 mA cm^{-2}. A lower Tafel slope (58 mV/dec) value with high exchange current density (114.63 mA cm^{-2}) for rapid electron migration observed during electrocatalytic study of $Pd_{0.6}Sn_{0.4}$ sample. The catalyst also showed long term cycling stability without any deviation for 6000 cycles and durability for maximum 48 h at high constant current density (100 mA cm^{-2}) which depicts its robust electrocatalysis.

Keywords: PdSn alloy; hollow nanoparticles; galvanic replacement; hydrogen evolution reaction; water splitting.

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OP-16

Kinetic study of the photo degradation of Azo dye in photo-ferrioxalate system

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An attempt has been made to study the kinetic of the photochemical degradation of commercial azo dye, acid orange 7. Waste water coming from different industrial fields contains azo dye as industrial effluent and they are resistant to common waste water treatments. Photo chemical degradation of those azo dyes, therefore, may an effort to reduce the damaging impact of them In this work, photocatalysis of $Fe(ox)_3$ in the presence of H_2O_2 and sun light has been studied[1]. The kinetic study of the photo degradation of the dye is dependent on various parameters like pH of the solution, concentration of H_2O_2, molar ratio of ox/Fe(III) etc. The reaction kinetic is showed to pseudo first order and suitable at moderate acid pH value 3 - 4. The molar ratio of oxalate ion/ Fe(III) up to 3 is most favourable for the degradation reaction.

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OP-17

Anticancer, DNA/HSA Binding Ability of Three Cu (II) Complexes Having Three Piperidine Based Schiff Base Ligand: A Combine Package of Practical and Theoretical Study

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Here in we have reported the developed three Cu(II) complexes, Cu(L1)N_3(1), [Cu(L2)N_3]n(2), Cu_2(L3)2(N_3)2(3) incorporating three different piperidine based Schiff base ligand HL1, HL2, HL3 respectively and identified properly by using different spectroscopic method. The single crystal structure reveled that complex 1 is a mono nuclear squre plannar unit with azide as a secondary anionic residue, complex 2 has 1D polymeric structure where two Cu center is connected via azide bridge and complex 3 possess a binuclear distorted octahedral structure having two azide bridge. After rigorous characterization the three complexes are exploited to check their biomedical application and for this purpose initially their binding potentiality against DNA and HSA protein has been examined by adopting several spectroscopic techniques. Experimental results unveil the potentiality of three complexes to associate with DNA/HSA and this is properly justified by molecular docking study. In nest step the anticancer effect of these three complexes is inspected by using MTT assay technique and results show that three complexes has effective anticancer property with low toxicity to the normal cell.

PP-1

Poster Presentation

Effect of Photochemical [2+2] Cycloaddition Reaction of Coordination Polymers (CPs) For the Exploration of Potential Applications

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The exploration on metal and organic ligand composed coordination polymers (CPs) has been incipient at an astonishing pace from its existence. The promising applications and essential diversity in structure of these materials are the driving force behind the extensive research of such kind. Inorganic metal ions and organic ligands (carboxylate, sulphate etc.) or neutral donor molecules (N, S donor's based pyridyl and thiophen etc.) are contented to formulate these polymeric coordination compounds. This is the leading accessories to the advancement of solid-state coordination chemistry which is termed as 'crystal engineering' presented by Schmidt. Although, this terminology has been used in regard to the solid-state photochemical [2+2] cycloaddition reaction, for first time. Subsequently, this [2+2] cycloaddition reactions have been unveiled with in the CP systems and resulting structural transformation promotes different potential applications: gas sorption, magnetism , sensing , dielectric property ,isolation of new organic ligand ,electrical conductivity, photo salient effect ,flexibility and elasticity of materials. Therefore, herewe are searching out the contribution of [2+2] cycloaddition reaction of CPs for the impact of different applications.

PP-2

Two New Copper Based MOFs and Their Magnetic Properties

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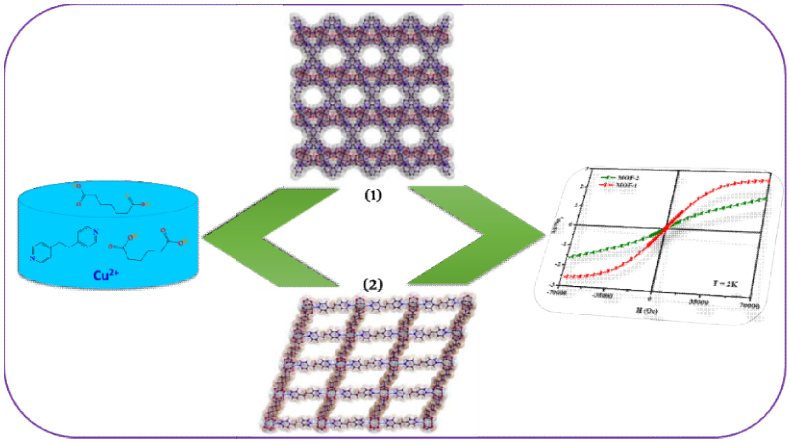
The area of research in the progress of porous metal-organic frameworks has attracted much attention due to their potential applications in field of catalysis, luminescence, drug delivery, separation, gas storage, and many more.[1] Although, the preparation of metal-organic frameworks depends upon the nature of organic linkers as well as the metal ions.[2] Over the past decades, the metal-organic frameworks having Cu (II) metal ions and flexible ligands have been interesting due to the possibility of antiferromagnetic coupling of metal centers.[3] Therefore, two new copper metal organic frameworks having 1,2-bis(4-pyridyl)ethane, Adipic and Pimelic acids have been synthesized and structurally characterized. MOFs 1 and 2 exhibit three-dimensional and two-dimensional networks, respectively. The magnetic properties of 1–2 have also been investigated, and displayed the antiferromagnetic coupling between the Cu(II) metal centres.[4]



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PP-3

Recent Trends in Chemical Sciences

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A number of broader social trends are shaping the research in chemical science such as ageing population leading to growth in demand of medicine to prevent, control and treat age-related conditions. Such research and development will be key to the future of chemistry. The chemical sciences have the potential to solve many of the world's greatest challenges in health, energy and climate-changes.

At present diabetes at global level, especially in India, is in alarming situation and posechallenges for chemists to prevent and cure this health problem.

In this regard Schiff base of metformin and their metal complexes will be very useful to help prevent type-2 diabetes. This paper presents finding on Schiff base of the metformin benzothiozol derivatives and their metal complexes which are very effective in anti-diabetic activity and shows decrease in glucose level to significant extent at different interval of time. Metformin complexes with cobalt has maximum potency to reduce blood glucose in hyper-condition. First of all, Schiff base legand of MTF with benzothiozol was prepared by mixing aquous solution of MTF and benzothiozol, then complex of Co(II) was prepared. This complex was analyzed with the help of IR, NMR, etc. Biological activity of Schiff base and their complexes were tested as anti-diabetes which proved to be effective against diabetes.

PP-4

Ancillary Ligands Effect on Emission Behavior of Iridium(III) Complexes

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Iridium(III) complexes with phenyl pyridine based ligands are usually be emissive in solution and solid states. The complexes were designed with two phenyl pyridines and an ancillary ligand. The ligands coordination around iridium(III) centerprovide an octahedral geometry as well as suitable HOMO-LUMO separation for luminescence behavior. The phenyl pyridine based ligands make the decisive energy gap, whereas the third ligands further tune the emissioncolour. A series of Iridium (III) complexes were synthesized with phenyl pyridine (ppy), difluoro substituted phenyl pyridine (F2ppy), pyridine aldoxime (pyrald), and Shciff base (sb) ligands of formula $[Ir(ppy)_2(pyald)]$, $[Ir(ppy)_2(sb)]$, $[Ir(F2ppy)_2(pyald)]$, and $[Ir(F2ppy)_2(sb)]$. The luminescence studies of these complexes revealed that $[Ir(ppy)_2(pyald)]$ and $[Ir(ppy)_2(sb)]$ were non-emissive, whereas $[Ir(F2ppy)_2(pyald)]$ and $[Ir(F2ppy)_2(sb)]$ were found emissive. Theobservation was reasoned that fluoro substituted ligands provides the suitable energy gap to the observed emissive light. The complexes were weakly emissive which could be due the effect of coordinating third ligand which might have enhanced the non radiative decay processes. The higher HOMO-LUMO energy separation revealed through theoretical calculations could be another reason in support of the non-emissive behavior of the Schiff base complexes.All the new complexes were thoroughly characterized by different analytical and spectroscopic methods. The molecular structures were confirmed using single crystal X-ray structure determination method.

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PP-5

Phosphate-Diester Molecular Templates for the Encapsulation of Water Dimer

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The study of water clusters in a confined state has received considerable attention.[1] The simplest among such assemblies of water molecules is the water dimer. Distinct water dimers were characterized via a matrix isolation method[2] and as an endohedral motif in C70,[3] as well as in the interiors of cage-like structures of some organic compounds.[4] Stabilizing this unit at ambient conditions in an appropriate host-template, however, has remained a challenge. Herein, we report 2,6-(diphenylmethyl)-4-iso-propyl-phenyl substituted phosphate diesters (both in their neutral and anionic forms) as molecular templates for hosting the water dimer.[5]

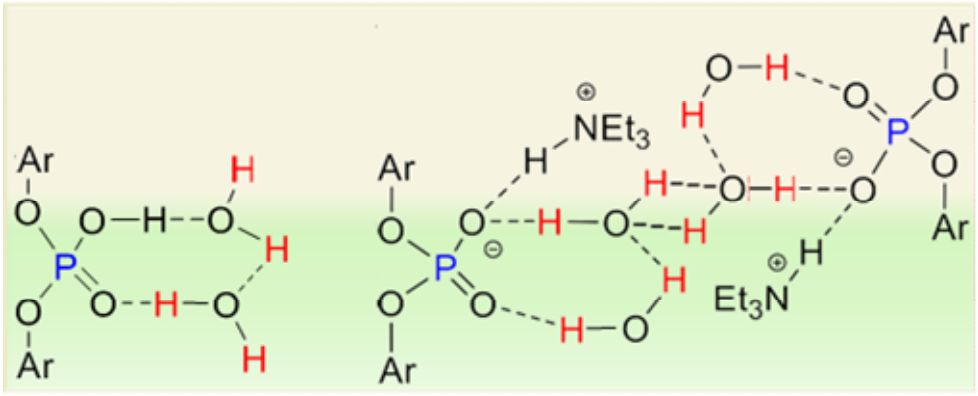

Figure 1. Phosphate diesters as molecular templates for hosting the water dimer

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PP-6

Reversible Sensing Execution of A Rhodamine Based Diad ff\or The Recognition of Al^{3+} and HF_2^- with Live Cell Imaging and INHIBIT Logic Gate

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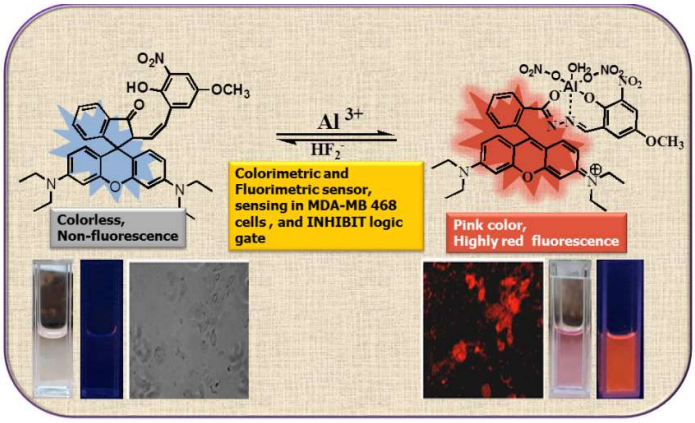
A new fluorophore Rhodamine B with 2-Hydroxy-5-methoxy-3-nitrobenzaldehyde Schiff base dyad (**HSR)** isdesigned and its optical behavior toward various metal ions has been examined in MeCN–H_2O (1:1, v/v; HEPES buffer, pH, 7.4) solution by both UV-vis absorption and fluorescent techniques. The **HSR** achieves tuning the high sensitivity, and selectivity to Al^{3+} ions in the spectroscopic studies via chelation-enhanced fluorescence (CHEF)), while other metal ions including Na^+, K^+, Mg^{2+}, Ca^{2+}, Ba^{2+}, Cr^{3+}, Mn^{2+}, $Fe^{2+/+3}$, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+},Cd^{2+}, Pb^{2+},Tb^{3+}, Gd^{3+}, Sm^{3+}, Ag^+, Hg^{2+}, Sn^{4+}, Pd^{+2}, Pt^{2+}, Rh^{3+}, Ru^{3+} ions induced commonly no spectral change. The evidence of possible sensing mechanism has been done by FT-IR, Mass spectra, ^1H NMR titration, Benesi-Hildebrand plot, Job's plot, and DFT technique. Upon interaction withHF_2^- ions, the fluorescent signal intensity of resultant $[SR–Al]^{2+}$ complex quenches (weakly quenching by F^- and PO_4^{3}). This constitutes a reversible sensor for Al^{3+} ions HF_2^- ions, respectively.The limit of detection for Al^{+3} and HF_2^- are 19.4 nM and 65.6 nM respectively. The **HSR** has certain practical applicability such as the construction of the logic gate (**INHIBIT)** and to detect Al^{3+} ions in intracellular Human breast.



PP-7

Synthesis and Characterization of Aromatic CNS Palladium Comlexes

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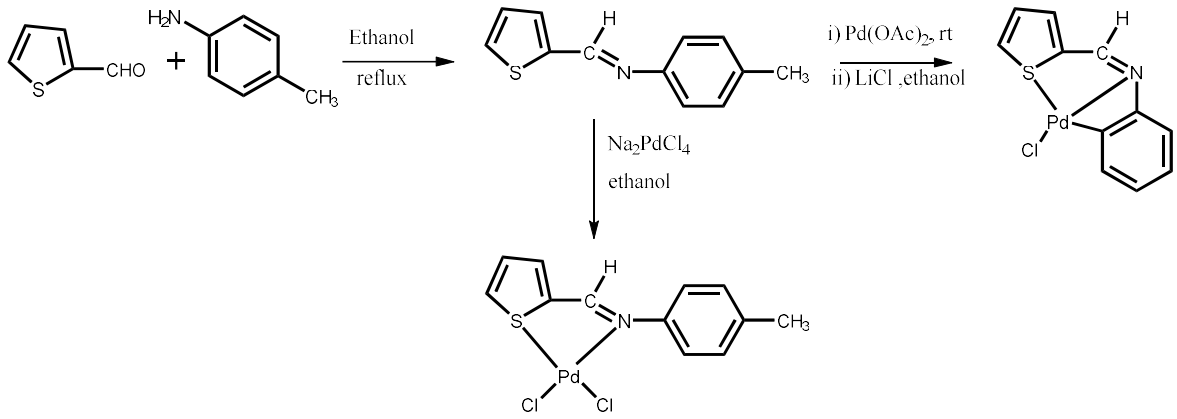
A series of unsymmetrical CNS Pincer Pd(II) complexes with ligands were synthesized via the C-H activation or oxidation addition method. The CNS ligand were prepared from commercially available 2-Carboxyl-Thiophen are treatment with p-Toluidine in dry ethanolsolvent allow to reflux at 78 ^{0}C afforded (E)-1- (thiphen-2-yl)-N-(p-tolyl)methanimide in very good yield. The treatment of (E)-1- (thiphen-2-yl)-N-(p-tolyl)methanimide with $Pd(OAc)_2$ in dry ethanol at room temperature followed by addition of LiCl ,gave the Pd(II) Pincer complexes via direct aryl C-H activation.

Keyward: p-Toluidine ,2-Carboxyl Thiophene, Dry ethanol ,C-H Activation ,Palladium acetate



PP-8

Development of bis(trimethylsilylemethylene)Tellurium Diiodide

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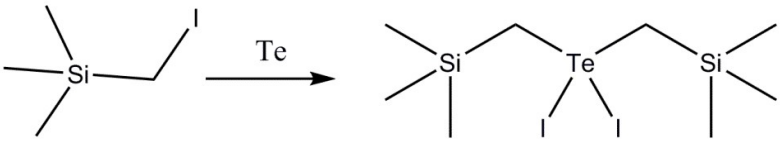
Available routes to organotellurium(IV) derivatives are oxidative addition reactions, electrophilic substitution reactions, and insertion reactions of elemental tellurium across the carbon–halogen bonds [1]. First time we are able to isolate, bis(trimethylsilanemethyl)tellurium(IV) diiodide, $(Me_3SiCH_2)_2TeI_2$ in good yield at high temperature. Activation of the C-I bond by trimethylsilane group appears to be insufficient as the reaction takes place only at high temperatures.

Keywords: Silyl, Iodided, Insertion, Tellurium, Room Temperature



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Biocompatible Porous Ceramics Based on Black Colored Calcium Phosphate Powders

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Porous resorbable ceramic materials based on calcium phosphates is necessary to treat the bone defects of critical size using advancedmethods of regenerative medicine.

Porous materials with a given geometry of the pore space were made using three-dimensional stereolithographic printing from a suspension of black colored inorganic (calcium phosphate) fine powder in a mixture of monomers, polymerization of which occurs under the influence of ultraviolet radiation. Powders were preparing from calcium salts of carboxylic acids and ammonium hydrophosphate followed by thermal treatment at 500-900^{o}C.

Fig. 1. Macroporous material before firing, which is a composite of "polymer/black colored calcium phosphate powder " (left) and macroporous calcium phosphate ceramic material after firing (right). The length of the sample before firing was 11.6 mm, and after firing – 6.1 mm.

The use of the black-colored calcium phosphate powders gives an opportunity to enhance the lateral resolution of stereo-lithographic printing.

RFBR supported this study under Grant No. 18-29-11079.

PP-10

Removal Of Cadmium From Water By Adsorption On Newly Synthesised Adsorbent Chitosan Impregnated With Carbon Nanoparticle

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Carbon nanoparticle Impregnated chitosan beads synthesized by using honey (green method) was investigated for uptake capacity of cadmium in batch studies. The concentrations of cadmium were measured using ICP-OES with constant adsorbent dosage 0.1g/100ml. As the initial concentration of cadmium is increasing the adsorption capacity is increasing at constant adsorbent dosage. Highest adsorbent capacity was found to be 76.77(24.62 mg/0.1g) when the initial concentration is 200ppm. Highest adsorption percentage removal of cadmium was observed 87.28% when the initial concentration is 200ppm. As the concentration increases there is no significant increase of adsorption percentage was observed, this may be saturation of 0.1g of adsorbent. The effects of various factors such as adsorbent dose, pH, contact time, cadmium concentration are under investigating.

Keyword: Chitosan, adsorption, carbon nanoparticle

PP-11

Biological,Photophysical and Catalytic Activitiesof Group 6 and Group 8 Metal Carbonyl Complexes Containing Coumarinyl azo/imine Ligand

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Group 6 and Group 8 metal carbonyl complexes containing coumarinylazo and imine ligand are very rich category of complexes having numerous activities. Group 6 metal carbonyl complexes of N-[(2-Pyridyl)methyliden]-6-coumarin (L) show anti-oxidant property and solvatochromism. These complexes possess very good antioxidant activity both in cell free system and in-vitro. $[W(CO)_4(L)]$ exhibits the strongest free radical scavenging activity compared to $[Cr(CO)_4(L)]$and $[Mo(CO)_4(L)]$. On the other hand Os(II) hydridocarbonyl complexes of coumarinylazoimidazoles are photostable and show photovoltaic power conversion efficiency. In addition, theses complexes were used as catalysts for the oxidation of primary/secondary alcohols to aldehydes/ketones using oxidizing agents like N-methylmorpholine N-oxide, t-BuOOH and H_2O_2.

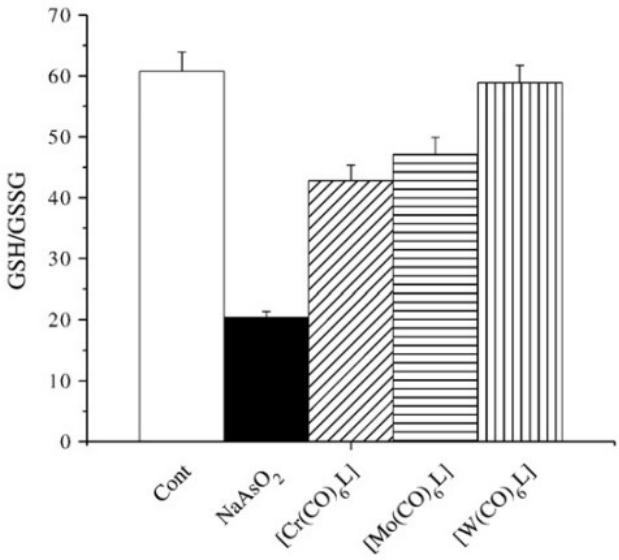

Fig. Effect of the metal carbonylson the reduction inGSH/ GSSGL

L= N-[(2-Pyridyl)methyliden]-6-coumarin

Organic and Biochemistry Section

Award Presentation

AO-1

Award Oral

Band Gap Engineering And Gas Adsorption in 2,4,6 tri(thiophen-2-yl)-1,3,5-triazine Conjugated Porous Polymers Of Tunable Porosities

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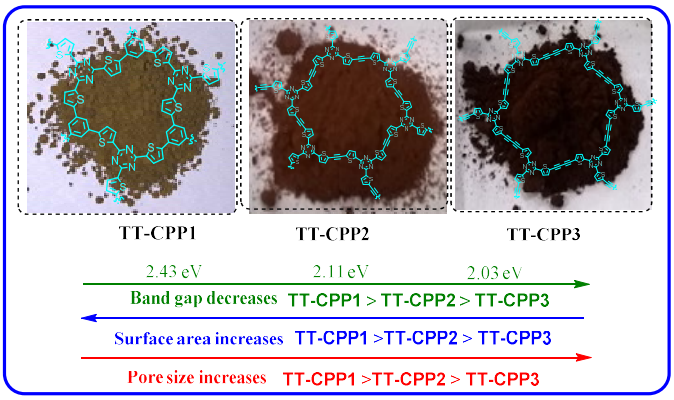
A series of four thiophene and nitrogen containing conjugated porous polymers with the same monomer but with optical band gaps ranging from 2.03 to 2.43 eV is synthesized using the conventional alkyne cyclotrimerisation reaction for **TT-CPP1**, Sonogashira coupling reaction for **TT-CPP2**, Glaser coupling reaction for **TT-CPP3** and Stille coupling reaction for **TT-CPP4**. By varying the spacer between the monomer, the porosity as well as the band gap have been engineered efficiently. The presence of triazine and thiophene moieties within the copolymer network increases the electron donating basic N and S sites in the porous frameworks. Thus, these porous polymers displayed efficient adsorption of Lewis acidic CO_2 molecules. The maximum CO_2 uptake of 11.4wt% (2.6 mmol g^{-1}) at 273 K under 100 kPa pressure has been observed for **TT-CPP1**. The structure–property relationship established in these thienyl triazine based narrow band-gap conjugated porous polymers will be important for rational material design towards applications in organic electronics, gas adsorption and water splitting.



Design and Characterization of Quinoline-3-Carboxamides as Selective Inhibitors of ATM Kinase for Cancer Therapeutics

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Kinases of the DNA Damage and Repair (DDR) pathway play a pivotal role in maintaining the integrity of our genetic material. As most of the cancer chemotherapeutics and radiotherapy destroy cancer cells by causing DNA damage, the hyperactivity of these kinases causes resistance to such treatments. Therefore, it is essential to target them for effective treatment of cancer. We aimed to target the key mediator of the DDR pathway, the ATM kinase, which is responsible for DNA double-strand break (DSB) repair. On inhibiting its kinase activity, DSB repair process is hindered, leading to the accumulation of DNA DSBs, and finally, cell death.We designed quinoline-based inhibitors for ATM based on the evidence that the quinoline nitrogen binds to the hinge region of PI3K-γ (close homolog of ATM). Cytotoxicity studies for the synthesized compounds were performed incancer cell lines and HEK293T. Three of the synthesized compounds showed significant cytotoxicity against the cancer cell lines. Western Blotting analysis indicated the inhibition of ATM kinase. The docking score for the compounds in ATM was in the range of -9 to -10.5. The compounds were also docked with other similar kinases, but the dock scores were not significant compared to that of ATM.

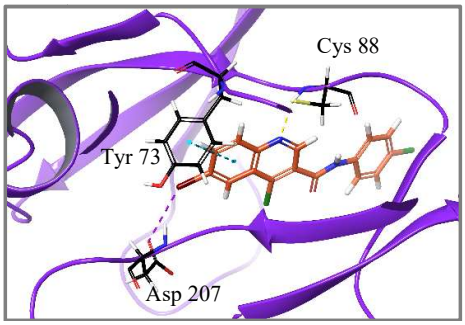

Figure 1. Compound 6f docked with ATM kinase

AO-3

Phosphine Free Manganese Pincer Complexes: Catalyst Development and Utilization in C-C and C-N coupling Reactions Employing Borrowing Hydrogen Strategy

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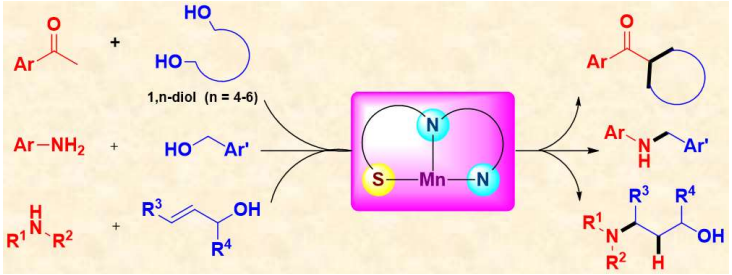
The development of methodology prioritizes the sustainable synthesis of complex organic molecules in a greener and atom economical way. In this regard, the organometallic complexes are fruitful in the way it can catalyze the synthesis of high value-added chemical feedstocks. In the recent past, indeed, noble metal based complexes have shown significant progress in this field. But due to the low availability and high cost of noble metal complexes, homogeneous catalysis needed a savior. In this regard, the Earth's abundant first-row transition metal complexes of Cu, Fe, Co, Ni have shown comparable reactivity as those of noble metals. Manganese being the third most abundant transition metal in the Earth's crust is a crucial substituent than its higher congeners. In past four years, significant advancement has been achieved in the field of hydrogenation, dehydrogenation, and hydrogen autotransfer reaction employing manganese pincer complexes. Based on the previous developments, we presently focus on synthesizing manganese pincer complexes from readily available and cheaper feedstock and their application in borrowing hydrogenation reactions. We have recently reported the SNN pincer manganese complexes for the stereoselective synthesis of (1+n) membered cycloalkanes from methyl ketones and 1,n-diols. Apart from the metal-ligand bifunctional behavior, the hemilability of the sulfur-containing sidearm is playing a crucial role in achieving the stereo-defined products. The catalysts developed also shown significant activity for the N-alkylation of aromatic amine derivatives and aza-Michael addition of amines to allylic alcohols. In most reactions, water is the sole byproduct paving the pathway to greener synthesis.



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AO-4

Amino Acid-Catalyzed Direct Synthesis of β-KetoSulfones via Aerobic Difunctionalization of Terminal Alkynes in an Aqueous Medium

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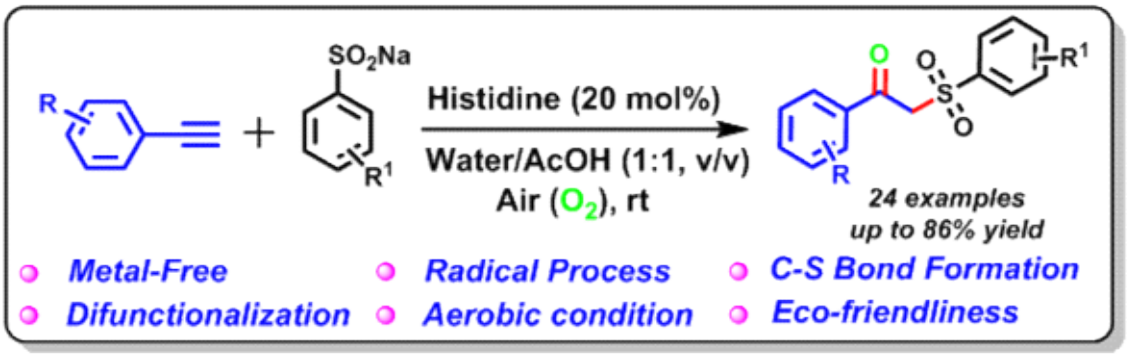
An efficient amino acid-catalyzed protocol for the synthesis of β-ketosulfones using terminal alkynes and arylsulfinic acid sodium salts under aerobic conditions in water/AcOH has been developed. This reaction involves an in situ generated vinyl radical intermediate and an atom transfer radical addition (ATRA) process via oxygen capture to form the desired products in good to excellent yields. This protocol is operationally simple and environmentally friendly and proceeds under very mild conditions.



Scheme: Amino acid-catalyzed direct synthesis of β-ketosulfonesviadifunctionalization of alkynes.

Keywords: Amino acid, Aerobic oxidation, Sulfones, Green approach, Metal-free.

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AO-5

Tuning the Chemoselectivity of Dehydroacetic acid Derived Enones Enabled by Isoniazid and Phenylhydrazines: An Undivulged Efficient Access to 3-Styryl Pyrano[2,3-*c*]pyrazolones

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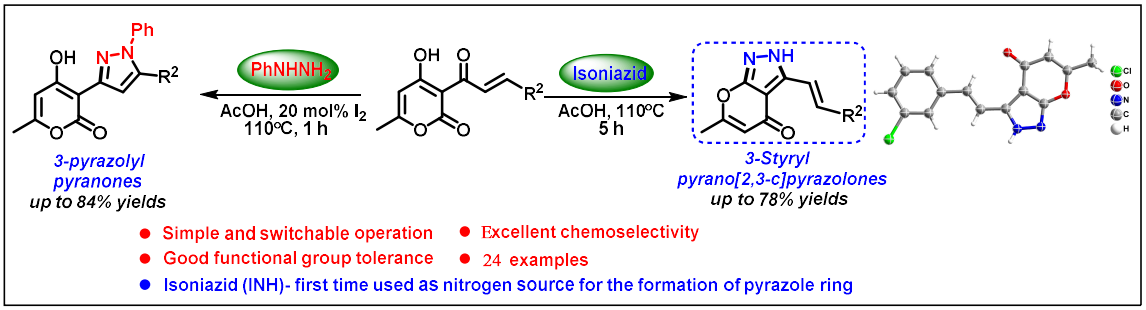
The first-time reported nitrogen source-based chemoselectivity of Dehydroacetic acid (DHA)-derived enones has been tuned by Isoniazid (INH), and phenylhydrazines respectively. When INH a first-line antitubercular drug, was employed as a new surrogate for nitrogen source, preferentially unconventional 1,3-dicarbonyl addition occurred, providing a series of fused 3-styryl pyrano [2,3-*c*] pyrazolones in good yields. While in the presence of phenylhydrazines and molecular iodine, the reaction was proceeded via oxidative annulation across enone framework, resulting in the efficient and straightforward access to 3-pyrazolyl pyranones.



Scheme: Strategy for the synthesis of pyrano[2,3-*c*] pyrazoles.

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AO-6

Base-promoted aza–Michael addition/intramolecular cascade cyclization betweenynones and 2–aminobenzonitriles: An assembly of multisubstituted 4–aminoquinolinederivatives

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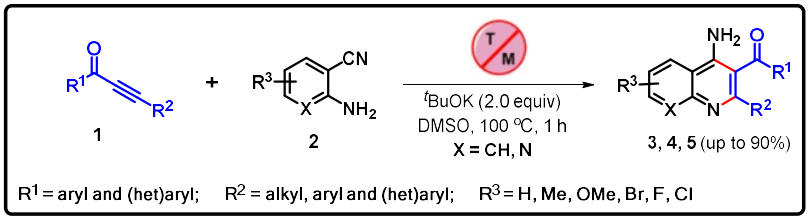
A Novel and efficient base–promoted one–pot reaction of ynones with 2–aminobezonitriles is described. The reaction initiated through sequential aza–Michael addition/intramolecular cascade cyclization to afford various multisubstituted 4–aminoquinolines and 4–amino[1,8]naphthyridines in good to excellent yields. Operational simplicity, high atom–economy with broad substrate scope makes this protocol more attractive. In addition, the gram–scale synthesis and further transformation of the product were studied. 2–Haloarylyones as substrate provide N–arylquinolones as sole product.



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AO-7

Synthesis, Characterization and Application of Chitosan-N-(4-hydroxyphenyl)-Methacrylamide Derivative for Drug Delivery System

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The aim of this study was to synthesizeda novel CS modified N-(4-hydroxyphenyl)-methacrylamide (CSNHMA) via aza Michael addition reaction between CS and N-(4-hydroxyphenyl)-methacrylamide (NHMA) in ethanoland to evaluate its biomedical potential. The synthesized conjugate was characterizedby FT-IR, ^{1}H-NMR, XRD and FE-SEM analysis. The FTIR spectrum of CSNHMA hybrid showed the presence of the new absorptionpeak at 929 cm^{-1} and 1422 cm^{-1} for the out of plane C–H bending and C-C stretching vibrations of aromatic ring present in NHMA, respectively and the ^{1}H-NMR spectrum of CSNHMA showed a new characteristic signalappears around 8 ppm corresponding to the protons of phenyl group present in NHMAconfirming the successful incorporation of the NHMA into CS framework. The FE-SEM images of CSNHMA showed a highly porous network. Consequently, it uses was analyzed as a drug delivery carrier. For in vitro drug release study, we prepared CSNHMA NPs and curcumin loaded CSNHMA NPs with small size (<300 nm) and (< 240 nm) respectively viaionic gelation route andthe encapsulation efficiency of drug was found to be 77%.In vitro release studies demonstrated a faster and sustained release of curcuminloaded CSNHMA NPs at a pH 5.0 compared to physiological pH. These findingshowed that CSNHMA NPs havethe advantage of sustained drug release, suggesting that CSNHMA NPs can be used as a carrier of anticancer drugs.

Keywords: Chitosan; N-(4-hydroxyphenyl)-methacrylamide; Michael addition; Drug delivery; Nanoparticles.

AO-8

The Simple and Efficient Synthesis of Fused Imino Pyrimido Pyrimidine Heterocycles

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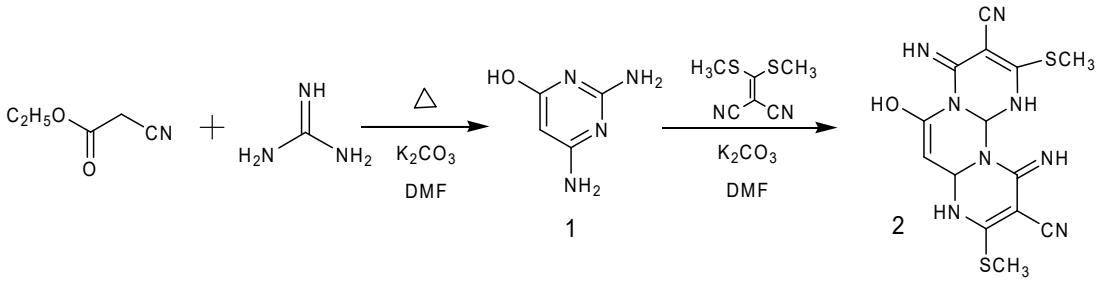
In the present communication a simple and efficient synthesis of iminopyrimido pyrimidine have been synthesized by using double Michael addition reaction, In first Michael acceptor is ethyl cyano acetate and Michael donoris guanidine nitrate reacted under reflux condition to give 2,6 diamino 4-hydroxy pyrimidine (1) . In second 2,6 diamino 4-hydroxy pyrimidine (1) Michael donorwas further reacted with ethyl 2,2-dicyano 3,3-bis (methylthio) Michael acceptor in the presence of catalytic amount of K_2CO_3 in DMF under reflux condition that offered 4,11-diimino-2,9-bis(methylthio)-6-hydroxy-7,11-dihydro-4H,6H-dipyrimido[1,2-a:1',2'-c]pyrimidine-3,10-dicarbonitrile (2). Synthesized compound 1 and 2 characterized by spectral method.



Keywords: Michael reaction, ethyl 2,2-dicyano 3,3-bis (methylthio), guanidine nitrate.

AO-9

From Equilibrium to Non-Equilibrium: Towards The Creation of Complex Living Catalyst

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How life was created from inanimate matter is still a mysterious and unanswered question but we know that three important parameters metabolism, replication and compartmentalization played an important role during evolution of life. Specifically, metabolism is considered as a heart of evolution composed of multiple cascades of bond formation and breaking that were critical for primitive evolution. Nature gradually chosehighly evolved and complex enzymes featuring binding pockets with precise arrangement of amino acids to efficiently foster such transformationswith remarkable selectivity of substrates. Here, in our first work, we have reported a lipidatedshort peptide which accesses homogenous nanotubular morphology to efficiently catalyze the C-C bond cleavage and formation. Our first catalyst was stable under thermodynamic equilibrium but most lifedistinguishingfeatures rely on non-equilibrium dynamics, involving constant energy dissipation, kinetic control, and are orchestrated through feedback loops. So, secondly, we have created a single amino acidbased catalyst through the self-assemblydriven by the substrate under out-of-equilibrium condition. Further, continuous supply of substrate was required to maintain the living state of the catalyst.

AO-10

Total Synthesis of (+)-Pseudophrynamine 272A and 270 *via N*-Deacylative Alkylations (DaA)

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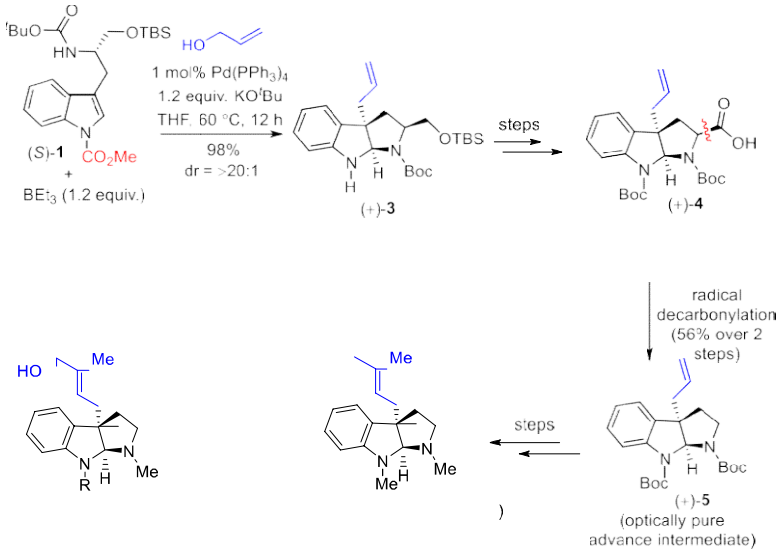
Naturally occurring hexahydropyrrolo[2,3-*b*]indolealkaloids(**2**) having a prenyl moiety adjacent to the pseudo benzylic 3a-site, *viz.* pseudophrynamine 272A (**2b**), pseudophrynamine 270 (**2c**), and pseudophrynaminol (**2a**) have gained considerable attention owing to their potential biological activities.[1] Biosynthetically, these alkaloids are believed to be originated from L-tryptophan.[2] Intrigued by their challenging structural arrays and impressive biological activities, we envisioned a unified approach to these targets in a diastereoselectivefashion.



Scheme: *N*-deacylative C-alkylations (DaA) towards Hexahydropyrrolo[2,3-*b*]indole alkaloids (**2**)

Inthisdirection,wehavedevelopedacatalyticsynthesisofhexahydropyrrolo[2,3-*b*]indoles(**2**)having C3 quaternary center from *N*-acyl 3-substituted indoles (**1**) involving a key Pd(0)-catalyzed *N*- deacylative C-alkylations (DaA).[3,4] Eventually, a highly diastereoselective synthesis of chiral pyrroloindolines (**3**), is also shown from compound (**1**) prepared from L-tryptophan. Further efforts toward a rational extension of this strategy to access medicinally important drug molecules (**2**), we investigate dakeyradicalde carbonylation of the acid (**4**) to establishthe advance intermediate (**5**), from where total synthesis of (+)-Pseudophrynamine 272A (**2b**) and 270 (**2c**) had beenreported.[4]

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AO-11

Catalytic Asymmetric Formal Total Syntheses of (+)- and (-) Cycloclavine

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Clavine family of ergot alkaloids (Figure 1) has a long-lasting and significant impact on both human health as well as agriculture. They were first documented as notorious poisons, stemming from the Middle Ages in central Europe, where consumption of ergot alkaloid contaminated cereal grains led to epidemics of ergotism (also known as St. Anthony's fire) resulting in about ten thousands of fatalities.[1]

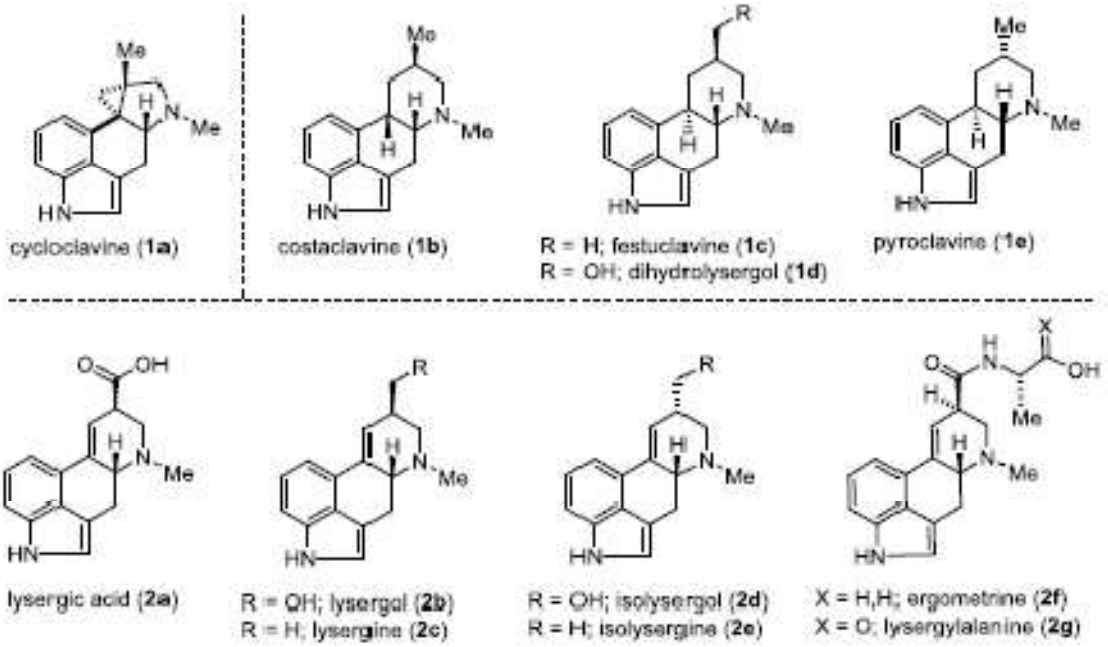
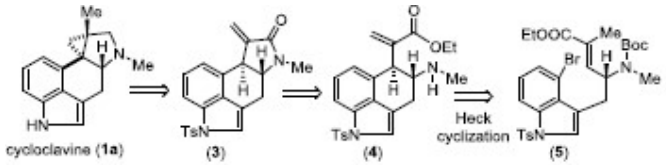
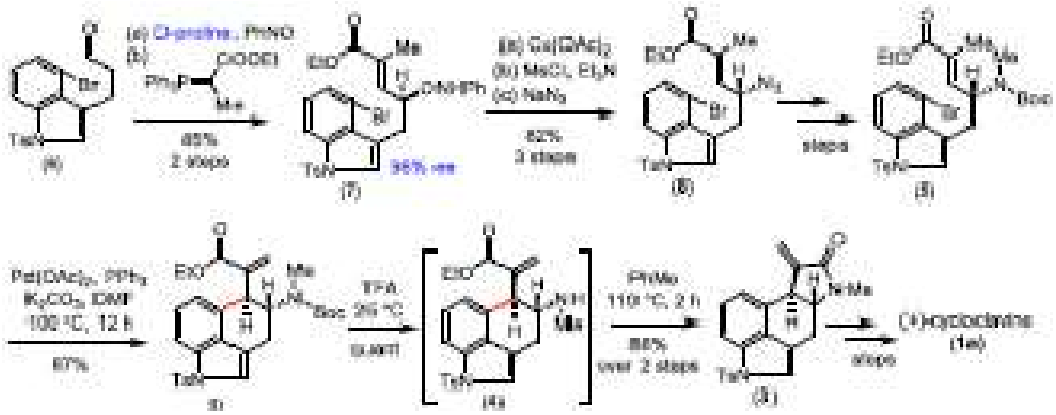


Figure. Selected clavine alkaloids (**1a-e**) and lysergine alkaloids (**2a-g**) of biological relevance.

Most ergot alkaloid structures contain a tetracyclic ergoline ring system (**1b-e** and **2a-g**), except cycloclavine (**1a**), which is sharing a pentacyclic framework with a vicinal all-carbon quaternary streo centre.[2] Because of the varied and powerful biological activities of these alkaloids have long attracted the interests of synthetic chemists. We also elaborated the total syntheses some of the congener of this family.[3] In this talk I would like t o discuss one of my doctoral research work Catalytic asymmetric formal total syntheses of (+)- and (-) cycloclavine.[4]



Retrosynthetically, it was envisioned that cycloclavine (**1a**) can be synthesized from an advanced enantiopure intermediate α, β-unsaturated amide **3** (Scheme 1) via isomerisation followed by reduction of amide functionality and cyclopropanation. Compound **3** can be accessed from α, β -unsaturated ester **4**, which could be, in fact, common intermediate for clavine alkaloids shown in Scheme 1.



Scheme 2: Enantioselective formal synthesis of cycloclavine.

Towards this, 3-indolyl-propanaldehyde **6** was reacted under catalytic enantioselective α- oxyamination reaction with nitrosobenzene in the presence of 10 mol% D-proline (Scheme 3). This reaction afforded α-oxyaminated aldehyde intermediate, which was immediately reacted with a stabilized Wittig, prepared from 2-bromo ethylpropionate, to afford compound **7** in 85% over 2 steps and with 96% ee. With enantioenriched **7** in hand, formal total synthesis of cycloclavine was achieved following a key 5-*exo-trig* cyclization (Scheme2).

In conclusion a total synthesis of cycloclavine (**1a**) is already reported by Szántay and co-workers,[2c] this efforts culminated in formal total synthesis of naturally occurring cycloclavine (**1a**).

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AO-12

Induction of Cytotoxic Misfold Malic de-Hydrogenase Conformer under Environment Stress Condition

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The fundamental mechanism for nucleation during protein misfolding and aggregation under the unrestricted influence of environmental tormentors, especially pesticides is poorly explored. These toxicants could play a major role in the genesis of several pathogenic disorders. Certain reports have established the effect of environmental toxicants on misfolding of Intrinsically Disordered Proteins (IDPs) but their role on non-IDPs or metabolic proteins and their gain of toxicity is still elusive. To fill this lacuna, we hypothesized that the pesticides (e.g. Rotenone) as environmental toxicants may interact with metabolic proteins and lead to the generation of toxic conformers.

Size exclusion chromatography with LC-MS and 1D NMR studies shows the strong affinity of rotenone to Malic Dehydrogenase (MDH), further docking studies have shown the interaction site was interestingly overlapping with the co-factor binding site. Further, Structural studies reveal the prominent structural changes. The hydrophobic changes in secondary structure of MDH were analyzed with Bis-ANS. Circular dichroism showed structural alterations accompanied by the complete loss of alpha helices with an increase in disordered form. Rotenone also destabilized the protein and reduced the melting temperature by 3°C as detected by thermal unfolding analysis. Rotenone also interferes with spontaneous refolding of MDH, leading to the formation of toxic conformers. The cytotoxic effect of the conformers was established by the decrease in viability of SH-SY5Y cells (60% viability for 0.25μM seeds). Further study reveals the cytotoxic impact of misfolded MDH conformers associate with the induction of oxidative stress. The study has confirmed the binding of Rotenone induces the misfolded MDH conformers formation which are cytotoxic in nature.

AO-13

Recent Advancement in The Design of Photoaffinity Chemical Probes for Protein And Its Application in Detecting Antibiotic Resistance

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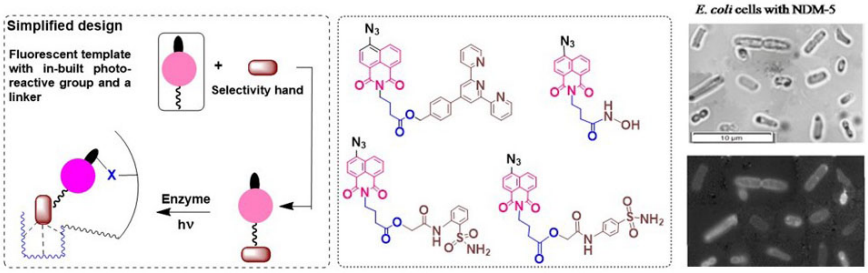
Photoaffinity-based chemical probes are powerful chemical tools for understanding complex biological systems through labeling and detection of disease-causingproteins in biomedical research, chemical proteomics and drug discovery. Designing these probes is an important issue as one needs to consider the desired biological potency, selectivity, and cell permeability of the probe. Conventional design of photoaffinity probe requires assembling of three components, namely selectivity hand also called reversible warhead, photoreactive hand and visualization hand on a template through linkers to provide the final molecular entity. This process is synthetically challenging and often the overall steric size of the probe restricts its applicability due to solubility problems in biocompatible solvents and poor cell permeability. To address these issues, a chronological improvement of the design technology of such small-molecule probes and the development of a sterically less demanding dual acting azido naphthalimide template have been achieved in our laboratory. In the current situation antibiotic resistance is the biggest threat to the modern medicine globally. The emergence of various classes of β-lactamases including the metallo-β-lactamases (class B-MBL) is the major cause for such resistance. Using the azido naphthalimide template we have designed affinity based fluorescent probesfor thedetection of New-Delhi-metallo-β-lactamases which renders carbapenems, one of the last-line of antibiotic, ineffective.The design, synthesis and the application of these probe



(a) (b)(c)
Figure:(a) Basis of design; (b)Structures of some probe molecules; (c)Fluorescence live cell imaging.

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AO-14

Pd-Catalysed Remotely C4-Functionalization of 2-aryl Benzoxazoles *via* Ortho C-H Activation of 2-Amido Phenol

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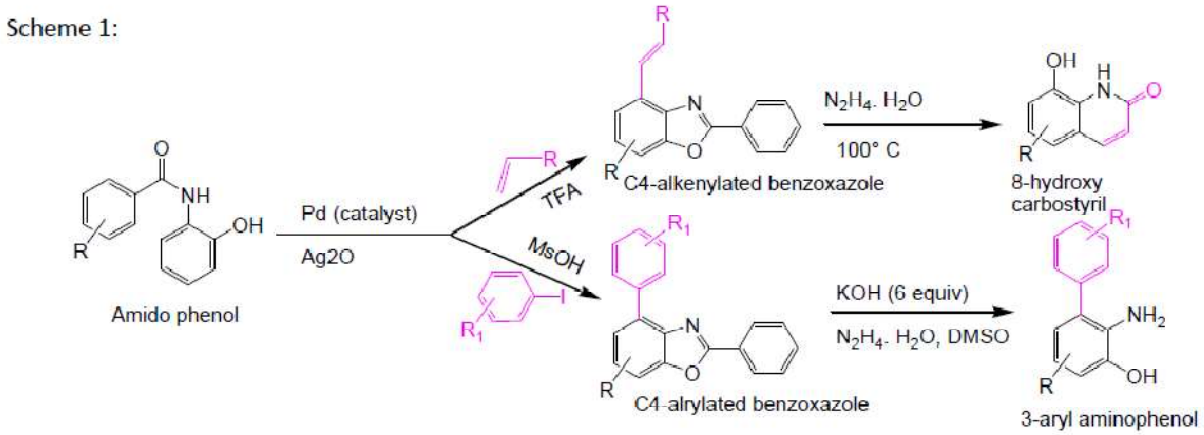
2-aryl benzoxazoles are one of the most important heterocyclic compounds having tremendous biological activity [1]. Owing to the unique chromophoric property, 2-arylated benzoxazole are found in optical brighteners, blue LED, etc[2]. Furthermore, benzoxazoles are often used as potential ligands in transition metal catalysed coupling reactions [3]. A one-pot direct transformation to remotely C-H alkene functionalized 2-aryl benzoxazoles from the reaction of amidophenol and electronically deficient olefin was reported. Control experiments confirm that the Pd-catalyzed regioselective C−H activation/alkenylation occurs at the first step by leading to *ortho*-alkenylated amidophenol which subsequently underwent tandem intramolecular annulation to afford C4-alkenylated 2-arylbenzoxazole derivatives [4]. Fortunately, one-pot hydrolysis of C4-alkenylated benzoxazoles produced 8-hydroxy carbostyril which is used as a resourceful intermediate for the preparation of two powerful β2-adrenergic receptor agonists i.e., procaterol and indacaterol for the treatment of asthma. Followed by this work, we have developed a Pd-catalyzed method for the direct synthesis of C4-aryl benzoxazoles from 2- amidophenols. The reaction proceeds with anilide directed *ortho*-arylation, followed by acid- catalyzed cyclization. Deuterium exchange experiment suggests that under optimized reaction conditions, the directing potential of –NHCOPh group dominates over the –OH and arylation occurs exclusively adjacent to the amide group. Finally, a simple one-pot method has been developed to access strategically difficult 3-aryl-2-aminophenols from the hydrolysis of 2,4- diaryl benzoxazole in good yield[5].

Scheme 1:



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AO-15

Development of a Red Emissive Biocompatible Serum Albumin Carrier for Drug-Delivery Application

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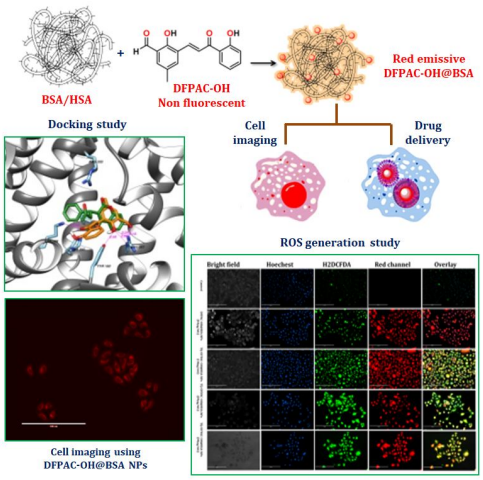
The present world is under a constant burden from cancer, which is having an increasing trend in the number of cases, crippling the physical, emotional, and financial state of affected individuals and their families. Cancer can be treated either by surgery, chemotherapy, or with a combination of both. Theranostics is the combination of two terms: "Therapeutics" and "Diagnostics"[1] that allows for simultaneous diagnosis and targeted therapy with minimal side effects. Fluorescent molecules have found their importance in the field of medicinal chemistry and image-guided surgery. A chemotherapeutic drug endowed with fluorescence could serve as a beacon to visualize the event of drug delivery. However, many chemotherapeutic agents suffer from poor water solubility, low bioavailability, and non-specific distribution in the body tissues and organs, leading to serious side effects and toxicity and force the patient to discontinue the treatment. Significant attention has been given to resolve the issue by encapsulating the chemotherapeutic agent with biodegradable nanocarriers.[2]Herein, we have designed a red emissive serum albumin nanoparticle carrier (DFPACOH@BSA-NPs)[3] that encapsulates a hydrophobic drug thymoquinone (TQ), successfully deliver, and image the event of delivery in A549 cells. The anticancer property was further evaluated for TQDFPAC-OH@BSA-NPs by intracellular Reactive Oxygen Species (ROS) generation study.



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AO-16

Design and Development of a Series of Flexible Water-Soluble Ferrocenylquinoline-Based Preclinical Drug Candidates targeting LeishmaniaDonovani

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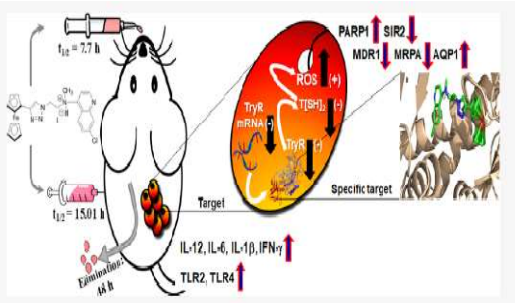
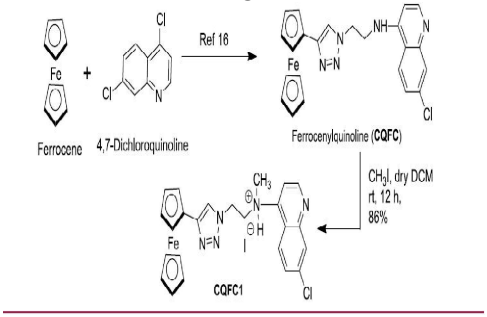
Visceral leishmaniasis (VL), or kala-azar, is a life-threating diseaseand is considered to be a major health problem in developing countries.The emergence of resistance against antileishmanial drugs incurrent use necessitates the search for new classes of antileishmanialcompounds.Herein, we havedeveloped a series of water-soluble ferrocenylquinoline derivativesfor targeting Leishmaniadonovani. Among them **CQFC1** showed the highest efficacy in comparison to other drugs, in use or used both in oral and intramuscular routes. In this study we aimed to exploit the quinoline as well as ferrocene nucleus for the development of a novel antileishmanial compound with minimal toxicity and greater antileishmanial efficacy. The newly modified drug did not induce any toxicity to splenocytes and on hematopoiesis, induced protective cytokines, and did not hamper the drug-metabolizing enzymes in hosts. It acts through the reduction and the inhibition of parasites' survival enzyme trypanothionereductase of replicating amastigotes in hosts' reticuloendothelialtissues.Unlike conventional drugs, this molecule did not induce the resistance-conferring genes in laboratory-maintained resistant L. donovani lines. Experimentally, this easily bioavailable preclinical drug candidate overcame all of the limitations causing the discontinuation of the other conventional antileishmanial drugs and we hope this will open up a convenient route for the treatment ofLeishmeniaDonovani.





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Synthesis of Secondary Amides from Ketones*via* Beckmann Rearrangement Using Hydroxylamine-*O*-Sulfonic Acid as Aminating Agent and Water as Solvent

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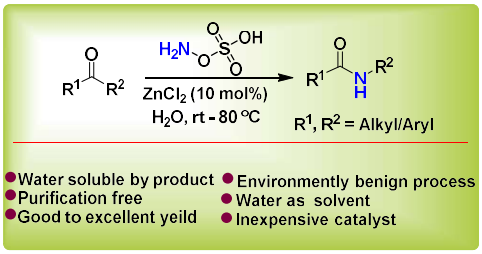
The synthesis of amide is an elegant transformation in synthetic organic chemistry and molecules having amide linkage arewidely distributed in the field of pharmaceuticals, natural products and agrochemical industries. Generally, amides are preparedusing carboxylic acid derivatives and amines or by Beckmann rearrangement. However, several limitations are associated with these protocols such as strong acidic media, use of additives, longer reaction time, harsh reaction conditions, use of toxic metals, tedious purification process andlow functional group tolerance. Herein, we describe mild, greener and the highly efficient Zn(II)-catalyzed direct synthesis of secondary amides from ketones using HOSA as the nitrogen source in aqueous media. [1]



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AO-18

$Cu(OTf)_2$ Catalyzed Single-Step Synthesis of Secondary Amides from Ketones via Beckmann Rearrangement

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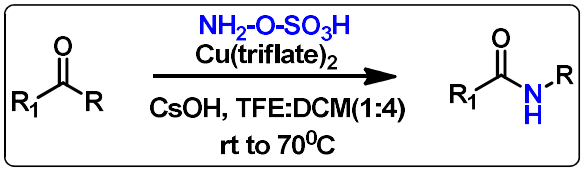
A conspicuous procedure for acid-catalyzed conversion of oxime intermediate to the amides is recognized as Beckmann Rearrangement. Although this is a prominent reaction, prerequisite of high reaction temperature and strongly acidic media at longer reaction time encumbers its applicability for acid-sensitive substrates (for eg. *N*-Boc, -COOR, -OH etc.). A literature study admits that there are limited methods available for the synthesis of secondary amides directly from ketones under mild reaction condition. In interest of this, herein we reported a copper catalyzed single step and mild synthesis of secondary amides from ketones using hydroxylamine-*O*-sulfonic acid (HOSA) as aminating agent and $Cs(OH).H_2O$ as base in TFE:DCM[1].



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Synthesis of 'Dapsone-Phytochemical Conjugates Against Mycobacterium Leprae: A Potential and Cost-Effective Approach in Novel Drug Discovery using Obsolete Drugs and Natural Products

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Leprosy continues to be the belligerent public health hazard for the causation of high disability and eventual morbidity cases with stable prevalence rates, even with treatment by the on-going WHO-recommended multidrug therapy (MDT). Indeed, dapsone (DDS) resistance by mutations in the target enzyme, dihydropteroate synthase (DHPS), has led to an increase in treatment failure from MDT. As a solution, obsolete DDS was reactive through chemical conjugation with five phytochemicals as 'dapsone-phytochemical conjugates' (DPCs), based on azo-coupling (R-N=N-R') reaction. The possible biological activity, mainly, antimycobacterial and antileprosy and toxicity profiles of proposed conjugates, was verified with several computational intelligence programs targeting both wild and mutant types of DHPS before synthesis. From vast bioinformatics and cheminformatics analyses confirmed that 'thymol-dapsone-thymol or DPC4' was the most potential candidate among all proposed conjugates. Later, synthesized all five DPCs in the desired laboratory conditions and spectral characterizations were done viz., proton-HNMR, FTIR, UV, and LC-MS study-cum-verification with suggested computational results. The *in vivo* antileprosy activity of DPCs was monitored with only available gold standard 'mouse-foot-pads (MFP) propagation method with WHO recommended concentration 0.01% mg/kg for three months. Afterward, the host-toxicity testing of the most active DPC4 was done with isolated cultured-human-lymphocytes *in vitro*. Remarkably among all conjugates, the DPC4 showed potential as only one-log bacilli cells in DDS-resistant and no bacilli cells were found in the DDS-sensitive *Mycobacterium leprae* infected mice-foot-pads. Simultaneously, the *in vitro* host-toxicity study also confirmed that the DCP4 up to the concentration of 5,000 mg/L level was safe for oral-administration since a minor number of dead cells were found in red color under a fluorescent microscope. Overall, the antioxidative and antimicrobial potency of thymol enhances the activity and reduces DDS's toxicity profile in conjugate form. Thus, evidence from *in vivo* antileprosy activity and *in vitro* host-toxicity study suggested that the DPC4 could be used in place of DDS in MDT after some pharmacological validation. Parallelly, this interdisciplinary inventive, cost-effective phytochemical conjugation drug development module could be a novel approach towards reactive-cum-reuse of obsolete/ clinically inactive drugs and utilization of more natural products in mainstream medicine-cum-sustainable nation-building program.

Keywords: Dapsone resistant *Mycobacterium leprae*; Dapsone-phytochemical conjugation; Mouse-foot-pad propagation method; Host-toxicity testing with cultured-human-lymphocytes.

Nickel-Catalyzed Cross-Coupling of Alkyl Carboxylic Acid Derivatives with Pyridinium Salts via C−N Bond Cleavage

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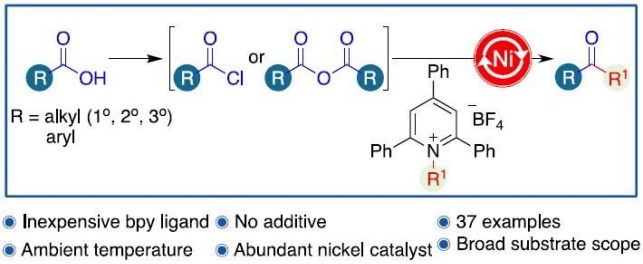
The transition metal-mediated cross-electrophile coupling *via* cleavage of $C(sp^3)$–N bonds to offer unsymmetrical diakyl ketones from various alkyl pyridnium salts and acyl chlorides was developed.[1] $NiBr_2 \cdot bpy$ catalyst, cosolvent system CH_3CN:DMA and Mn as reductant was the optimized condition. In substrate scope apart from 1^o, 2^o and 3^o acid chlorides, carboxylic acids were also employed as acylating agents which enabled the incorporation of acid-sensitive functional groups such as MOM, BOC and acetal to offer the acylated products in good yields.

The mechanistic studies in the preceding Ni catalyzed cross-coupling suggests (i) sequential reduction and (ii) radical chain process as the two most probable pathways for the complete catalytic cycle. In sequential reduction (i) oxidative addition of acyl chloride takes place as the initial step and then subsequent generation of alkyl radical from the pyridinium salts with the aid of Mn reduced nickel species occurs. In radical chain process (ii) there is a generation of alkyl radical by the low valent nickel catalyst as the first step and thereafter oxidative addition of the acid chloride takes place. Eventually, it leads to alkyl radical recombination on to the nickel centre and reductive elimination to complete the catalytic cycle. The radical scavenger TEMPO and radical inhibitor 2,4-Dinitrochlorobenzene corroborate the presence of radical intermediate.

This protocol gains its attention by accommodating no additives, cheap bipyridine ligand, proceeds at rt and by synthesis of vital compounds.



Scheme 1. Cross-coupling of 2,4,6-triphenylpyridinium salts and acid derivatives to obtain dialkyl ketones

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AO-21

Utilization of Reusable Pd NPs and NHC-Pd@MNPs for Denitrogenative Coupling and Regioselective Direct C2 Arylation of Indole, Benzothiophene and Benzofuran

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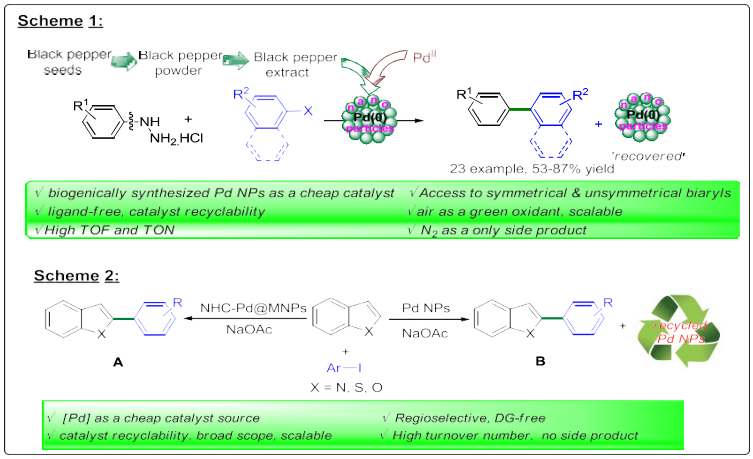
The greener approach for the synthesis of biaryl using palladium nanoparticle (Pd–NPs) catalyzed denitrogenative coupling between aryl hydrazine and aryl halides under ligand-free condition is established and on the other hand regioselective C2 arylation of indoles, benzothiophene and benzofuran without directing group has been accomplished using economically cheap Pd NPs and NHC-Pd@MNPs catalyst has been described. The phytochemicals of the black pepper extract plays a dual role in reduction of Pd^{II} to Pd^{0} and acts as stabilizing agent for Pd–NPs. The reusability of the catalyst is studied up to five cycles and a gram-scale synthesis has been achieved in both reactions. The reaction mechanism is well supported by control experiments and literature precedents, turnover number and turnover frequency studied.



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AO-22

Enhancement of angiogenin inhibition by polyphenol capped gold nanoparticles

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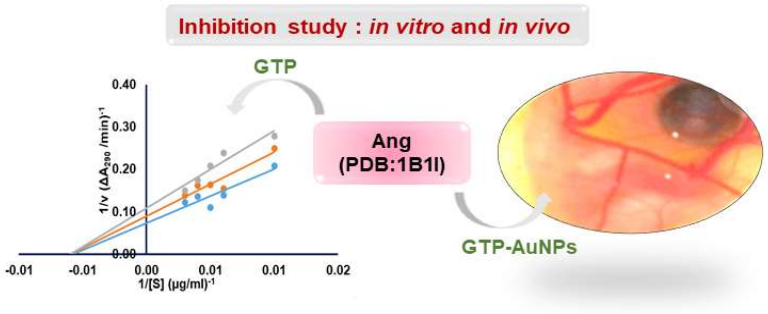
Angiogenin (Ang), a potent blood vessel inducerand its involvement in vascularisation makes it a potential target for the identification of the compound to inhibit its ribonucleolytic as well as angiogenic activity. Gallate containing moieties of green tea polyphenols (GTPs) have shown anti ribonucleolytic activity and the efficiency increases when gold nanoparticles serves as vehicle for the transport of GTPs.The inhibitory property of the ligands, was investigated using various spectroscopic techniques.Polyphenol conjugated gold nanoparticles were found to bind 10^2 times more strongly to the protein compared to only the polyphenols. UV-Vis kinetic studies determined the mode of binding of the polyphenols to be non-competitive in nature whereas that of polyphenol capped gold nanoparticles show a competitive mode of inhibition. This enhances its potential as an antiangiogenic drug, where the effect on angiogenesis of various samples was assessed by CAM assay. The polyphenol capped gold nanoparticles inhibit Ang with greater potency compared to the bare polyphenols and the presence of the gallate moiety significantly enhances the ribonucleolytic inhibitory potential. This structural aspect can be exploited for further studies in the development of antiangiogenic compounds based on natural polyphenols.



AO-23

Self-Assembling Short-Peptide Conjugates Nanostructures: A Forward Step against Antibiotic Resistant Crises

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Multidrug resistant (MDR) or multi-antibiotic resistance (MAR) has become a global life-threatening problem of the current century. Such resistance has been found against every antibiotic that is potentiated and propagated by antibiotic-tolerant microbial biofilm and affecting every medical, industrial and agricultural sector. Therefore there is a dire need for novel antibiotics. Antibiotic development has reached its perfections in Nature with antimicrobial peptides (AMPs), most of which have broad-spectrum activity with very little resistance. Therefore our group has developed novel short-peptides based self-assembling nanomaterials with a new intrinsic property that can work as efficient antimicrobial agents' hence better alternatives during this antibiotic resistant crisis. In this talk, we aim to discuss short peptide based novel antimicrobial nanoformulations and nanomaterials such as lipidatedtripeptide and H_2S-responsive tripeptides nanostructures. We have used plethora of biophysical techniques to obtain a molecular understanding of these peptide structures and interactions within polymer, lipid and metal nanoassemblies. Such strategy will reveal their potential for application in medicine and industry to combat antibiotic resistance.

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AO-24

Endogenous Stimuli-Responsive theranostics for "activatable" image-guided combination therapy

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Combining two or more treatment modalities has been proved to be successful therapeutic approaches for cancer eradication.[1] The different treatment modalities follow separate mechanisms of attack against the tumor cells, affecting cell destruction to a large extent. Combinations of treatment modalities, such as photodynamic therapy (PDT) with photothermal therapy (PTT), PDT with chemotherapy, or PTT with chemotherapy, have been well explored till date[2-5]; however, in most of these cases, two or more different drugs have been utilized for the different therapies. This causes undesired side effects and reduces the efficiency of the treatment. Moreover, such multimodal therapeutics are always in their "active" forms for annihilating cancer cells, leading to undesired interactions[6] with different physiological elements in its path to the respective tumor cell. For an anti-cancer therapeutic to be effective, it must be site-specific to avoid any damage to healthy tissues. In view of this, the heterogeneous medium of cancer cells, unlike healthy cells, has been exploited extensively.[7] Therefore, different endogenous stimuli, viz. intracellular pH, intracellular hypoxia, specific enzymes, etc., have been utilized as tools to activate the therapeutic specifically in tumor cells, leaving healthy cells unaffected.[8] To facilitate real-time monitoring of such localized multimodal therapies, the therapeutic compound has been designed to exhibit different luminescence behaviors in cancer cells and in normal cells. Such selectively "activatable" theranostic compounds showed superiority over traditional anti-cancer treatments, in terms of site-specific cancer treatment.

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AP-1

Award Poster

Fe_3O_4@Salicylicacid:An Efficient And Magnetically Recyclable Nanocatalyst For Solvent Free One-Pot Synthesis of 3,4dihydropyrimidin-2(1H)-ones/thiones via The Biginellire Action

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The use of the Fe_3O_4@Salicylic acid nanocatalyst is described in the synthesis of 3,4 dihydropyrimidin-2(1H)-ones/thiones via the Biginelli cyclo condensation reaction of various aldehydes with ethylacetoacetate and urea/thiourea under solvent free conditions at 80°C as a facile, efficient, and environmentally benign procedure. This novel, eco-friendly and green synthesis methodology has advantages, such as absence of hazardous organic solvents, magnetic ferrite nanocatalyst are easily separable and reusable, short reaction time, high yields of products made this protocol superior and robust.

Keywords: Nanocatalyst, biginelli, dihydropyrimidin, green synthesis, multicomponent reaction

Base-Mediated Anti-Markonikov Hydroamidation of Vinyl Arenes with Arylamides

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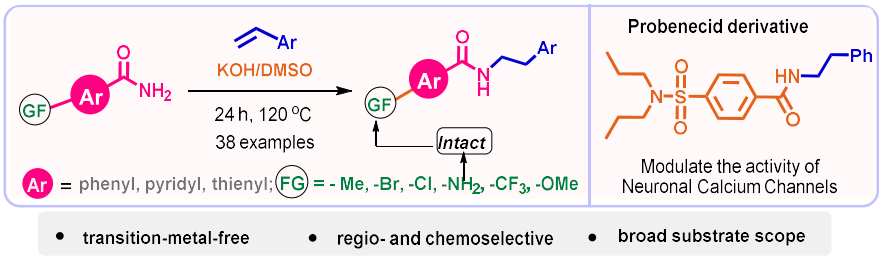

We report here a base-promoted protocol for the intermolecular anti-Markovnikov hydroamidation of vinyl arenes with arylamides to furnish the arylethylbenzamides with excellent chemo- and regioselectivity. The reaction tolerates a wide variety of functional groups which has been successfully extended with electronically varied handles, aminobenzamides, electron-rich/electron-deficient heterocyclic amides, and vinyl arenes to afford the hydroamidated products. Excellent chemoselectivity was observed for the amide group over amine. The proposed mechanism and significant role of the solvent was well supported by deuterium labelling studies and control experiments.

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AP-3

1,2-Disubstituted Benzimidazoles : Selective Synthesis and Molecular Docking Studies

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A greener, facile, and scalable mechanochemical protocol has been developed from easily available substrate aromatic aldehydes and o-phenylenediamine using urea nitrate catalyst to afford 1,2-disubstituted benzimidazoles within minutes. The highly efficient urea nitrate catalyzed synthesis proceeded *via* carbonyl activation-cyclization-atmospheric oxidation pathway. Present methodology exhibited several advantages like solvent free synthesis, easy preparation of catalyst, recyclable catalyst, easy isolation, short reaction time, and excellent yields at ambient temperature. Green chemistry matrix of synthesized compounds revealed high atom-economy (90.74%), high reaction mass efficiency (89.9%),low e-factor(0.11),and excellent eco-score (78.5%).The molecular docking study of all the synthesized compounds for antibacterial and centromere associated protesin inhibitor activity gave potential hits *via* presence of high interaction pattern. Compound demonstrated -26.7009kJ/mol and -25.0285kJ/mol highest docking score with the selected 2XCS and 1T5C proteins, respectively.

AP-4

Green Synthesis of 5-Chloro-2-arylbenzo[d]thiazole Derivatives using Grindstone Technique through C-N and C-S Bond Formation

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An array of substituted 5-Chloro-2-arylbenzo[d]thiazoles was synthesized using 4-chloro-2-aminothiophenol and aromatic aldehydes in the presence of catalytic amount of urea nitrate under mechano-chemical grind stone technique. The designing of biologically active scaffolds and lead compounds using green protocols by minimizing the pollution and adverse impact on the environment is inevitable. Therefore, this pathway was successfully carried out under metal-free conditions in mild reaction condition and the desired products were obtained in high to excellent yields in short reaction time (30-60 sec) to avoid the adverse impact on the environment. The structural characterization of all the synthesized analogs was established by techniques like FT-IR, ^{1}H, and ^{13}C NMR sepctroscopy. The designed pathway has several advantages like eco-friendly, easy workup, high yields, solvent-free, and recyclability of catalyst. The urea was reusable at least four times for the further synthesis of catalyst without significant loss of activity. The high functional group tolerance with a variety of derivatives has been established. In this study we have established a highly promising approach for the synthesis of 5-Chloro-2-arylbenzo[d]thiazoles derivatives.

AP-5

Advancements in Synthetic Approaches of Bisdimedones

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Bis-cyclic molecules are designed by attachment of two cyclic moieties around various linkers such as alkynic, aliphatic, olefinic and aromatic intermediate molecules. The presence of two cyclic moieties together in the same molecule either symmetrically or non-symmetrically influences the biological profiles of the resultant bis-cyclic molecules. Among bis-cyclic moieties, bisdimedones have emerged as an important and versatile moiety in the field of synthetic and medicinal chemistry. They are screened as precursors for the synthesis of several heterocycles such as acridinediones, xanthenediones, thioxanthenes and benzopyrans that exhibit immense pharmacological as well as industrial applications. Its extensive characteristics have attracted the scientists to develop various protocols for its synthesis from the reaction of dimedone with several aldehydes under different environmental conditions using various types of catalysts. This article encapsulates the recent progress in the synthesis of bisdimedone derivatives under several reaction protocols such as use of nanoparticles, ionic liquids, metal salts, simple organic compounds, and catalyst-free conditions etc. in the last 20 years.

Keywords: Bisdimedone; Tetraketone; Dimedone; Knoevenagel condensation; Michael addition

AP-6

Enhancing the properties of the film of the cataractous eye protein isolate (CEPI)

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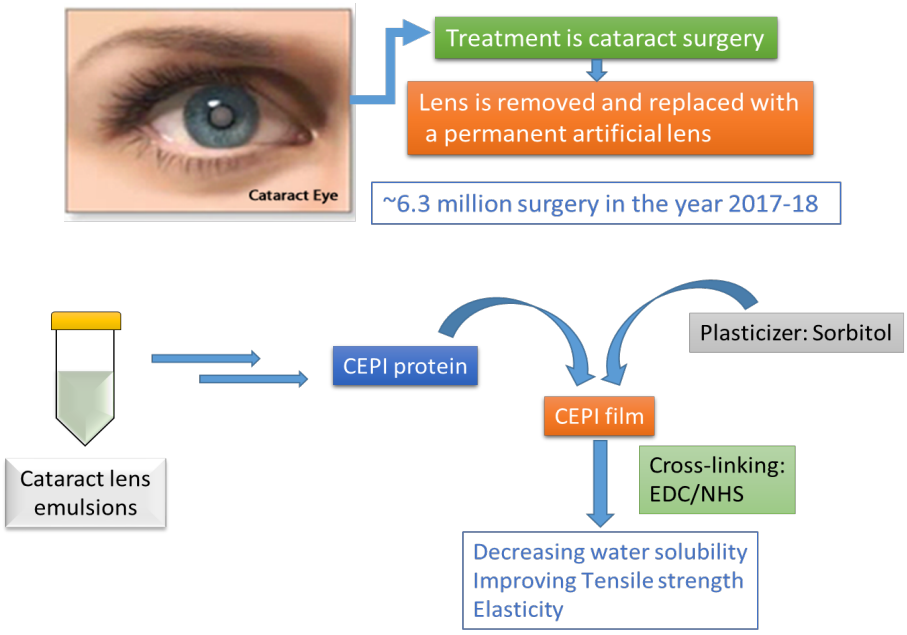
Thin films prepared from protein sources arebiodegradability, biocompatibilityand finds application as a biomaterial for corneal tissue engineering; slow-release drug carrier for skin treatment in burns, ulcers or infected wounds. Cataract eye lens containing high protein concentration are discarded after surgery. Protein from discarded cataract eye lens can be extracted and be used to form biodegradable films having potential to be used as a material for drug delivery. To further enhance the mechanical property of the films, cross-linking of the proteins is done using varying concentrations of 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC) in presence of NHS (N-hydroxysuccinimide). It significantly reduces the water solubility of the films.



General Presentation

OP-1

Oral Presentation

Click Chemistry Inspired Green and Mechanochemical Synthesis of Perimidines

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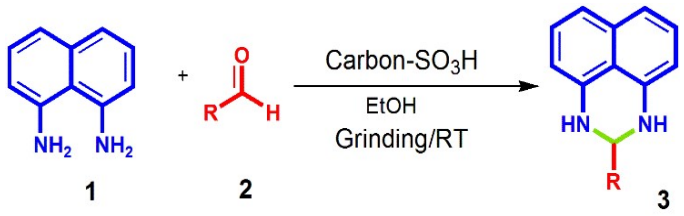
Catalysis is always known as a straightforward, sustainable and economical process for the formation of heterocycles and generation of C-N bonds. In the past few years, SO_3H functionalized carbon materials are a new addition to solid Bronsted acid catalysts, owing to its special characteristics like low cost and high Bronsted acidity. A new and scalable mechanochemical approach has been developed for the synthesis of perimidine derivatives using a highly efficient and recyclable carbon based sulfonic acid catalyst under metal-free conditions. A wide variety of aldehydes displayed cyclo-condensation reaction with 1,8-diaminonaphthalene in EtOH under ambient reaction conditions *via* grind-stone technique to produce substituted perimidines in excellent yields in a very short reaction time. This method has interesting features like single-step synthesis, high functional group tolerance, transition-metal free synthesis, high atom-economy, recyclable catalyst, no-need of tedious purification process, high green chemistry matrix (Eco-score and E-factor) that make this protocol green and eco-friendly.



Keywords: Solid acid catalysis, Click chemistry, Grind-stone method, Green chemistry, N-heterocycles, Perimidine

OP-2

Study on Inhibtion of Mineralization of Urinary Calcium Oxalate Stone by Sodium Pyrophosphate

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Biological importance of sodium pyrophosphatealso to understand its applicability as inhibitors in urolithiasis, we have presently studied the inhibition efficiency of sodium pyrophosphate towards the mineralization of urinary stone forming minerals *viz.*, calcium oxalate, in aqueous as well as urinary media. An attempt has been made to unfold, tentatively, the mechanism of inhibition by this inhibitor. **Methods:** It was Observational experiment. The Studywas Conducted in the chemistry lab of university department of chemistry, B N Mandal University, Madhepura, Period between January 2019- June 2019 An experimental model was designed with the salt forming solutions, the whole operation took about 40 min. At the end the contents of beaker were digested in a hot water bath for 10 min, cooled to room temperature and centrifuged in small volumes. The total centrifugate was collected. Next oxalate content of the centrifugate of calcium oxalate mineralization experiments were determined.

Result: sodium pyrophosphate has a moderate inhibition efficiency towards calcium oxalate mineralization. At 0.05 M concentration, sodium pyrophosphate has a net inhibition of 30 % which is 26.65 % more than that of water (blank). Compared to water the percentage inhibition increased by 795.52%. With decreasing concentrations of sodium pyrophosphate, the centrifuge efficiency decreases. At very low concentration (0.01 M) its inhibition is only slightly higher than that of water. In urinary medium sodium pyrophosphate seems to function as a better inhibitor of oxalate mineralization. At 0.05 M concentration, sodium pyrophosphate has a net inhibition of 89.22 % which is 75.36 % more than that of urine.

Conclusion: it is observed that sodium pyrophosphate solution, under different concentrations, exhibits moderate to good efficiency of inhibition towards mineralization of urinary stone forming minerals *viz.*, calcium oxalate in aqueous as well as urinary milieu.

Key words: Urolithiasis, sodium pyrophosphate, centrifuge, inhibition

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OP-3

Synthesis and Antifungal Activities of 3,5-diphenyl-7-amino-[1,3]-thiazolo[3,2-*a*]pyrimidine-6-nitrile Derivatives

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The attention of chemists towards thiazole derivatives is due to their antiviral, antimalarial, hypertension, HIV infection, and hypnotics properties and because they are new inhibitors of bacterial DNA gyrase B. 2-Aminothiazoles are versatile intermediates for highly functionalized heterocycles of widespread pharmaceutical use. Thiazole analogs exhibit the possible core skeletons of A3 receptor antagonists with moderate affinity and selectivity. A3 receptor antagonists are associated with the treatment of glaucoma. The thiazolo[3,2-*a*] pyrimidine ring system established a lot of attention in the literature mainly because of interesting biological properties associated with this ring system. These compounds are reported to possess antimicrobial, anti-inflammatory, antitumor, and immunomodulatory activities. The arylidinemalononitriles are versatile intermediates for the synthesis of a large number of biologically important heterocyclic molecules. Many of these derivatives are playing continually expanding roles in the development of different areas of chemistry, industry, pharmacology, and medicines. The diverse and interesting biological activities of thiazolo pyrimidine ring system led us to synthesize some novel 3,5-diphenyl-7-amino[1,3]-thiazolo[3,2-a]pyrimidine-6-nitrile derivatives by refluxing 2-amino-4-phenyl-1,3-thiazole and arylidinemalononitrile in propanol using NaOH as catalyst. Various synthesized products were characterized by ^{1}H NMR, mass spectrometry (MS), infrared (IR), and elemental analysis. Antifungal activities of the synthesized compounds were done by testing against Rhizoctonia solani and Drechslera orazae, two fungal pathogens causing diseases on rice crops.

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OP-4

Controlled Ethanolic Fermentation Exposed To 2-Acetylaminofluorine

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The efficacy of 2-acetylaminofluorine on controlled ethanolic fermentation with the yeast Saccharomyces cerevisiae NCIM-2012 has been assessed. It has been found that the mutagen 2 acetylaminofluorine under trial has stimulatory effect on controlled ethanolic fermentation with the yeast Saccharomyces cerevisiae NCIM-2012 and enhances the yield of ethanol to anextentor 6.74531% higher in comparison to control fermentor flasks, i.e., 7.20 ml/100ml. in 50 hrs of incubation period. 5.1 pH and 26"C temperature with 22% (w/v) molasses solution.

Keywords: Saccharomyces cerevisiae NCIM-2012, Molasses, ethanol, 2-acetylaminofluorinc

Tulasi Decreases Pathogenic Microorganisms from Water

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The Ocimum sanctum is a natural plant having antimicrobial movement against a large number of the microorganisms and in Ayurveda, In my childhood days my grandmother cured some infections with tulasi leaf extracts, tulasi lead extract is used to treat blocked nose and throat infection are cured by chewing of fresh tulasi leafs. It's my great memory with my grandmother. Tulsi used as antiasthmatic drugs. It is also used in treatment of fever, bronchitis, arthritis etc. The current investigation was centeredaround assessment of antimicrobial movement of Ocimum sanctum leaf remove in ordinary tap water and river water. The antimicrobial impact was concentrated with distinctive focus (300 to 600 mg L^{-1}) of Tulsi leaf separate in tap. In this, 600 mg L^{-1} grouping of plant removes treated water demonstrated successful antimicrobial action at 15 to 16 hrs. The Minimum Bactericidal Concentration (MBC) was seen in 600 mg L^{-1} remove fixation. The centralization of the bacterial cells restrained progressively for an hour was concentrated by spread plate technique.

OP-6

Oligofurostanosides-Furostanol Saponins from *Asparagus filicinus* Buch-Ham. Fruits from Himachal Pradesh

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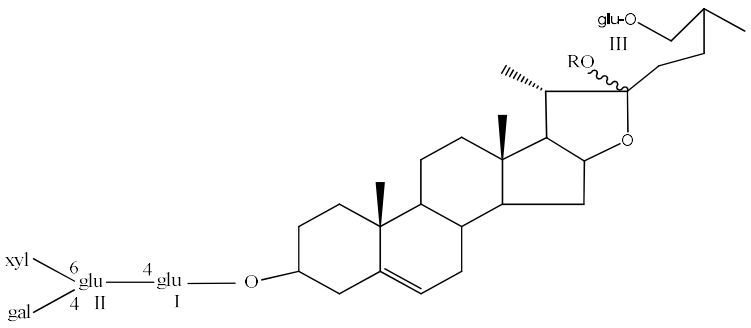
Asparagus filicinus Buch-Ham.(Family-Liliaceae) commonly called *'Saunspaur'*and *'Sensarpal'*, a wild growing plant of Himachal Pradesh and Punjab, has been taken for chemical studies due to its medicinal values.

The methanol extracts of fresh fruits of *Asparagus filicinus Buch-Ham*. on purification and chromatographic separation has been found to contain a complex mixture of steroidal saponins, out of which two new oligofurostanosides, **Filicinoside-E(1)&F(2)** have been isolated. Filicinoside-E &F, positive to Ehrlich reagent, could not be separated by CC. Acid hydrolysis of this mixture gave an aglycone -Diosgenin which was further confirmed by chemical and spectral techniques. The aqueous hydrolysate on usual work up revealed the presence of D-galactose, D-glucose and D-xylose. Further, on the basis of spectral (FAB-MS,^{13}C-NMR, IR) and chemical studies (permethylation, methanolysis followed by hydrolysis, Kiliani hydrolysis) **Filicinoside-E(1)&Filicinoside-F(2)** have been assigned structures as: 3-O-[{ β-D-galactopyranosyl (*1* →4)}{β-D-xylopyranosyl (1→6) }-β-D-glucopyranosyl (1→4)-β-D-glucopyranosyl]-26-O-β-D-glucopyranosyl-22α-methoxy- (25R)-furost-5-en,3β, 26-diol (Filicinoside-E) and 3-O-[{ β-D-galactopyranosyl (1→4)}{β-D-xylopyranosyl (1→6) }-β-D-glucopyranosyl (1→4)-β-D-glucopyranosyl] -26-O-β-D-glucopyranosyl- (25R)-furost-5-en,3β,22α, 26-triol (Filicinoside-F).



1. R= Me
2. R= H

OP-7

Studies on Structural and Spectral Investigation of Substituted Benzoins using DFT studies

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4-methoxy benzoin and 2-chloro-4-methoxy benzoin synthesized by crossed benzoin condensation and characterization done using FT-IR, UV-VIS spectra and structures were confirmed using single crystal XRD studies. The optimized molecular structure of the title compound were calculated using Density Functional Theory (DFT/B3LYP)/6-31G (d,p) basis set. The calculated geometric parameters were in good agreement with the experimental data obtained from our reported X-ay structure. The charge transfers in the molecules proved using calculated HOMO-LUMO energies.

Keywords: DFT, HOMO-LUMO,Single XRD

OP-8

An Efficient Solvent-Free Synthesis of 3,4-Disubstituted Isoxazole-5(4h)-Ones Using Microwave Irradiation

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Isoxazoles, a privileged class of five-member nitrogen and oxygen-containing heterocycles, conquer reputation in organic chemistry for their wide applications in pharmaceuticals, biologically active molecules, advanced organic materials, and as intermediates in organic synthesis. Most of the reported methods for the synthesis of these compounds suffer from disadvantages, including the use of toxic or odorous, expensive catalysts, catalyst preparation required, strong acid or base catalysts, use of organic solvent, tedious work-up procedures, troublesome waste discarding, two step procedure, long reaction times, and low yields. Hence there is scope to develop new methods for the synthesis of this molecule.

I have reported one-pot and three-component synthesis of 3-mehyl-4-arylmethyleneisoxazol-5(4H)-ones using microwave radiation under the solvent-free conditions, in the presence of potassium bromide as the catalyst. The method has given the products in high yields and short reaction times with an easy work-up process. The present method provides an easy and efficient approach for the synthesis of this class of compounds, because of its clean reaction profile and operational simplicity.

OP-9

A balance between Free Radicals and Antioxidants in Homoeopathy Treatment

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In chemistry there has been a great deal of attention toward the field of free radicals, radicals and free electron and assist the drug action in homoeopathy treatment. A balance between free radicals and antioxidants is necessary for proper physiological function. Free radicals weakens the body's abilityto regulate them, a condition known as oxidative stress. Free radicals thus adversely alter lipids, proteins, and DNA and trigger a number of human diseases. Hence some times application of external source of antioxidants can assist in coping free radicals and oxidative stress. The present review provides a brief overview on free radicals and oxidative stress which cause cellular damages and the role of free electron, radicals as antioxidants in homoeopathy in the management of free radicals in human diseases.

Keywords: antioxidant, free radicals, oxidative stress

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OP-10

Design and Development of Axially Chiral Bis(Naphthofuran) Luminogens as Fluorescent Probe for Cell-imaging

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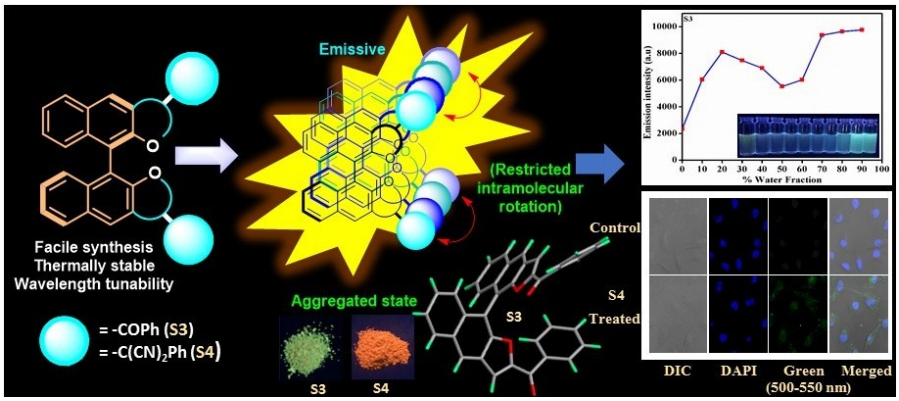
Designing chiral AIEgens without any externally tagged AIE active molecules to the chiral scaffold remains a long-standing challenge to the scientific community.[1-3] The inherent ACQ phenomenon associated with the axially chiral (R)-BINOL scaffold, together with the marginal Stokes shift limits their application as chiral AIE active materials. Herein, in our effort to design chiral luminogens, we have come across a design strategy where 2-phenacyl furans[4] when appropriately fused with the BINOL scaffold will generate solid-state emissive materials with high thermal and photostability stability as well as color tunable property**.** The structures were fully characterized and thermal stabilities, electronic properties, photophysical and electrochemical properties were systematically investigated. The unique twist in the molecules as evident from their X-ray crystal structure along with the short intermolecular interactions ameliorates the structural rigidification and restricts the detrimental π-π stacking interactions, restricting the internal rotations (RIR) accompanied by curbing the ICT process, resulting in the enhanced emission in the aggregated state The excellent biocompatibility together with high fluorescence quantum yield and large Stokes shift of one of the luminogen stimulated us to investigate its cell-imaging potential. The luminogen was observed well internalized and uniformly dispersed within the cytoplasm of MDA-MB-231 cancer cellswith high fluorescence intensity.



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Photocatalyst-Free Visible Light Mediated Synthesis of Stilbenes From Cinnamic Acids and Arylazosulfones

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Visible light driven decarboxylative cross-coupling reactions have transpired as an extremely resourceful tool for the construction of C-C and C-heteroatom bonds over the last few years. The approach is highly ecosustainable but relies on the use of expensive or degradable photocatalysts.One tactic to preclude the use of these external photosensitizers can be the replacement of these photocatalystswith a photoactive substrate or reagent.In this regard, arylazosulfones are interesting bench-stable photoactive compounds which can furnish arylradicals under visible light irradiation and havebeen used for the synthesis of many important scaffolds in the absence of any metal, photocatalyst or additives. However, stilbenes, which are widely recognized for their biological activity and synthetic utility, have never been synthesized from cinnamic acidsvia avisible light mediated pathway.In the present work, we have exploited the emerging dyedauxiliary group approachfor developing aphotocatalyst-free visible light mediated decarboxylative synthesis of trans-stilbenes from cinnamic acids and arylazosulfones.The decarboxylation process is facilitated by the use of a base Cs_2CO_3, air and KI. A number of cinnamic acids and arylazosulfones were compatible with the developed synthetic protocol. The experimental results establish that the reaction proceeds via a radical pathway.

Keywords: Visible light, photocatalyst-free, cinnamic acids, arylazosulfones, stilbenes

OP-12

Ring Opening of Pyridotriazole for Synthesize N-heterocycles

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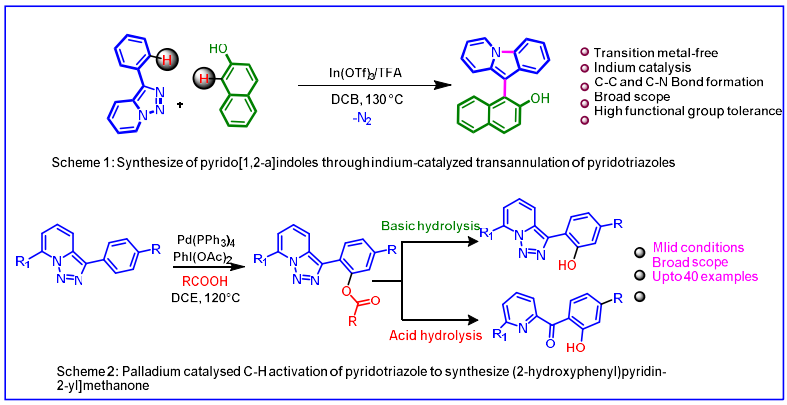
Nitrogen-fused heterocycles are key structural motifs found in material chemistry and medicinal chemistry.Trans annulation of pyridotriazoles is an extraordinarilyefficient and show excellent selectivity through *in-situ* generationof metal-carbenoid species and their reactions with different coupling partners transformed into a desired heterocycles.[1] Denitrogenative transannulation of pyridotriazoles offers anefficient method to obtain various heterocycles which are important intermediates in medicinal chemistry.[2,3] We have developed a convenient and efficient route to synthesize pyrido[1,2-a]indoles through indium-catalyzed transannulation of pyridotriazoles with different arenes and palladium-catalyzed direct *ortho* C–H acyloxylation of 3-phenyl-pyridotriazoles (Scheme 1).[4] The reaction was facilitated by $PhI(OAc)_2$ (PIDA) as an oxidant and with carboxylic acids as acyloxylation reagents followed by the hydrolysis yield the potential drug intermediates [(2-hydroxyphenyl)pyridin-2-yl]methanone (Scheme 2).[5]



Scheme 1: Synthesize of pyrido[1,2-a]indoles through indium-catalyzed transannulation of pyridotriazoles

Scheme 2: Palladium catalysed C-H activation of pyridotriazole to synthesize (2-hydroxyphenyl)pyridin-2-yl]methanone

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OP-13

Direct Transformation of Ketones into Secondary Amides *via* Beckmann Rearrangement using *O*-(Mesitylsulfonyl) Hydroxylamine (MSH)

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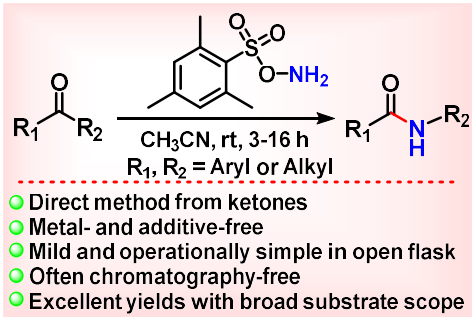
The Beckmann rearrangement is a versatile method for the synthesis of secondary amides or lactams from ketoximes in the synthetic organic chemistry. Secondary amides are widely present in pharmaceuticals, bioactive natural products, polymers and agrochemicals, hence their synthesis is also important. Traditional Beckmann rearrangement requires harsh conditions (strong acid and high temperature) which impeded the applicability of this process towards the sensitive substrates. To overcome these limitations, we have developed a highly efficient method for the synthesis of secondary amides directly from ketones using *O*-(mesitylsulfonyl)-hydroxylamine. This reaction tolerates multiple functional groups, proceed rapidly at room temperature without any additive, and a simple basic aqueous work-up provide the products in excellent yield with high purity.[1-2]



Scheme 1: Synthesis of *sec*-amide using MSH

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OP-14

Greener Synthesis of Curcumin Diimino Stabilized Silver Nanoparticles: Efficient Sustainable Catalyst for Nitroaromatics Reduction in Water with Bactericidal Properties

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A green one step method of synthesizing silver nanoparticles stablized by curcumin derived diimino Schiff base is developed. Three curcumin diimino Schiff base prepared by a simple method from curcumin and 1,2-diaminoethane, 1,4-diaminobutane and 1,6-diaminohexane with improved aqueous solubilty compared to insoluble curcumin, were used as support in nanoformulation process. The stabilized silver nanoparticles were prepared in aqueous solution and at room temperature within 3 hours. These silver nanoparticles act as heterogenous sustainable catalyst in reduction of substituted nitroaromatics in aquous solution solution of sodium borohydride as reductant. Thus, the methodologies of silver nanoparticle synthesis and reduction of nitroaromtics is completed in water medium and so considered as eco-friendly. Secondly, both the support and stabilized silver nanoparticles showed bactericidal properties against bacterial strains (Staphylococcus aureus, Bacillus subtilis, Escherchia coli, and Pseudomonas aeruginosa).

Manganese-Catalyzed Electrochemical Tandem Azidation-Coarctate Reaction: Facile Access to 2-Azo-benzonitriles

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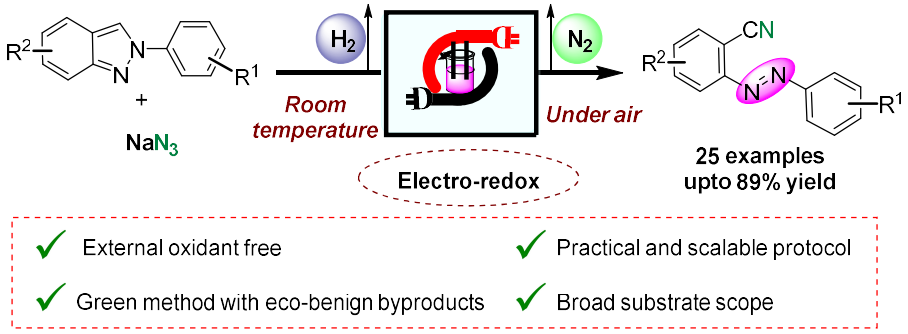
Coarctate reactions belong to a specific class of concerted reactions those comprise a reactive center (coarctate atom) at which simultaneously two bonds are cleaved and two bonds are formed in a single step.[1] These versatile reactions exhibit broad applications for the construction of important carbo- and heterocyclic motifs via ring closing pathways.[2] Conversely, ring opening strategies privilege the access to several highly conjugated systems which are otherwise synthetically more challenging.[3].

Recently organo-electrochemistry has realized a renaissance for redox mediated transformations,[4] which has opened of a new platform in organic synthesis from its environment friendly and economic perspective. Herein, we report a successful implementation of the electro generated azide radical in C3–H azidation of various 2-*H*-indazoles and a follow-up fragmentation to access the conjugated 2-azo-benzonitrile derivatives. Advantageously, this undivided cell electrolysis proceeds under mediator and oxidant free condition at room temperature and under air which supports its sustainability.



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Molecular Properties Prediction of Novel Organo Phosphonate -1, 2, 3-Triazole Hybrids

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Antimicrobial resistance has become a significant threat to global public health, thus precipitating an exigent need for new drugs with improved therapeutic efficacy. ADME fundamental pharmacokinetic properties useful for evaluation of the drugability of promising drug candidates. In the light of the above findings and of our former promising results with 1,2,3-triazoles as antibacterial agents.1-2 we undertook rational molecular design of novel antimicrobials in the class of organo phosphonate -1, 2, 3-triazole hybrids. The designed target compounds were initially submitted to Molinspiration, Molsoft and Osiris programs to predict their molecular properties that are important for drug candidates. The compounds showed moderate to good drug score 0.12.

Keywords: Molinspiration, Molsoft, Triazoles.

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Non-Equilibrium Generation of Catalytic Proto Nucleobase Supramolecular polymers

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Nature has developed nucleic acid polymers for crucial functions such as information transfer. The kinetically stable yet thermodynamically activated nature of the linkages hints towards their generation under a supply of energy, which also might have endowed them with properties such as catalysis, thereby facilitating the evolutionary pathway. Here we show the generation of supramolecular polymers of melamine, a possible proto-RNA building block driven by the addition of an activated monomer, an approach often seen in Nature in the form of generation of tubulins and actin polymers. Inspired from extant hairpin ribozyme, we utilize reversible covalent modification to install a catalytic imidazole moiety in the polymer backbone. This helps us achieve dissipation through hydrolysis, predominantly from the assembled state, resulting in disassembly and also creates a kinetic asymmetry in the cycle. Lack of dissipation on use of a non-catalytic analogue leads to polymers that are trapped in time. Interestingly, addition of a planar intercalating molecule increases the stability of the polymers, similar to what the midwives did during early evolution.

OP-18

Synthesis & Characterization of Benzothiazole Derivative Schiff Base Ligand with,Complex of Co(II)

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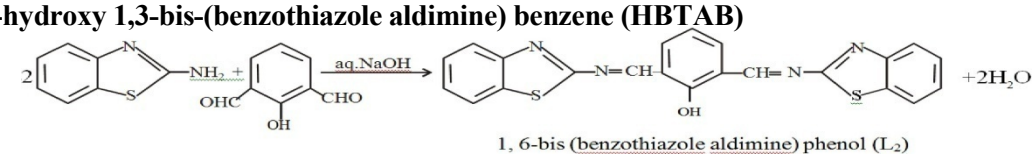
Organometallic compound and Schiff base complex are important area in modern science specially in biomedical science. Here Schiff base ligand and complex is most vital due to its widely usefulness. Benzothiazole & its derivatives play an important role in biological activities like anticancer agent, antidiabetic agent, anti- inflammatory agent, antimalarial agent etc. While its Schiff base also play an important role. As a metal complex of BT derivatives exhibited higher therapeutically value.

This paper deals with synthesis & characterization of BT Schiff base ligand & their Co (II) complex. Schiff base obtained shows very effective biological activities while complex of Co (II) is very much important for that very purpose.

Key words: Benzothiazole, 3-formyle benzaldehyde, ABT, Schiff Base, BTAB

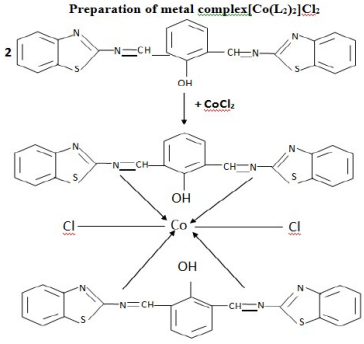
Synthesis of ligand-L

2-hydroxy 1,3-bis-(benzothiazole aldimine) benzene (HBTAB)



1, 6-bis (benzothiazole aldimine) phenol (L_2)

Bis-[2-hydroxy 1,3-bis-(benzothiazole aldimine) benzene]cobalt(II)chloride



[Co $(L)_2$] Cl_2Bis-[2-hydroxy 1, 3-bis-(benzothiazole aldimine) benzene]cobalt(II)chloride

Conclusion

All Co(II) complexes were found diamagnetic. Their electronic spectra did not show any d – d bands but were only dominated by charge transfer bands. The charge transfer band at 28, 455 – 28610 $cm^{-1}$was to t2g eg their possible tetrahedral environment.

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Emergence of Enhanced Protometabolic Activity and Promiscuity via Dissipative Self Assembly

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In living systems, energy is consumed to fuel the metabolic networks of enzymatic reactions in conditions that are far from equilibrium. The emergence of metabolic pathways is intricately related to the evolutionary journey of modern enzyme with different theories suggesting retrograde evolution model to the early emergence of promiscuous enzymes. Herein, we report substrate driven non-equilibrium generation of catalytic machinery from a single amino acid functionalized fatty acid in presence of a cofactor hemin. The non-equilibrium assembled state showed acceleration of catalytic potential by degradation of the substrate and subsequently resulted in disassembly. Controls that promoted equilibration could not access the three-dimensional microphases and showed substantially lower catalytic activity. Significantly, the assembled state showed latent catalytic function that helped in the creation of the same substrate via hydrolysis of a precursor. Utilizing a promiscuous cascade, the assembly was benefitted with augmented lifetime of the catalytic state and thus promoted protometabolism. The results contribute towards our understanding of primitive promiscuous catalytic machineries that assisted the minimal metabolism of early life.

Spectral and Conformational Studies of Some Novel *N*-Acyl-Piperidin-4-One Oximes

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A collection of novel *N*-formyl-*t*(3)-methyl-r(2), *c*(6)-bis(2'-furyl)piperidin-4-one oxime **(1)**, *N*-acetyl-*t*(3)-methyl-r(2), *c*(6)-bis(2'-furyl)piperidin-4-one oxime **(2)**, *N*-propanoyl-*t*(3)-methyl-r(2),*c*(6)-bis(2'-furyl)piperidin-4-one oxime **(3)**, *N*-benzoyl-*t*(3)-methyl-r(2),*c*(6)-bis(2'-furyl)piperidin-4-one oxime **(4)** are synthesized, characterized by melting point, one dimensional NMR (^{1}H & ^{13}C) and two dimensional ^{1}H-^{1}H COSY spectrum. The spectra shows that very broad signals at room temperature, but well resolved signals obtained at lower temperatures(+15, 0, -15, -30ºC). The spectra reveal the presence of two isomeric forms i.e., E and Z isomers for **1-4** at lower temperatures**.** The possible conformations for **1-4** (E and Z isomers) exist as an equilibrium mixture of alternate chair form **CA** and boat form $\mathbf{B_1}$ based on chemical shift, coupling constant values and torsional angle values.

Keywords **:** NMR Spectra, molecular conformation, N-acyl-piperdin-4-one oximes

OP-21

Catalyst- and Additive-Free Cascade Reaction to Construct Benzo-Oxazine, Benzo-Oxazepine and Benzo-Oxazocine: O-Atom Transfer and New C=O, C-N and C-O Bond Formation

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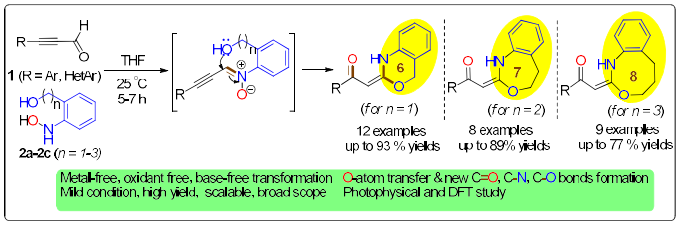
Heterocycles are an extremely important class of compounds, making up more than half of all known organic compounds[1]. Therefore, substantial attention has been paid to develop efficient new methods to synthesize heterocycles.

Here, we have done the exclusive synthesis of benzo-oxazine, benzo-oxazepine and benzo-oxazocine from arylpropioladehyde and hydroxyamino phenyl alcohol under the transition metal-free condition[2]. The O-atom transfer and formation of new C=O, C-N and C-O bond occurs at room temperature under one-pot reaction condition without using external oxidant and base[3]. The wide range of substrates are utilized for the synthesis of medicinally valuable and synthetically important N, O-containing six, seven and eight membered heterocycles in good to excellent yield. The UV-visible absorption study and photoluminescence studies have been showcased for functionalized heterocycles and their photo physical properties have been successively studied. Additionally, the proposed mechanistic elucidation is well supported by control experiment, and literature precedents.



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OP-22

Structural Investigation of Binding Mode of Vinblastine and Components with Normal and Modified DNA duplexes

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Vinblastine is known to be an indole alkaloid which is formed by the combination of vindoline and catharanthine. It is isolated from the plant *Vinca rosea Linn* and is used as a chemotherapeutic drug which acts as a part of chemotherapy regimen in various types of cancer treatment. The main function of vinblastine is that it alters the growth of fast growing cells in DNA and prevents them from growing (Pandya et al., 2014). Although vinblastine functions primarily by interacting with tubulin protein, it is also known to bind with duplex DNA. However, its mode of binding is considered to be major groove (Pandya et al., 2012). In this paper we have attempted to identify the binding mode by computational investigations using two types of DNA duplexes. We have also compared the binding interactions of structural halves of vinblastine viz., vindoline and catharanthine for their DNA binding ability. The study has revealed that vinblastine binds in the major groove of both normal and methylated DNA. On comparing their binding energy, it is revealed that the binding energy of vinblastine with normal and methylated DNA is ΔG = -6.58 and -6.98 respectively. Vindoline binds in the major groove of both normal and methylated DNA with the binding energy of ΔG = -6.44 and -6.26 respectively. On the other hand, Catharanthine binds in the minor groove of both normal and methylated DNA with the weaker binding interactions as indicated with ΔG = -5.92 and -5.77 respectively. The structural details of binding of Vinblastine, Vindoline and Catharanthine have also been disclosed which includes multiple hydrogen bonds, van-der-Waals interactions, etc.

Keywords – DNA interaction, Drug - DNA binding, Vinblastine, Molecular docking.

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Pandya, P., Gupta, S. P., Pandav, K., Barthwal, R., Jayaram, B., & Kumar, S. (2012). DNA binding studies of vinca alkaloids: Experimental and computational evidence. *Natural Product Communications*, *7*(3), 305–309. https://doi.org/10.1177/1934578x1200700308

OP-23

Development of Novel *C* and *O* – Glycosylation Methods for The Synthesis of Oxabicyclic Scaffold and *O*-Aryl Ethers

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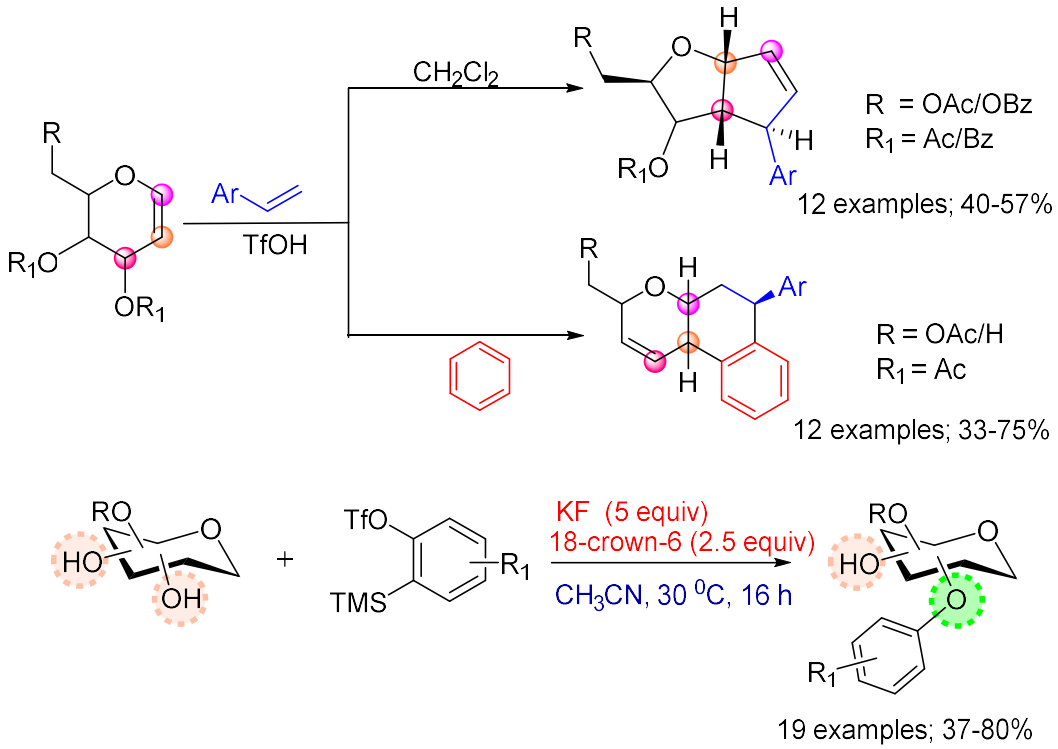

Domino reaction has become one of the most effective methodologyfor the construction of various functionalized molecules and complex products. We have developed an unprecedented reaction strategy for the synthesis of complex oxabicyclic scaffolds with the reaction of glycals and stryrenes. The solvent played a major role in the outcome of the reaction. In the presence of participating solvents like benzene/toluene, cascade Ferrier C-glycosylation and double Friedel−Crafts reaction leads to densely chiral benzo-fused oxadecalins, whereas in DCM, an unprecedented ring-opening, ring-closing sequence generated cis-cyclopentanofurans. We carried out Isotope-labeling studies which revealed that glycosylation is the slowest step. We have also developed a new methodology for the *O*-arylation of carbohydrates under metal free conditions. Our approach worked well with mono, di and trihydroxy compounds and selectively arylated one hydroxyl in the presence of other.

OP-24

Direct N-H/N-Me Aziridination of Alkenes

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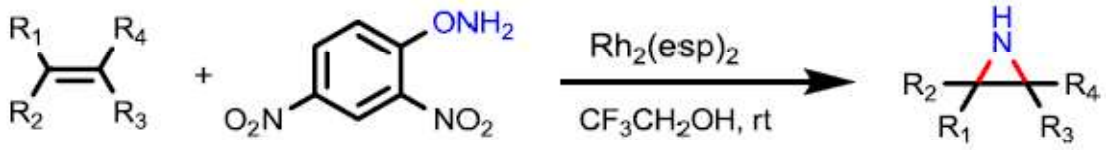
Aziridines are present in a number of bioactive natural products and pharmaceuticals. These are highly useful synthetic intermediates and can be transformed into varieties of useful synthetic intermediates like amino alcohol o diamine etc. While the synthesis of *N*-protected aziridines has been thoroughly investigated, the direct synthesis of N-H aziridines from alkenes has been less investigated. Herein, we describe the regio- and stereo-specific synthesis of N-H aziridines from unactivated alkenes, in a single step using *O*-(2,4-dinitrophenyl)hydroxylamine (DPH) and a di- rhodium catalyst in 2,2,2-trifluoroethanol in good to excellent yields[1].



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OP-25

Synthesis of biodegradable hydrogels PAAc by Inverse suspension polymerization

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Crosslinked Poly (Acrylic acid) was synthesized by inverse suspension polymerization. This process was investigated to determine the influence of different parameters like initiators concentration, stirring speed, and cross linker. An aqueous phase containing partially neutralized acrylic acid, crosslinking agent, and initiator agent was dispersed in an organic phase and stabilized by a surfactant. The polymerization was initiated by potassium persulfate ($K_2S_2O_8$) with MBA as a cross linker and SPAN 80 as a surfactant. The inverse suspension was carried out in toluene (hydrocarbon) as an organic phase because the availability of cross-linker in the aqueous phase is controlled by the partition coefficient of the cross-linker between the aqueous phase and the continuous hydrocarbon phase with varying conditions, such as initiator, cross- linker concentration, dispersant concentration degree of neutralization and stirring speeds on absorption capacities and effect of poly vinyl alcohol in both phases was investigated. The hydrogels were evaluated for their free absorption capacities in saline (0.9% NaCl). These results led to optimization of swelling and absorption behaviors.

Key words: Inverse suspension polymerization, Acrylic Acid, Hydrogels, Absorbency

OP-26

Synthesis of biodegradable superabsorbent polymer by Inverse Suspension Polymerization

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Crosslinked Poly (Itaconic Acid) was synthesized by inverse suspension polymerization. This process was investigated to determine the influence of different parameters like initiators concentration, stirring speed, and cross linker. An aqueous phase containing partially neutralized acrylic acid, crosslinking agent, and initiator agent was dispersed in an organic phase and stabilized by a surfactant. The polymerization was initiated by potassium persulfate ($K_2S_2O_8$) with MBA as a cross linker and SPAN 80 as a surfactant. The inverse suspension was carried out in toluene (hydrocarbon) as an organic phase because the availability of cross-linker in the aqueous phase is controlled by the partition coefficient of the cross-linker between the aqueous phase and the continuous hydrocarbon phase with varying conditions, such as initiator, cross-linker concentration, dispersant concentration degree of neutralization and stirring speeds on absorption capacities and effect of poly vinyl alcohol in both phases was investigated. The hydrogels were evaluated for their free absorption capacities in saline (0.9% NaCl). These results led to optimization of swelling and absorption behaviors.

Keywords: Inverse suspension polymerization, Itaconic Acid, Hydrogels, Absorbenc

OP-27

Palladium-Catalyzed One-Pot Synthesis of 2-(Pyridin-4-yl)quinolines via an Unprecedented Multicomponent Reaction of Pyridine-4-carbaldehyde, 2-Iodoaniline and Triethylamine

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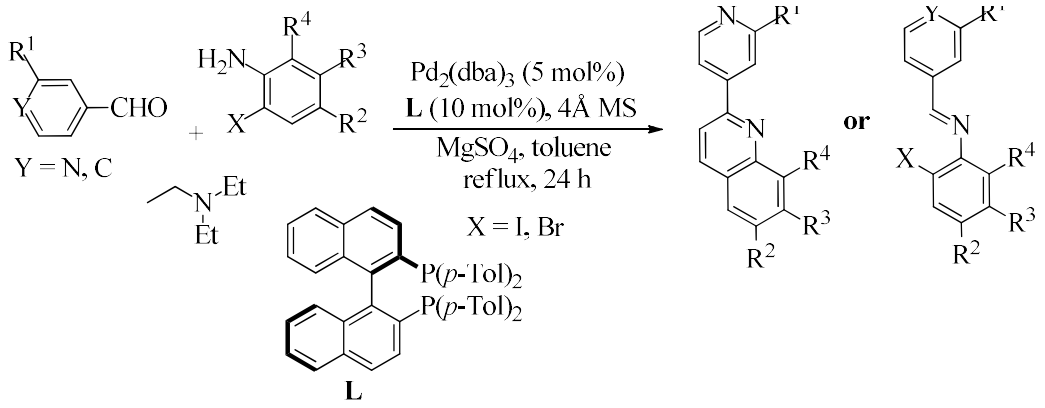
Quinoline is one of the most prominent N-containing heterocyclic aromatic compounds. Quinoline derivatives exhibit a broad range of biological activities like anti-bacterial, antifungal and HIV-1 replication inhibitors. In addition, they also provide other properties, such as anti-asthmatic, anti-hypertensive, anti-inflammatory and anti-platelet activities. In this regard, the literature on the advancement of alternative strategies for the formation of quinoline scaffold has experienced an extensive growth. The advantages of MCRs had drawn our attention to synthesize this scaffold. The reaction of pyridine-4-carbaldehyde and 2-iodoaniline in DMF (5 mL) in the presence of Et_3N (7 equiv.), $Pd_2(dba)_3$ (5 mol%) and PPh_3 (10 mol%) for about 24 h at 110 ^oC showed unprecedented result with the production of 2-(pyridin-4-yl)quinoline. The scope of this unprecedented reaction was explored with the preparation of variety of 2-(pyridin-4-yl)quinolines in one-pot by serendipity via the multicomponent reaction of pyridine-4-carbaldehyde, 2-iodoaniline and triethylamine. In this reaction, three new bonds were formed with the assembly of [3 + 2 + 1] atom fragments. The reactions deal with longer reaction time. However, the simultaneous formation of one C-N and two C-C bonds along with the unprecedented double C-H insertions of Et_3N have made this protocol novel.



A.Ahmed et.al. RSC Adv., 2014, **4**, 53137-53141

OP-28

Rapid synthesis of silver nanoparticles using aqueous plant extract

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Currently, society is facing a crucial issue of environmental pollution. This results in the requirement of the development of a green method nanoparticle synthesis that is eco-friendly. This paper reports a non-toxic, cost-effective, facile, and rapid synthesis of silver nanoparticles using Delonix regia extract. The plant extract is used as a reducing and capping agent for the synthesis of silver nanoparticles. The change in color of the reaction mixture to brownish-yellow indicated the formation of silver nanoparticles. The nanoparticles were characterized by UV- Visible spectroscopy, FTIR, SEM equipped with EDS. The nanoparticles were found to be spherical.

OP-29

Unified Catalytic Enantioselective Total Synthesis of Sesquiterpenoids

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Naturally occurring secondary metabolites cuparenes (1a-b, Figures1), herbertenes (3a-b) and ar-tenuifolene (6a-b) are sesquiterpenoids with cyclopentanoid and cyclohexanoid backbone. They possess a vicinal all carbon quaternary centers including at least one stereogenic quaternary center situated the psedobenzylic position. This sesquiterpenoids are isolated in 1964. Reportedly, these compounds are used to treat fungal infection, cancer, coughs, and arthritic pains. A general catalytic asymmetric route to either enantiomers of sesquiterpenes, cuparenes and herbertenes is disclosed from commercially available 3-methyl cyclopenten-2-one. Following a catalytic enantioselective addition of arylboronic acids to enone, compounds 7a-b with all carbon quaternary stereocenters are synthesized in up to 90% ee in the presence of Pd(II)-PyOx (pyridine oxazoline).

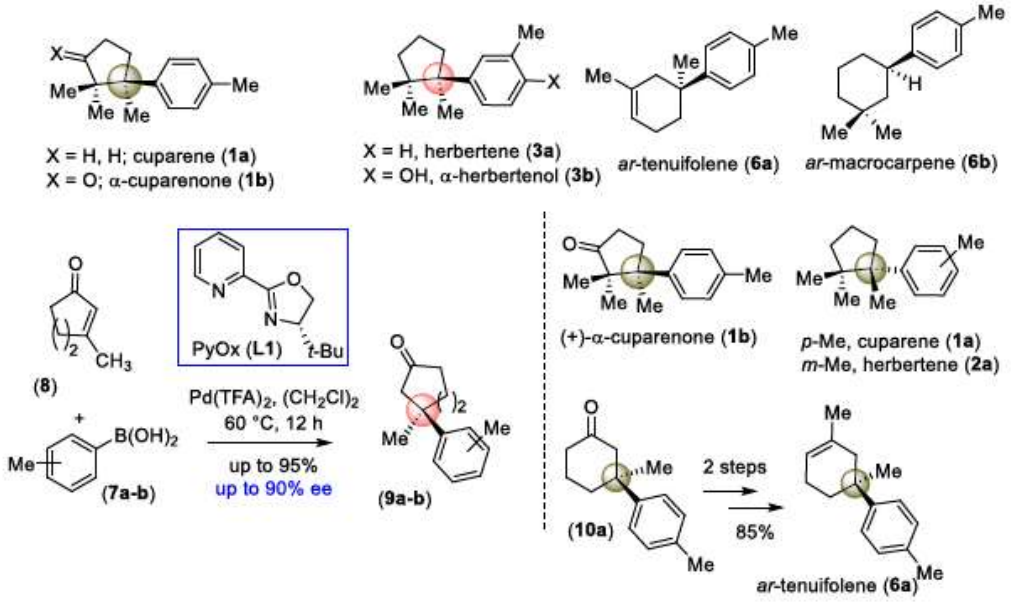

Figure:1 Naturally occurring sesquiterpenoids and our approach

The asymmetric total syntheses of (+)-cuparene (1a) (35% overall yield in 3 steps), (+)-herbertene (3a) (34% overall yield in 3 steps). First catalytic asymmetric total synthesis of aromatic sesquiterpene, ( )-*ar*-teunifolene (6a) is featured (3 steps, 75% overall yields) from commercially available 3-methyl cyclohex-2-enone 4. The enantioenriched 3,3-disubstituted cyclohexanone 12 is obtained from Pd(II)-catalyzed enantioselective (*p*-tolyl)boronic acid addition to 3-methyl cyclohex-2-enone in 95% ee, which is found to be the key intermediate. A diastereoselective methyllithium addition of this enantioenriched product followed by dehydration completes straightforward access to ( )-*ar*- teunifolene (6a).

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OP-30

Concise Asymmetric Total Syntheses of (-)-Nuciferol, (-)-Nuciferal, and (-)- Dihydrocurcumene via Rh(I)-Catalyzed Boronic Acid Addition

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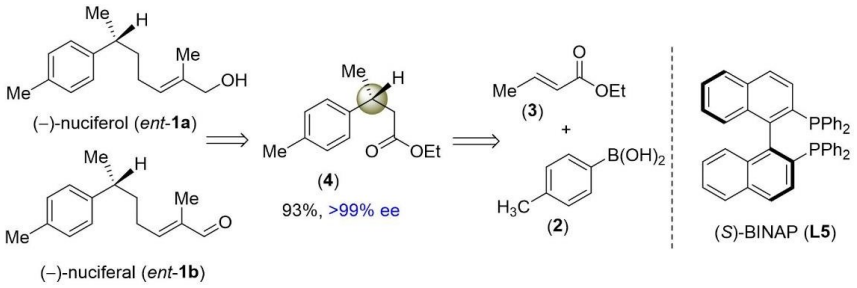
Among various sesquiterpenoids, naturally occurring aromatic bisabolanes are components of many plant essential oils that possess a benzylic stereogenic centers.[1] In particular, oxidized aromatic bisabolanes are attracting increasing attention because of their valuable biological activities.[2] The monocyclic aromatic bisabolane type sesquiterpene (+)-nuciferal (**1b)** was isolated from the wood oil of *Torreya nucifera* by Sakai, Nishimura and Hirose in 1965.[3] Although, there are many reports on racemic approaches to these congeners,[4] however, a catalytic asymmetric approach would be very much welcome to these targets having oxidized side chains, given their interesting biological profiles.



Scheme: Total Syntheses of (-)-Nuciferol and (-)-Nuciferal via Rh(I)-Catalyzed Boronic Acid Addition

In this synthesis we have shown a general catalytic asymmetric total synthesis of aromatic bisabolane sesquiterpenes, (-)-nuciferol (*ent*-**1a**), and (--nuciferal (*ent*-**1b**) in 5-6 steps in high chemical yields from commercially available (*E*)-ethylcrotonate.[5] A key catalytic enantioselective boronic acid addition onto (*E*)-crotonate in the presence of Rh(I)-(*S*)-BINAP (**L5**) afforded enantioenriched product with benzylic stereogenic center in 93% yield with up to >99% ee. Further exploration of aldehyde enabled the total synthesis of (-)-dihydrocurcumene (*ent*-**1c**).

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PP-1

Poster Presentation

Efficient Rh-Catalyzed Tandem C-C/C-N Bond Formation of Quinoxalines with Alkynes: Synthesis of Heterocyclic Quaternary Ammonium Salts

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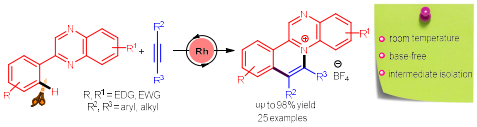
An efficient Rh-catalyzed oxidative C-H activation/annulation of 2-arylquinoxalines with internal alkynes has been described using $Cu(OAc)_2 \cdot H_2O$ and $AgBF_4$ towards the syntheses of diversely substituted quarternary ammonium salts at room temperature. The mechanism of the protocol has been established on the basis of isolation of the 5-membered rhodacycle intermediate and kinetic isotope studies. Mild reaction condition, broad substrates scope and functional group diversity are the salient practical features.



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Synthesis and Antimicrobial Evaluation of Some Novel Sulfonamide Derivatives ContainingOxazole Moiety

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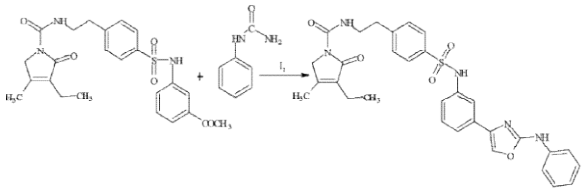
Some oxazole containing sulfonamide analogs have been synthesized by reaction of 4-(2-{[(3-ethyl-4-methyl-2-oxo-2,5-dihydro-1H-pyrrol-1-yl) carbonyl] amino} ethyl) benzenesulfonyl chloride with 3-aminoacetophenone in acetone for 36 h. Which afforded N-(2-{4-[(3-acetylanilino) sulfonyl] phenyl}ethyl)-3-ethyl-4-methyl-2-oxo-2,5-dihydro-1H-pyrrole-1-carboxamide. Different anilines were treated with hydrochloric acid giving aniline hydrochloride, which on further reaction with urea resulted in various phenyl ureas. (N-(2-{4-[(3-acetylanilino) sulfonyl]phenyl}ethyl)-3-ethyl-4-methyl-2-oxo-2,5-dihydro-1H-pyrrole-1-carboxamide) i.e.sulfonamide was reacted with different phenyl ureas in presence of iodine to form oxazoles, which were recrystallised from ethanol. As-synthesized oxazole derivatives were characterized by different techniques. The antimicrobial activity of as-synthesized compounds were tested against (gram-negative bacteria) *Escherichia coli*, and (gram-positive bacteria) *Staphylococcus aureus*.



PP-3

A Literature Serve on Study, Use and Recent Development in Synthesis of Antimalarial Drug Hydroxychloroquine (HCQ) will be Presented in Poster Format

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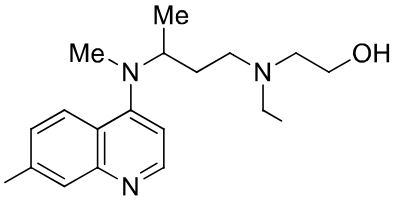
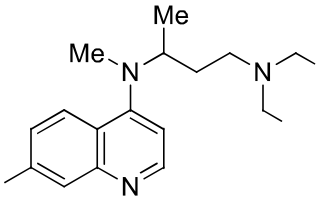
Hydroxychloroquine (1, HCQ) is an effective nonsteroidal drug with anti-inflammatory activity for the treatment of rheumatoid arthritis (RA) in patients with cardiovascular disease. HCQ (**1**) has been identified as an essential antimalarial medication for a basic healthcare system, but global access to HCQ (**1**) has been hindered by high manufacturing costs of the API. Thus, the development of cost effective synthetic strategies to increase the global access to this important global health drug is of great importance.



, **1**)



Chloroquine (**2**)

l drugs

PP-4

Addressing the Background Amplification in RCA: Investigation of the Role of Circular DNA preparation with Three Different Ligation Techniques

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Nucleic acid amplification is a valuable technique in biology and medicine because of its ability to detect trace of target nucleotide sequence. There are different types of nucleic acid amplification techniques such as Polymerase Chain Reaction (PCR), RT PCR, Loop Mediated Isothermal Amplification (LAMP), Rolling Circle Amplification (RCA) etc. Because of its power, simplicity and versatility, RCA can be chosen as an efficient method to develop sensitive diagnostic methods for a variety of target nucleic acids. In RCA, a short DNA or RNA primer is amplified to form a long single stranded DNA or RNA using a circular DNA template and special DNA or RNA polymerases. However, non-specific amplification originating from the choice of ligation process and the subsequent exonuclease treatment is a well-documented problem for RCA-based assay. In this study, three types of ligation processes are investigated, namely, self-annealing ligation, splint-padlock ligation, and sticky end ligation for their role in non-specific amplification. Upon comparison, our investigation demonstrated that only self-annealing ligation followed by combined exonuclease I and III digestion generated circular DNA with a complete absence of non-specific amplification in RCA. The absence of non-specific amplification is possibly due to its independence from the interaction of two or more DNA fragments for circular DNA synthesis. A mechanistic model to rationalize our findings has been proposed. Given the increasing application of RCA as a bioanalytical technique, we anticipate that this work will help the development of non-specific amplification-free RCA-based bioanalytical methods.

References

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Vandana K Nair, Chandrika Sharma, Mrittika Sengupta, Souradyuti Ghosh. Mitigating the Non-Specific Amplification in RCA: Assessment of the Role of Ligation and Exonuclease Digestion in Circular DNA Preparation (submitted to Analytica Chimica Acta)

Selective Cyanation of Heteroaromatic *N*-Oxides with Trimethylsilyl Cyanide: Easily Access to C2-Substituted Heteroaromatic Nitriles under Metal-, Activator-, Base- and Solvent- Free Condition

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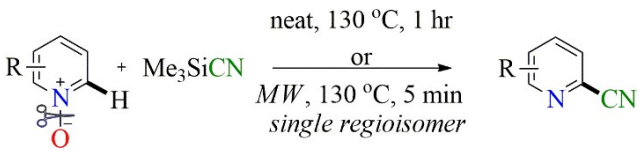
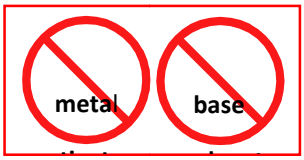
2-Cyanoheterocyclicscaffoldsareaprominentclassofsyntheticintermediates,which have found application in the preparation of a wide variety of biorelevant compounds and pharmaceuticals. To date, a number of synthetic protocol was developed with metal, base and activating agent. However, all of these bear their own limitations, such as (a) lack of regioselectivity (b) metal contamination; (c) required super-stoichiometric amount of base (d) toxic, hazardous, air and moisture sensitive reagent used as activator and (e) halogenated solvent used as solvent medium. Overall, these factors necessitate not only high cost but also exhibit environmental issues. Herein, we report a simple, one-pot, eco-friendly method for the C-H cyanation of heteroarenes *N*-oxides withtrimethylsilylcyanideundermetal-, activator-, base-andsolvent-free conditions.The present protocolis applicable to broad range of substrates with good chemoselectivity and regioselectivity. The synthetic utility of C2-substituted heteroaromatic nitriles is widely explored into several bio- active molecules including late-stage functionalization of anti-malarial drug quinine, and (±)-α- tocopherol modified quinoline derivative. Based on experimental studies, a plausible mechanism is put





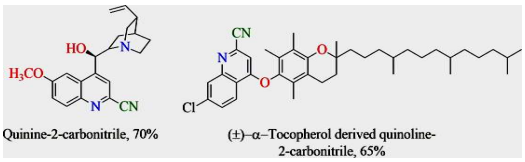
forward involving dual role of trimethylsilylcyanideas cyanide source as well as activating agent. Finally, in terms of industrial perspective, this method is promising as it's simple, highly efficient, eco-friendly and easy toscale-up.

Scheme: C2-cyanation of N-heteroarene-1-oxides with trimethylsilyl cyanide

- ✓ Metal-, activator-, base- and solvent-free
- ✓ Excellent regio- andchemo-selectivity

Broad substrate scope,scale-up

- ✓ No aqueous work up, yields upto98



PP-6

Interaction of Carbazole Derivatives with Xanthene Alkaloids: Spectroscopic Analysis and Density Functional Calculations

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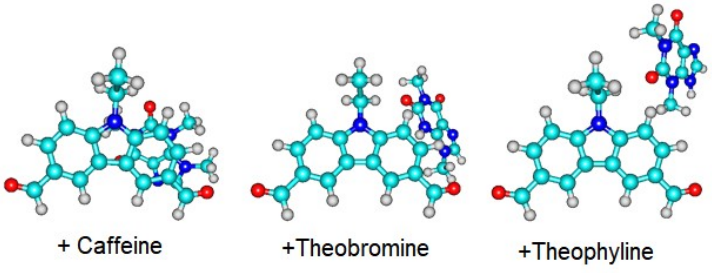
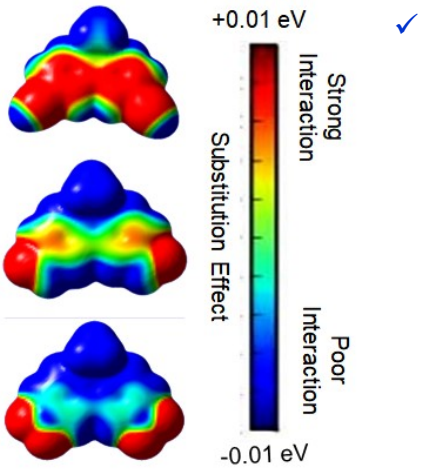
Xanthene alkaloids, such as caffeine, theobromine, and theophylline have often been prescribed as psychoactive drugs despite their negative consequence in the human body. Here we have studied interaction of 9-ethyl-carbazole-3,6-dicarbaldehyde with different xanthene alkaloids using B3LYP/6-31G* level of theory.[1] The shorter π-stacking distance betweenprobe and caffeine as compared to theophylline and theobromine indicates preferential interactiontowards caffeine. Also, compound showed larger binding affinity towards caffeine (ΔE = 13.1 kcal/mol) than that of theophylline and theobromine. These observations could explain the experimentally-observed selectiveinteraction towards caffeine. The prescence of the low-lying LUMO orbitals indicates electron transfer from compound to caffeine in π-stacked complex. Such electron-transfer could explain the caffeine-induced fluorescence quenching. Further, to understand the electronic influence of substituents on analyte-binding, carbazole derivatives with different end-functional groups were included in studies. The π-stacking distances of caffeine complexes were found to be greatly affected by the electronics of the carbazole end-functionality. In the presence of electron-withdrawing substituent, two interactive moieties were found to be drifted apart, while for the electron-rich substituent, π-stacking distance becomes shorter. Experimentally also, we observed larger fluorescence quenching in the case of the electron-deficient substituent (-NO_2).

References:N Dey, B Maji, S Bhattacharya, A Versatile Probe for Caffeine Detection in Real-Life Samples via Excitation-Triggered Alteration in the Sensing Behavior of Fluorescent Organic Nanoaggregates, Analytical chemistry, 2018, 90 (1), 821-829.



Analytes	Binding energy (Kcal/mol)	Δr G_0 298K (Kcal/mol)	Dipole moment (D)
Caffeine	13.1	-19.45	8.47
Theophylline	5.9	-13.14	3.84
Theobromine	9.2	-13.14	3.81



Boric Acid Catalyzed Chemoselective Reduction of Quinolines

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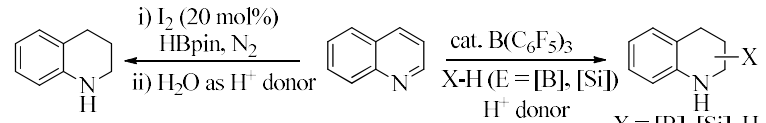
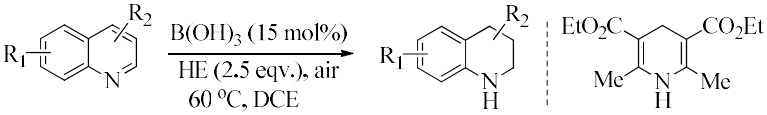
Boric acid catalysed transfer hydrogenation of substituted quinolines under mild conditions with Hantzsch ester as a mild organic hydrogen source is described. The protocol proceeds smoothly in presence of various reducible groups, makes the process more efficient and practical. The work is extended by scale-up studies and transform to several bio-active molecules including nicainoprol.

Previous studies



This work



- Versatile, nontoxic, bottle reagents as hydrogen source
- Metal free, economical and abundant catalyst
- Reducable functional groups tolerance
- Mild conditions, broad substrate scope, upto 98% yield

Calix[4]pyrrole Encapsulated Noble Metal Nanoparticles: A Mini Review

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The calix[4]pyrrole ishetero-calixarenecyclooligomer with intrinsic void like structure, which possessfour pyrrole rings with each pyrrole unit at 2nd and 5th positions bridged with sp^3 carbon atoms, on the other hand nanoparticles are tiny units of the order of nanoscale. Calix[4]pyrrole with nanoparticles emerged as captivating combination that found applications in diverse fields in modern chemistry such as sensors, catalysts, molecular recognition, antimicrobial agents etc. The present mini-review is focusing onfew latest researches on theuses of functionalized calix[4]pyrroleencapsulatednoblemetal nanoparticles like silver, gold, palladium and platinum.

Keywords: calix[4]pyrrole, calixarene, nanoparticles, sensing, catalysis

DFT Study of Metal-Free Organic Azides Addition to C-H Bond: Mechanism Part-II

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Organic azides are important reagents for organic synthesis. Different types of reactions of azides with the C-H bond are possible, yielding useful products. The azide can decompose to nitrene before adding to the C-H bond or it can directly add to the C-H bond, forming the corresponding products. The DFT method B3LYP/6-311++G** was used to calculate the gas phase whole azide addition to C-H bond and substitution reaction of azides to alkane. Three organic azides **R**N_3 (**R** = Hydrogen (H), Methyl (Me), Acyl (Ac)) were reacted with alkane substrates, forming amine/amide and respective products. The direct addition of azide to alkane is exothermic and substitution reaction of azide is endothermic. The geometries of the transition states for various reaction steps studied here are described as “early” or “late” in good accordance with the Hammond postulate.

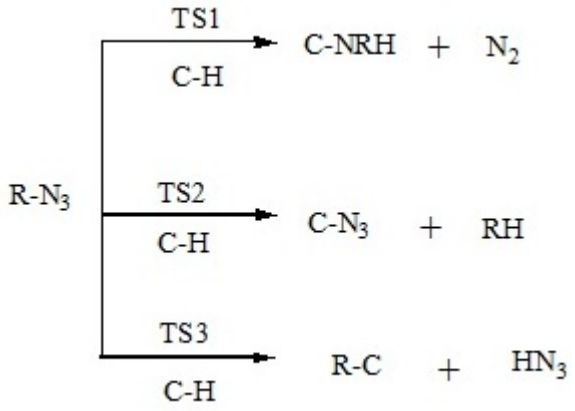

Figure: Three mechanisms of organic azide addition to C-H bond

Comparison of Surface Chemistry of Fluorosurfactants and Hydrocarbon Surfactants

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An alternative short-chain anionic fluorosurfactant (AFS) was synthesized to address the toxicity related issues of long-chain perfluorosurfactants including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). To make AFS more environment friendly than the legacy fluorosurfactants, recent strategies found in literature were incorporated into its structure. It consists of an alkene moiety, hetero atoms such as oxygen and sulfur and a shortened perfluorocarbon chain. Its structure analysis was carried out by ^{1}H NMR, ^{13}C NMR, ^{19}F NMR and FT-IR spectroscopy. The surface chemistry was examined by finding out its surface tension, dynamic surface tension (DST), critical micelle concentration (CMC) and contact angle. The surface tension was 17.6 mN/m at CMC (1.13 mmol/L). The DSTvalue above CMC for AFS was ~29 mN/m at ~10s for 2 mmol/L. It was compared with hydrocarbon surfactants such as sodium dodecyl sulfate (DST ~40 mN/m at ~10s for 10 mmol/L) and sodium lauryl ether sulfate (DST ~40 mN/m at ~10s for 10 mmol/L).It was found comparable to other commercial anionic fluorosurfactant (DST ~25-30 mN/m at 10s above CMC). The obtained surface tension values reflect its applicability in areas requiring high surface activity such as aqueous fire fighting foam (AFFF), paints, coatings and polishes.

Dissipative Self-Assembly For Accessing Functional Non-Equilibrium Gels

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Hydrophobic collapse responsible for the thermodynamically downhill aggregation of aberrant proteins, which has interestingly led to the development of a unique class of soft nanomaterials. However, hydrophobic collapse plays crucial roles in protein functions, from accessing the complex three-dimensional structures of native enzymes to the dynamic polymerizationof non-equilibrium microtubules. The non-equilibrium polymerization is accessed by the dissipative processes which are driven by the endergonic hydrolysis of chemical fuels such as nucleo side tri phosphates. Now, through the simple model systems, the transient self-assembled states are realized by utilizing the catalytic effect of histidine on the formation and breaking of ester bonds. First, histidine facilitates the ester bond formation, which then rapidly co-assembles to form a self-supporting gel. An out-of-equilibrium state is realized owing to the cooperative catalysis by the proximal histidines in the assembled state, driving the second pathway and resulting in disassembly to sol. Such non-equilibrium nanostructures were utilized to access temporal control over its electronic properties. Cooperative effects that use the dual role of imidazoles as nucleophile and as proton donor is utilized to achieve transient assemblies. This simple system mimics the structural journey seen in microtubule formation where the substrate GTP facilitates the non-covalent assembly and triggers a cooperative catalytic process, leading to substrate hydrolysis and subsequent disassembly.

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Coupling Reaction of Nitromethane with Aza-Aromatics Activated by Chloroformate Ester

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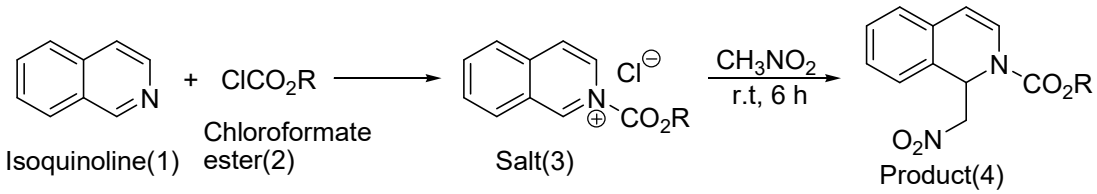
Quinolines and isoquinolines, also known as aza-aromatics are structural isomer to each other. They are very important structural unit present in many natural products, pharmaceuticals and also in advanced organic materials used as electroluminescent dopants for light emitting devices.[1]

Herein, we report that when these aza-aromatics were activated with chloroformate ester activated compound(3) is formed, which when treated with nitromethane produces product(4) (Scheme 1).



Scheme 1

This method was used to couple nitromethane with various aza-aromatics to yield various dihydro isoquinolines/quinolines. The whole reaction proceeds in a single step, at room temperature and without any catalyst. The reaction is highly regio-specific making it a useful process for the synthesis of 1-substituted/2-substituted nitromethyl derivatives of dihydroisoquinolines/dihydroquinolines respectively in a single step.

Keywords: aza-aromatics, electroluminescent dopants, chloroformate ester, regio-specific.

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PP-13

Catalytic N-Deacylative Alkylation of Indoles for The Total Synthesis of Hexahydropyrrolo[2,3-b]indole Alkaloids

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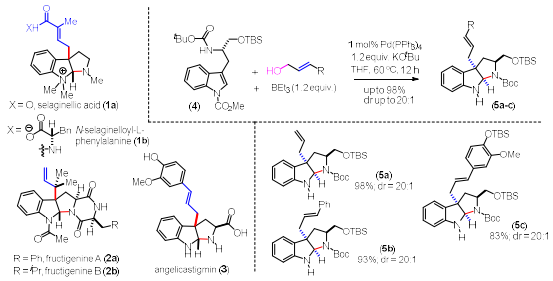
Hexahydropyrrolo[2,3-b]indolines with a C(3)-quaternary center, have received significant attention both fromthe chemistry and biology communities because of their impressive pharmacological activities.[1]This structural motif is prevalent in myriad of architecturally complexand biologically active compounds which are mostly found in fungi, bryozoans, cyanobacteria[2] and other species. We targeted a subset of this class of natural products with hexahydropyrrolo[2,3-b]indole moieties having 1-(3,3-dimethylallyl) substituent flanked at the indolineC3 quaternary center (see, 1a-b.3)



Scheme: Hexahydropyrrolo[2,3-b]indoles alkaloids and our hypothesis via catalytic DaA.

In this direction, we have developed a catalytic synthesis of hexahydropyrrolo[2,3-b]indoles having C3 quaternary center from N-acyl 3-substituted indolesinvolving a key Pd(0)-catalyzed N-deacylative C-alkylations).[4] Eventually, a highly diastereoselective synthesis of chiral pyrroloindolines 5a-c is also shown from compound 4prepared from L-tryptophan. Given their biological importance and recent interest in the synthesis of complex pyrroloindoline alkaloids, this transformation is particularly notable in context of potentially interesting molecules.[5]

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Oxidative Cyanation onto 2-Oxindoles: Formal Total Synthesis of (±)- Gliocladin C''

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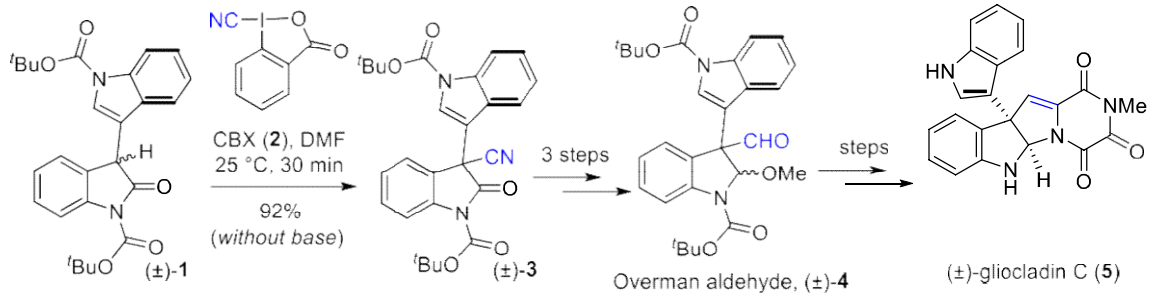
The tryptophan derived hexahydropyrrolo[2,3-*b*]indole diketopiperazine (DKP) substructure (**5**) is found in a large number of structurally diverse natural products.[1a] Compounds of this family that bear an indole moiety at the C-3 position have shown a considerable attraction due to their complex molecular structures and their potential biological activity as antiviral, and antibacterial agents. For example, (+)-gliocladin C (**5**), isolated in 2004 by Usami and co-workers,[1b] exhibits potent cytotoxic effects in P388 lymphocytic leukemia cells in vitro with a reported EC_{50} value of 2.4 μg/mL.[1b]

In this direction, we have developed a novel entry for the direct incorporation of a nitrile functionality onto 3-substituted 2-oxindoles [(±)-**3**] employing Cyano-1,2-BenziodoXol-3(1H)-one (CBX, **2**) reagents under *transition-metal free* oxidative condition.[2] This method affords a wide variety of 2- oxindole 3-cyano-3'-alkyl/indolyl [(±)-**3**] under *transition-metal free* condition (Scheme 1). It has been found that, the C-3 proton of 3-substituted 2-oxindoles which seems to be more acidic, are excellent substrates, where electrophilic cyanation works without the use of any base (Scheme 1).



Scheme 1: Formal Total Synthesis of (±)-gliocladin C (**5**).

Compound [(±)-**3**] having an all-carbon quaternary steroecenter synthesized *via* the key oxidative cyanation reaction of oxindole [(±)-**1**] using CBX (**2**) reagent under the standard condition (Scheme 2). Later, a formal total synthesis of (±)-gliocladin C [(±)-**4**] had been reported from aldehyde compound (±)-**4** [(±)-**4** known as Overman aldehyde] *via* few synthetic elaborations.[3]

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Total Syntheses of Naturally Ocurring Bis-Hexahydropyrrolo[2,3-*b*]indole Alkaloids

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Total synthesis of naturally ocurring alkaloids can play a crucial role in bioactivity evaluation by providing access to significant quantity.[1, 2] It also provides platform for the innovation of new strategies for chemical synthesis. Further, catalytic asymmetric construction of organic molecules sharing all-carbon quaternary stereocenter is one of the challenging aspects of synthetic organic chemistry.[2] Enantioselective syntheses of targets having contiguous all-carbon quaternary stereocenters (see, **1-3**) invariably face even more difficulty.[3] Towards this, naturally occurring Bis- hexahydropyrrolo[2,3-*b*]indole alkaloids (**Figure 1**) with impressive diversity of biological activities drew our interest. Biosynthetically, they are imagined to be arisen from L-tryptophan.[3] Interestingly, a variety of alkaloids of this family show antibacterial and cytotoxic activities. Our catalytic asymmetric approach via the development of allylation at the pseudobenzylic position of 2-oxindoles (Scheme 1) will be discussed for the total syntheses of these alkaloids.[4]

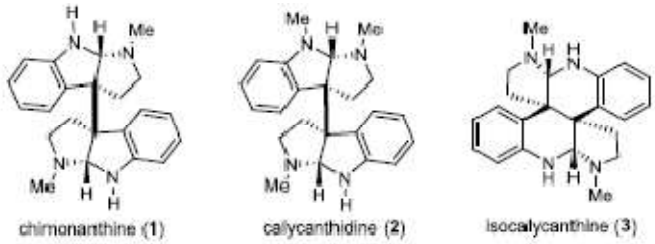
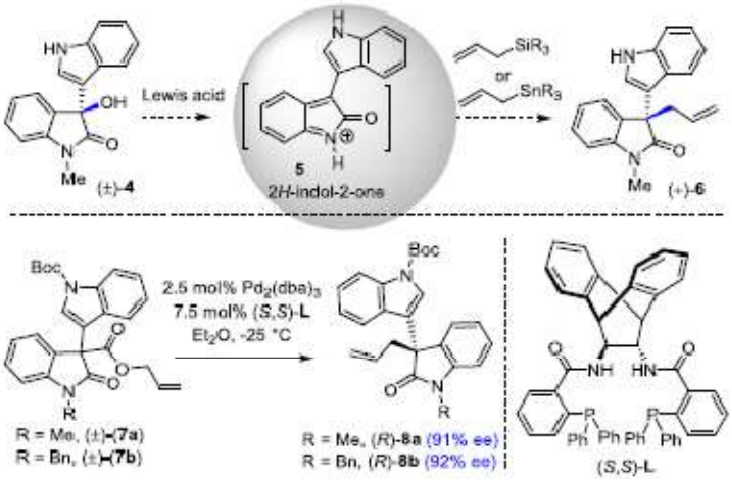


Figure 1: Bis-hexahydropyrrolo[2,3-*b*]indole alkaloids.



Scheme 1: Our approach to Bis-hexahydropyrrolo[2,3-*b*]indole alkaloids (**1-2**).

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PP-16

Harnessing Free Amine Directing Group in Ruthenium-Catalyzed C-H Bond Activation/Annulation Reaction for Natural Product Scaffolds

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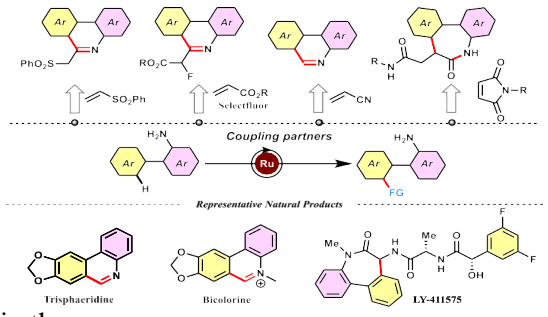
Over the last two decades, transition-metal-catalyzed C–H bond activation/functionalization has emerged as a vibrant area of research, allowing functionalization of otherwise unactivated C–H bonds and offering unconventional disconnection approach for the synthesis of complex molecules.[1] Directing group (DG) plays pivotal role in this strategy in controlling reactivity and regioselectity issue. Obviously, consideration of free amine functionality as a DG is highly rewarding as it is an important constituent of a large variety of natural products and can also be easily transformed into variety of other functionalities.[2] However, materialization of this concept constitutes several challenges, like formation of stable yet unreactive transition metal complexes, direct nucleophilic reactions with coupling partners, as well as competing undesired side reactions such as oxidative degradation and *β*-hydride elimination. With judicious tuning of reaction conditions, we have successfully engaged free amine functionality as a DG in arene C-H bond activation reactions under inexpensive ruthenium catalysis. A cross-ring (5+1) annulation reaction between 2-arylanilines and activated olefins has been established for the synthesis of phenanthridines frameworks.[3a] Following this strategy, bioactive natural products such as *trisphaeridine* and *bicolorine* were also prepared in high yields. When maleimides was employed as coupling partners with ruthenium(II) catalyst, dibenzo[*b,d*]azepinones, which represent the core of several bioactive molecules including LY-411575, were isolated in very high yields.[3b] Dibenzo[*b,d*]azepinones with side-chains derived from chiral amino acids were also obtained in one step, highlighting the synthetic utility of this protocol. Mechanistic investigation covering deuterium exchange studies and *KIE* experiments suggest that the C□H bond activation takes place via an organometallic pathway in these processes.



Scheme 1: Ruthenium-catalyzed free amine directed cross-ring annulation.

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PP-17

DNA-binding and Photocleavage studies of Benzimidazo[2,1-a] ellipticine derivatives

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The DNA-binding properties of novel three Benzimidazo [2,1-a]ellipticine derivatives with CT-DNA has been investigated by absorption spectroscopy, EB-DNA displacement, circular dichroism, viscosity measurement and thermal denaturation studies. The experimental evidences indicated that these compounds could interact with CT-DNA through intercalation into the base pairs of DNA.The binding affinity of the compounds was quantified by calculating the K_b values, suggesting that compounds showing greater DNA binding propensity. Furthermore, to understand the binding mechanisms of these compounds with DNA, the effect of ionic strength on the fluorescence property of the system have been investigated. The results indicated the presence of electrostatic interaction via phosphate backbone of DNA helix. These compounds have also been found to promote the cleavage of plasmid pBR322 DNA under physiological conditions. The results indicate that DNA might also serve as the primary target of these compounds, hence demonstrating promise in their further development as potential anti-cancer agents.

PP-18

Determination of Carbofuran in Various Samples of Water and Vegetables Using 3, 4-Dimethyl Aniline

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A carbamate insecticide carbofuran is determined by simple and sensitive spectrophotometric method. The method is based on the fact that on hydrolysis of carbofuran under alkaline condition carbofuranphenol is formed, on coupling it with 3, 4 dimethyl aniline. The colored dyes is formed which give absorption maxima at 455 nm. Beer's law is followed at the concentration range of 4 to 35 µg in a final solution of 25 ml. The molar absorptivity, sandell's sensitivity, standard deviation and relative standard deviation were calculated. The method was free from interference of other pesticides and diverse ions, and can be used for the determination of carbofuran in different water and vegetable samples.

Keywords- Carbofuran, spectrophotometer, 3, 4 -dimethyl analine, water and vegetable samples.

PP-19

Synthesis and anti-bacterial and cytotoxic evaluation of terminal alkynes from NSAIDS via O,N,S Propargylation

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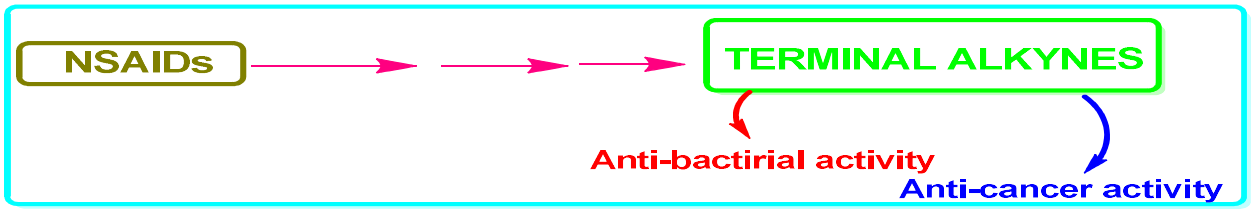
A terminal alkyne is an alkyne in whose molecule there is at least one hydrogen atom bonded to a triply bonded carbon atom. According to Ferdinand Bohlmann, the first naturally occurring acetylenic compound, dehydromatricaria ester, was isolated from an *Artemisia* species in 1826. In the last two centuries over a thousand naturally occurring acetylenes have been discovered and reported. Polyynes, a subset of this class of natural products, have been isolated from a wide variety of plant species, cultures of higher fungi, bacteria, marine sponges, and corals.[1,2] Alkynes occur in some pharmaceuticals, including the contraceptive noretynodrel. A carbon–carbon triple bond is also present in marketed drugs such as the antiretroviral Efavirenzand the antifungal Terbinafine. The acidic hydrogen on terminal alkynes can be replaced by a variety of groups. Based on this we prepared some terminal alkynes from NSAIDS via N,O, Spropargylationin aqueous DMF media. All the synthesized compounds were purified by chromatographic techniques and well characterized by spectral data IR, NMR and Mass. These compounds were further used to test for antibacterial activity and anti-cancer activity.



Key words:Terminal Alkyne, NSAID, eco-friendly synthesis, Antibacterial activity and anti-cancer activity.

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PP-20

Synthesis and Anti-bacterial, Anti-cancer activity and docking study of nsaid-triazole-peptide conjugates

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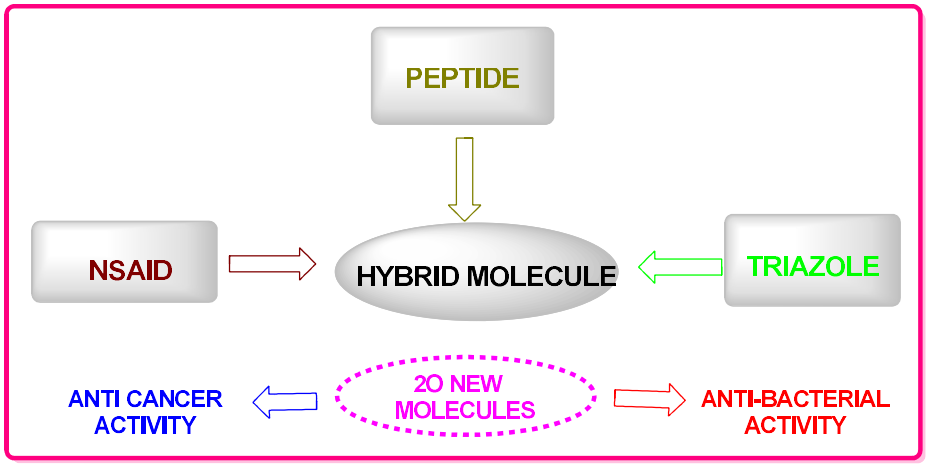
In search for new drug entities, the hybridization approach, is a promising route that can successfully target multifactorial diseases including cancer. Peptides are found throughout every cell and tissue in the body and are an integral part of most biologic processes. Clinically some of the peptides are used as antibiotics, anticancer drugs Triazoles are appeared as a suitable pharmacophoric equivalent as they are known for their versatile pharmacological applications. A new hybrid template designed by linking three pharmacophores, i.e. triazole, NSAID and peptide moieties have been used for the generation of a library of 20 molecules. All the products were characterized by IR, NMR and Mass spectral data. These compounds were further used to test for cytotoxic properties against Human Colon Cancer Cell Line A549, and antibacterial properties against both gm positive and gm negative bacteria.

Key words: Peptide, 1,2,3-Triazole, NSAID, Peptide Alkyne, eco-friendly synthesis, Anticancer activity and Antibacterial activity



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PP-21

A Cost Effective and Facile Method for the Synthesis of Graphene Oxide and its Microstructural Analysis

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A highly sustainable approach for the preparation of high-quality graphene oxide has been demonstrated by oxidation of graphite flakes via modified Hummers method using H_2SO_4 as an intercalating agent and $KMnO_4$ and H_2O_2 as oxidizing agents. The interpretation has been done under different reaction conditions. The present method does not require costly membranes for the separation of unwanted carbonaceous and metallic residues. The pre-cooling method is used to eradicate the explosive nature of intermediate steps. The synthesized graphene oxides are of high quality which was confirmed by a host of characterization techniques including FTIR, TGA, XRD, EDX, FE-SEM and AFM. The outcomes of characterization revealed that the synthesized product, GO-2 has high percentage of oxygen-containing groups and an increase in the carbon/oxygen (C/O) ratio established the synthesis of high-quality graphene oxide.

Keywords: Graphene oxide, Modified Hummer's method, Characterization

PP-22

Total synthesis of (+)-*ar*-macrocarpene

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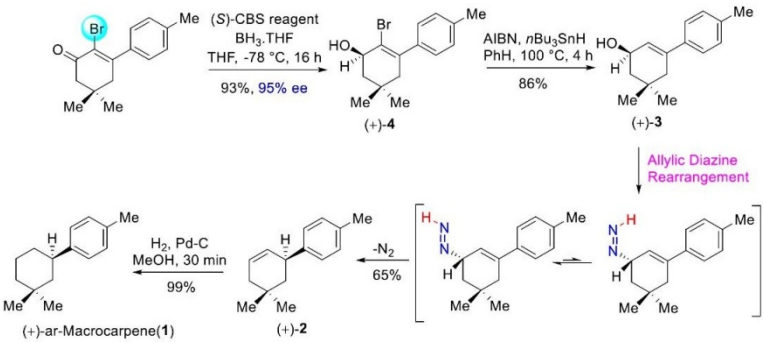
Sesquiterpenoids display diverse commercial applications in the pharmaceutical and perfumery industries together with their roles in interactions of plants with other organisms (e.g., allelochemicals and insecticides). Macrocarpenes including one such group of naturally occurring irregular sesquiterpenes possessing a 3,3,4′-trimethyl-1,1’-(bicyclohexyl) skeleton seems to be biogenetically derived from rearrangement of structural scaffold. These sesquiterpenoids were identified in foliage of Cupressus *macrocarpa* by Cool in 2005 in widely varying amount.[1] Since its isolation more than a decade ago, to date just a single racemic approach of *ar*-macrocarpene (**1**) has been featured in the literature by Srikrishna and co-workers in 2007.[2]

In this direction, we have developed the first catalytic asymmetric total synthesis of a sesquiterpene, (+)-*ar*-macrocarpene (**1**), in 7 steps with 42.1% overall yields from commercially available inexpensive 5,5-



Scheme: Total synthesis of (+)-*ar*-macrocarpene(**1**)

dimethylcyclohexane 1,3-dione.[3] This strategy relies on a key [3,3]- sigmatropic rearrangement effecting reductive transposition through allylic diazene rearrangement[4] (ADR) in a single step from intermediate allylic alcohol under the Mitsunobu reaction conditions with *o*-nitrobenzenesulfonyl hydrazide (*o*-NBSH). Enantioselective reduction of α-bromo vinylogous ester under the Corey–Bakshi–Shibata reduction[5] conditions forges the required stereocenter in the allylic alcohol (+)-**4** in a highly enantioenriched manner (95% ee).

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In silico modeling of 5-Chloro-2-thiophenyl-1,2,3 triazolymethyldihydro quinolines inhibitors as Mycobacterium Tuberculosis target

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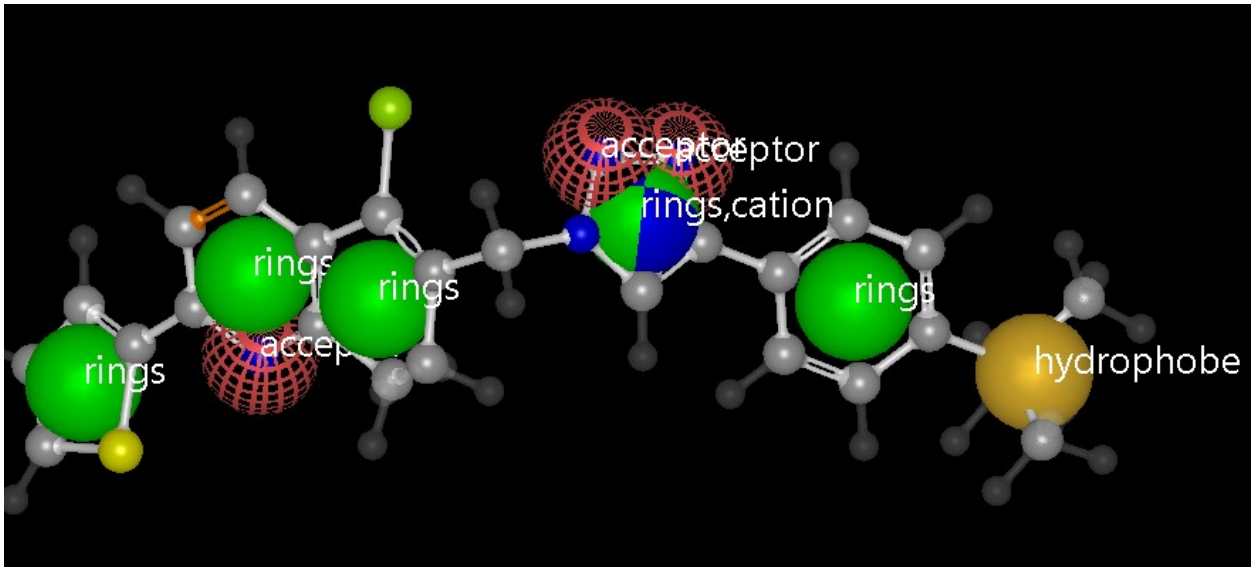
The silico study on Mycobacterium Tuberculosis the inhibitors with a series of 5- Chloro-2-thiophenyl-1,2,3-triazolymethyldihydroquinolines is reported. A large set of Preclav descriptors have been used to obtain four parametric models. This study presents quantitative structure activity relationships (QSAR) study on a pool of 15 compounds. The quality of prediction is high enough (*Se* =*0*.0583 r^2 = *0*.9607, *F* =97.7573, *Q* =7686). A heuristic algorithm selects the best multiple linear regression (MLR) equation showed the correlation between the observed values and the calculated values of activity is very good.



Keywords: 5- chloro-2-thiophenyl-1,2,3-triazolymethyldihydroquinolines, MOPAC, PRECLAV, inhibitors, Mycobacterium Tuberculosis

PP-24

Chemometric modeling and in silico design of Tumor-Associated Carbonic Anhydrases IX Sulfocoumarins inhibitors

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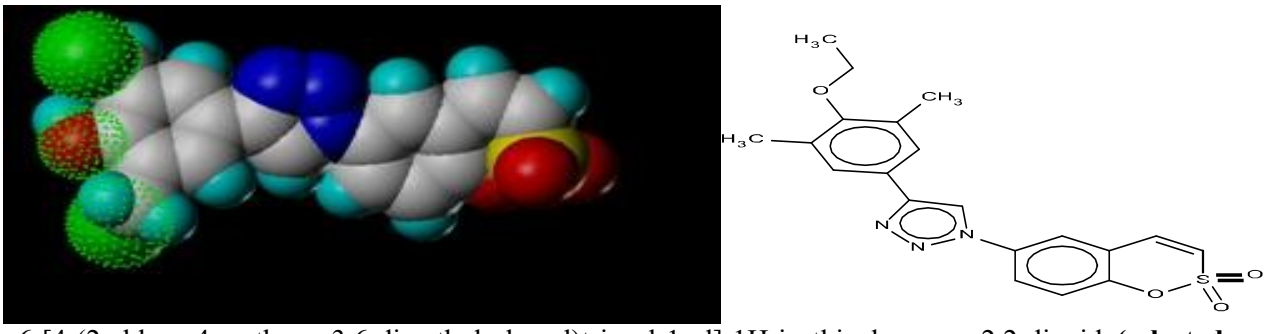
We have attempted to build QSAR models on Tumor-Associated Carbonic Anhydrases CAIX inhibitory activities. The quality of prediction is high enough (***Se*** **=0 .**2306**,** r^2 **=*0*.**9027**,** ***F*** =40.1919**,** r^2_{cv} =0.7716 ***).*** The virtual molecular fragment that lead to a significant increase of the inhibitor activity of hCA IX is C_2HN_3 , The virtual fragments , Br atom and NO_2 leads to a significant decrease of the inhibitor activity value. The innovation of this work consists in not only exploring the structural attributes of bioactive molecules but in predicting in silico the structures of twenty eight new compounds which may show Tumor-Associated Carbonic Anhydrases IX (CAIX) inhibitory activity. The various pharmacokinetic evaluations and synthetic accessibility test were also carried out to search more suitable compounds. The molecules of the prediction set include many molecules having high computed activity.

Keywords:: CAIX inhibitor; sulfocoumarins (1,2-benzoxathiine2,2-dioxides)QSA*R* PRECLAV; BROOD; DRAGON



_6-[4-(2-chloro-4-methoxy-3,6-dimethyl-phenyl)triazol-1-yl]-1H-isothiochromene 2,2-dioxide**(selected area shows the most active side of compound**

Physical Chemistry Section

Award Presentation

AO-1

Award Oral

Protein-Templated Gold Nanoclusters as Specific Bio-Imaging Probe for the Detection of Hg(II) Ions in *In Vivo* and *In Vitro* Systems: Discriminating MDA-MB-231 and MCF10A Cells

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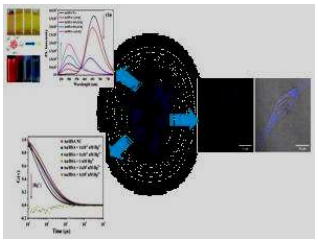
Owing to their unique quantized optical properties, low toxicity and bio-compatibility small sized luminescent noble metal nanoclusters (NCs) have been a topic of global contemporary research.[1-4]



In this work[#], gold nanoclusters (AuNCs) are synthesized within a protein template (Human Serum Albumin, HSA) which is exhibiting long excited state luminescence lifetime. These AuNCs own promising quantum yield about >10% having intense red luminescence with the peak centered at 660 nm and remarkable photo and cluster-core stability for a prolonged period (more than a year). This AuNCs were efficient to quantify the Hg(II) in solution as well as bound to the hormone, Insulin at single molecule sensitivity using fluorescence correlation spectroscopy (FCS) highlighting a sub-nanomolar detection limit. Cell-viability study directs that this NCs can be used as a probe for cell imaging by particularstaining of the cancerous cell, MDAMB231. Interestingly, this AuNCs is able to sense Hg(II) ion inside the MDAMB231 too. From the cell imaging study, it was revealed that the fluorescence of AuNCs was also quenched by Hg(II) ion inside the MDAMB231 cell lines. Thus the

output of our study apprises the sensitive *in vivo* as well as *in vitro* detection of Hg(II) ions using AuNCs as a probe.[#]

Keywords: Gold Nanoclusters, Single molecule sensing, Bio imaging

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AO-2

Deciphering the Evolution of Supramolecular Nanofibers through a Combined Microscopic and Spectroscopic Approach

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Supramolecular self-association of small π-conjugated organic molecules leads to well-defined nanoarchitectures like vesicles, micelles, low molecular weight gels, and other noncovalent aggregates with morphology-dependent tunable emission.[1-3] However, the correlation between the nature of the morphology (solid-state characterization) and the emission behaviour (dispersion-state analysis) of the aggregates are often rudimentary and can be benefitted through further analysis. In this present study, we demonstrated the detailed insight of the nanofiber evolution from a true solution.The field emission scanning electron microscopy (FESEM) imagesshowed the formation of the connected network of nanofibers for the dispersion having water content 80%. However, the formation of smaller-sized nanofibers in the dispersion was realized from fluorescence correlation spectroscopy (FCS) results (Fig. 1). Such smaller nanofibers can be transformed into the connected network of nanofibers through agglomeration during the solvent evaporation in the course of sample preparation for the electron microscopy. Further, the mechanism of nanofiber evolution was demonstrated through reversible morphological transformation in the presence of external stimuli (acid, base) and molecular modelling studies (Fig. 1). Hence, we believe the present study will provide a general experimental protocol to establish the relation between the nature of morphology and emission behaviour for all-organic fluorescent nanoaggregates.

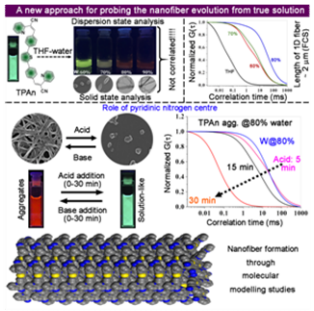

Fig. 1 Schematic illustration depicting the evolution of nanofibers from true solution through electron microscopy coupled with fluorescence correlation spectroscopy (FCS). The role of pyridinic nitrogen centre for the nanofiber formation was also demonstrated using FCS and molecular modelling studies.

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AO-3

In vitro distinctive complete inhibition of fibril formation of bovine and human serum albumins by methotrexate: A combined experimental and molecular simulation studies

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Apparently never-ending lag-phase in the fibrillationof serum albumins (SAs) with low concentrated drug, methotrexate (MTX) is very promising and unique for clinical aspect toward inhibition of amyloidosis. Here we revealed that MTX significantly inhibits thermally induced bovine serum albumin and human serum albumin fibrillation by using fluorescence spectra, circular dichroism (CD) spectra, FESEM images, native gel electrophoresis and simultaneously theoretical studies. The kinetic profiles of BSA-MTX and HSA-MTX exhibit the appearance of lag phase followed by significant inhibition of fibrillation.Additionally, theobservation of negligible changesin CD dataof SA in presence of MTX at 65 ^{O}C, except a little increase of a-helix content, indicated that the secondary structure of SA is not significantly affected by thermal treatment. Furthermore, SEM studiesdistinct the formation of larger oligomeric speciesinstead of fibrillar aggregates during heating of SAsinpresence of MTX. Moreover, aggregation propensity, molecular docking and molecular dynamic simulation studies revealed a molecular level scenario that also explained high suppression of fibrillation and the longer lag-phase in kinetics by MTX, which further support experimental results. The results are beneficial for clinical potential having therapeutic relevance for drugs with structural similarity to MTX in controlling aggregation related diseases.

AO-4

Organic and Inorganic Benzene Transform to Superalkalis: An *InSilico* Study

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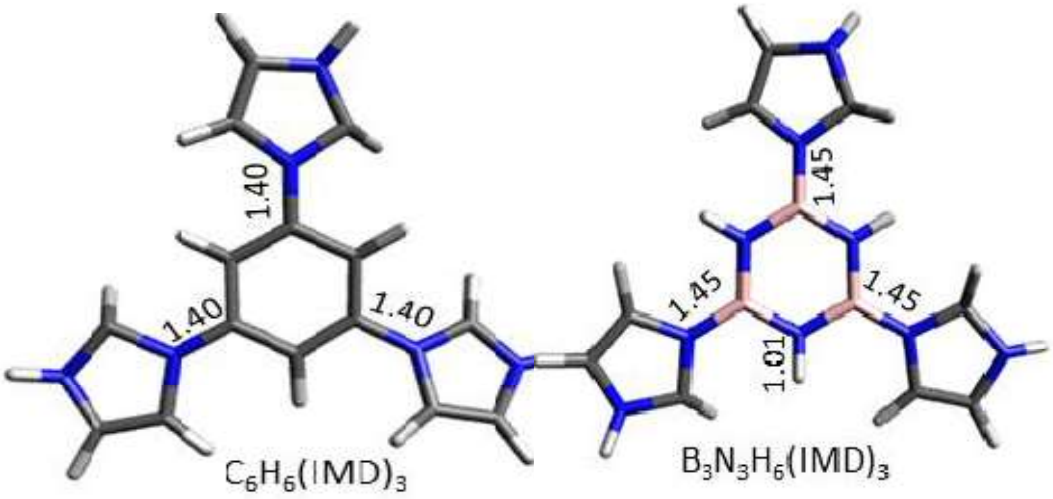
Organic molecules, Benzene, and its inorganic version, Borazine are stable due to their aromaticity. The high ionization energies of these molecules suggest that they are reluctant to release the electron. Based on first principle calculation, we have shown the possibility of having superalkali molecules where benzene and borazine are acting as a core. Two different ligands, imidazole (IMD) and imidazole-based N-Heterocyclic carbene (NHC) have been used to get the superalkali molecules. It has been found that both benzene and borazine can from superalkali with these ligands and the ionization energy decreases to ~ 3.0 eV in tri-substituted complexes. We have observed that benzene can make better superalkali than borazine with suitable ligands like imidazole and NHC.



AO-5

Cryostablization of the Cell Membrane of a Psychrotolerent Bacteria via Homeoviscous Adaptation

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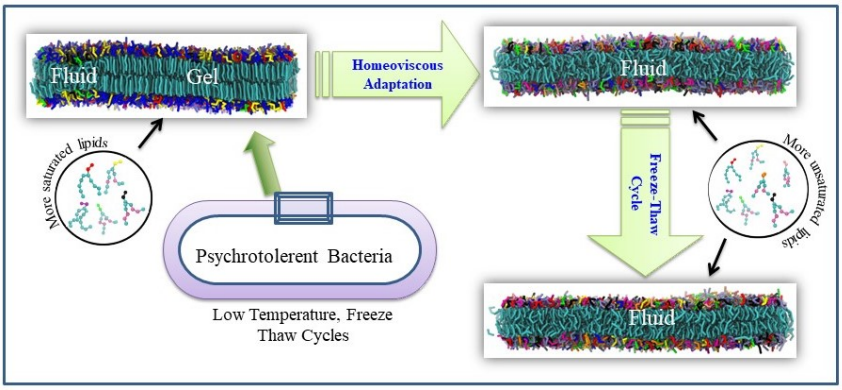
Homeoviscous adaptation (maintenance of a critical balance between the saturated and unsaturated lipids) of the cell membrane of psychrotolerent bacteria is essential to protect them against freeze-thaw cycle. But, how does the homeoviscous adaptation protects the cell membrane during cold stress? In this letter, we answer this question using coarse grained (CG) molecular dynamics (MD) simulation technique. Based on the reported fatty acid profiles of a psychrotolerent bacteria at different temperatures, multiple lipid membranes are simulated at wide range of temperatures between 250 K and 300 K. We explicate how the homeoviscous adaptation minimizes the effect of cold stress on the structure and fluidity of the membrane. Partial freezing of the saturated lipid domain occurs with the self-aggregation of saturated and unsaturated lipids near melting temperature of the unadapted lipid membrane. The gel-like phase provides necessary local packing density to be sensed by the sensor proteins responsible for homeoviscous adaptation.



Graphical Abstract

AO-6

Atomic and Molecular Level Study of Substrate Binding and Small Ligand Migration in 8-Lipoxygenase

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Lipoxygenases are a family of non-haem, non-sulphur iron-containing lipid peroxidising enzymes that catalyse stereo and regio-specific formation of hydroperoxy derivatives from poly-unsaturated fatty acids in the presence of molecular oxygen[1,2]. Lipoxygenases are found in plants, animals and fungi. Their catalytic action has important consequences in a range of inflammatory and associated diseases. In this presentation, we would discuss the presence of a multi-channel network of oxygen migration pathways that allow an effective transfer of oxygen from bulk to the active site. We will discuss the relation between oxygen population in different migration channels and formation of different stereo and regio-specific products in wild-type as well as several mutants of lipoxygenases. The results indicate a possibility of evolutionarily optimized migration channels in lipoxygenases that allow accumulation of oxygen density at certain regions to attain regio-and stereo-specificity. In particular, we will highlight the effect of a single point mutation (L434F) on the conformational dynamics in the active site and consequent change in oxygen migration channels resulting in a complete change of the regio- and stereo-specificity of theproducts.

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AO-7

Role of Solvent in the Relaxation Dynamics of Core-Shell Au-SiO_2 Nanoparticles

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Relaxation dynamics of surface plasmons in Au-SiO_2 core-shell nanoparticles has been followed by femtosecond pump-probe technique.[1,2] The effect of excitation pump energy and surrounding medium on the time constants associated has been elucidated. A gradual increase in the electron-phonon relaxation time with pump energy is observed and can be attributed to the higher perturbation of the electron distribution in AuNPs at higher pump energy.[3] Variation in time constants for electron-phonon relaxation in different solvents is rationalized on the basis of their thermal conductivities, which govern the rate of dissipation of heat of photoexcited nanoparticles.[4] On the other hand, phonon-phonon relaxation is found to be much less effective than electron-phonon relaxation and the time constants associated with it remain unaffected by thermal conductivity of the solvent.

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AO-8

Synthesis and characterization of cobalt nanoparticles to investigate their acoustical properties and biological potentials

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In present research, cobalt (Co) nanoparticles were synthesized by metal reduction method followed by their characterization to study acoustical parameters and biological potentials. Five different concentrations (0.05-0.25% by weight) of Co nanofluids were developed by suspending Co nanoparticles in gum arabic – ethylene glycol (EG) mixture followed by ultrasonication. The variation of speed of sound, viscosity and density, and different acoustical parameters of these nanofluids were investigated at different temperatures. Co-EG nanofluids exhibits a maximum speed of sound for a specific concentration (0.15 wt %), which is higher than the speed of sound in the EG. Speed of sound was decreased with the rise of temperature. Viscosity and density of nanofluids increased with concentration and decreased with temperature. Variations in acoustical parameters were used to understand the associations between particle and fluid molecules. In wound healing study, Co nanoparticles ointment increased per cent wound contraction on day 5, 10 and 15 post-wounding in comparison to control group. Quality of healing was also better in wounds treated with Co nanoparticles. In conclusion, acoustical results are helpful in extending the use of Co-EG nanofluids to different industrial areas. Co nanoparticles might be envisioned as a promising wound healing agent.

Mechanism of Pb^{2+} sensing in water with PEI-capped photoluminescent CdS quantum dots

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Polyethyleneimine (PEI) capped CdS quantum dots (QDs) have been synthesised directly in water and their metal-ion sensing properties are investigated. Photoluminescence (PL) of the QDs is severely quenched (~80%) in presence of lead ions along with decrease in PL lifetime. We further elaborate upon the mechanism of quenching using transient absorption (TA) measurements of CdS QDs in presence of various concentration of Pb^{2+} ions. We observe signatures of efficient hot electron transfer.[1] Mechanism of quenching is found to be surface adsorption of Pb^{2+} ions and quenching due to electron transfer. Surface adsorption binding constant is estimated to be 5.35×10^{4} M^{-1}.[2] Additionally electron transfer rate from conduction band edge is calculated to be 1.45×10^{11} s^{-1}.[3] Driving force, QD surface quality and capping agent are found to be deterministic factors in the observed response and selectivity to metal ions.

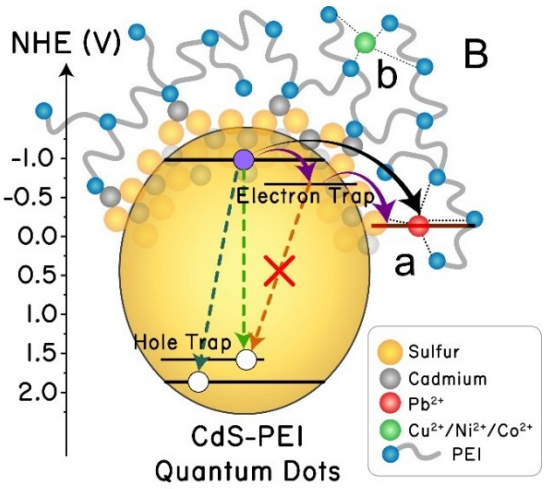

Figure 1. Schematic representation of PL quenching mechanism of CdS QDs in presence of lead ions.

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AO-10

Ultrafast carrier dynamics of Cu doped CdSe nanotetrapods

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It is important to know the carrier relaxation in excited state of Cu doped CdSe nanotetrapods (NTPs) as it has many applications in in different fields like LEDs, photovoltaic devices, solar cells and transisters etc.[1,2] We have studied the optical properties and exciton dynamics after Cu doping in CdSe TPs in excited state. The PLQYs of CdSe TPs increased from 1.7% to 38% after Cu doping and the PL decay time also increased because conduction band electron recombine to the Cu^{2+} (d-level) hole instead of direct electron-hole recombination.[3,4] We have performed Transient Absorption (TA) Spectroscopy to know the hot electron cooling time and recovery kinetics of exciton at different pump power in excited state. It is observed that the hot electron relaxation time increased from 400fs to 540fs and recovery kinetics also slowed after Cu doping in CdSe TPs. So slow electron cooling and recovery kinetics is depend on dopant concentration.[5]

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AO-11

Diffusion viscosity decoupling in supercool water and binary mixture: Explanation using the Translational Jump-diffusion Approach

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Water and its binary mixture are fascinating liquids withvarious anomalous properties. The decoupling of diffusion from the viscosity of the medium is one of them. This anomaly depends on several factors like temperature, pressure, solute size, neighboring particle, and the dynamical heterogeneity of liquid. The diffusion-viscosity decoupling can be easily understood from the violation of the Stokes-Einstein (SE) relation, which connects the diffusion of the molecules with the viscosity. The recent development in experimental techniques makes it possible to observe the above decoupling phenomena in great detail inthe supercool regime. Here, we usea molecular dynamics simulation tool to observe the breakdown in the pure water and water/methanol binary mixture in a wide range of temperature and pressure. We have used the translational jump-diffusion (TJD) approach to calculate the jump-diffusion coefficient D_Jump and explain the role of jump-diffusion in the SE breakdown. We have separated out the jump-diffusion from the total diffusion of the molecules and found that the residual part strongly couples to the viscosity and thereby follows the SE relation. This TJD approach, therefore, puts forward an alternative approachfor explaining the experimentally observed SE breakdown in supercooled water and related medium.

Quantum Dot-Based Hybrid Coacervate Nanodroplets for Ultrasensitive Detection of Hg^{2+}

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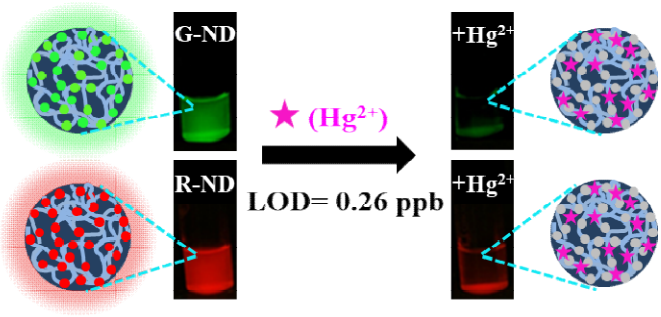
Multifunctional organic-inorganic hybrid materials with inherent optical, electrical and/or magnetic properties find tremendous importance in various fields such as sensing, therapeutics, bio-imaging, and light-emitting devices.[1-2] Herein, we have fabricated a simple organic-inorganic hybrid nanocomposite-based sensing platform for the detection and efficient removal of Hg^{2+} ions from contaminated water simultaneously. The self assembly of negatively charged CdTe quantum dots (QDs) in the presence of positively charged poly(diallyldimethylammonium chloride) (PDADMAC) leads to the formation of luminescent nanodroplets with average size of 430 ± 20 nm. Our findings reveal that Hg^{2+} ions specifically associate with the porous structure of these nanodroplets via electrostatic interactions with



the free carboxylate groups of MSA ligands at the surface of CdTe QDs and undergo photoinduced electron transfer (PET) with photoexcited QDs. The limit of detection (LOD) for Hg^{2+} sensing with our present system is estimated to be 1.32 nM which is significantly lower than most of the earlier reported self-assembled materials. Moreover, these hybrid nanodroplets efficiently sequester trace quantity of Hg^{2+} from contaminated water. The overall performance of our present system towards Hg^{2+} remediation is superior over most of the earlier reported hybrid nanocomposites in terms of fast uptake kinetics (within 15 min), ultrasensitive detection (LOD: 0.26 ppb), and high sequestration efficiency (98.3%). Our present findings in particular, the tailorability of surface ligands and inorganic nanoparticles in hybrid nanodroplets provide great advantage for the development of multifunctional nanomaterials for diverse range of applications.

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AO-13

Fabrication of Biocompatible pH-Responsive Luminescent CoacervateNanodroplets toward TheranosticApplications

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Cytotoxicity is one of the essential in-vitro studies used forbioimaging applications. Herein, we have fabricateda pH-responsive inherently luminescent carbon dot (CD) – based coacervate nanodroplets (NDs) in the presence of cationic polymer PDADMAC. Thephysicochemical and photoluminescence properties have been explored as a function of equilibration time (1 and 18 h), pH (2-12), and ionic strength (1-1000 mM). Equilibrating the binary mixture of CD and PDADMAC for 1 and 18 h results in the formation of SNDs (73.0 ± 2.3 nm) and LNDs (□400 nm). While these NDs are stable in a broad pH range (5−12) and low ionic strength (<200 mM) medium, however they disassembled in lower acidic pH(<5.5)and a high ionic strength (>200mM) medium. These negatively charged (ζ-potential =−17.0±0.5mV) ND scans pontaneously sequester neutral, cationic, anionic dyes and anticancer drug doxorubicin inside their porous nanostructure without any structural disruption. Biocompatibility assay in BHK-21 reveals the non-toxic nature of these SNDs. Finally, the bare and ethidium bromide (EtBr)-loaded SNDs have been utilized toward time-dependent cellular uptake experiments. While released EtBr in the cytosol specifically bind with nucleic acid within the cell nucleus without losing their affinity, free CDs on the other hand stain the whole cell without any specificity.Takentogether, our present findingshighlight the potential of thesebiocompatible inherently luminescentpH-responsive NDs toward theranostic applications.

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AO-14

Key factors for design of solid emitters by aggregation of organic fluorophores

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Peculiar photophysics of Schiff bases has drawn significant interest over the past few decades. Torsional motion coupled with rapid proton transfer have been predicted to be the major non radiative pathways contributing to the very low lifetime as well as emission intensity of these class of molecules.[1] In this work we have tried to hinder the rapid Excited State Intramolecular Proton Transfer (ESIPT) of HSALIMP by complexation with Zn^{2+} and Al^{3+}. As expected both the metal complexes now undergoes a slower single exponential decay as compared to the uncomplexed ligand, however the Zn complex decays faster than that of its Al congener.[2] This has been rationalized by considering the monomer dimer equilibrium of both the complexes. Inhibition of π-π stacking in Zn complexes by formation of bridge bonds and corresponding effects on dynamics has also been examined.[3] Effect of addition of one more Zn centre further delineates the complex interplay between structure i.e. π-π stacking interactions and electronic factors which might be operative in determining the lifetime and quantum yield of this series of complexes

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AO-15

Multi-Spectroscopic Monitoring of β-Cyclodextrin encapsulated Novel Anti-Alzheimer's Agents and Investigating their Response to Mitochondrial Respiration

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The elusive and multifactorial nature of Alzheimer disease (AD) clearly shed light on the fact that currently available drugs and therapies are unanswerable to the treatment of AD. To meet this end, formulations which could enhance the efficacy of the drugs and their delivery to the targeted enzyme need to be developed for improving the cognition. Thus, in our work, host-guest complex between novel anti-AD agents (PC-25 and PC-37) and β-CD are prepared and tested for their stability at three different temperatures (293, 298, 305 K). The formation constant (K_a) advocated the successful complexation and Job's plot indicated their 1:1 stoichiometry. Moreover, thermodynamic parameters [Gibb's free energy (ΔG), enthalpy (ΔH) and entropy (ΔS)] have well supported over the spontaneity and nature of the inclusion complexes (ICs). The complexation behaviour are studied using FTIR and the extent of complexation are determined by NMR (1H NMR, COSY and NOESY) measurements. ICs induced alterations are examined in mitochondrial respiration for scrutinizing the efficacy of these β-CD encapsulated ICs. The ICs are tested for their potency and inhibitory effects on mitochondrial respiratory rate along with their respective IC50 values. This intriguing and promising approach is the subject to another perspective while the exploration may pave a way to impede this neurodegenration.

AO-16

Studies of Host-Guest complexation between functionalized Ionic Liquids and Cyclodextrins

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Host-guest complexation between oxime functionalized ionic liquids (ILs) (S)-2-((hydroxyimino)methyl)-1-(2-((1-(octylamino)-1-oxo-3-phenylpropan-2-yl)amino)-2-oxoethyl)pyridin-1-ium bromide (2-PyPheC8) and (S)-4-((hydroxyimino)methyl)-1-(2-((1-(octylamino)-1-oxo-3-phenylpropan-2-yl)amino)-2-oxoethyl)pyridin-1-ium bromide (4-PyPheC8) with cyclodextrins (α and β CDs) have been studied. The formation of inclusion complexes (ICs) were confirmed by UV–vis spectroscopy which further have been validated by FT-IR, ^{1}H NMR and COSY methods. The binding constant of ICs complex was determined by UV–vis spectroscopy and the effect of temperature was also checked. Job's plot method revealed formation of 1:1 stoichiometry. Significant thermodynamic parameters like enthalpy (ΔH), entropy (ΔS) and Gibb's free energy (ΔG) were also calculated. The FT-IR data provided the information of functional groups involved in complexation. The 1H NMR confirmed the H-bonding, electrostatic and hydrophobic interactions were involved in the formation of complexes. The study of supramolecular chemistry may help in developing the potential application in modern science and fundamental research.

AO-17

Molecular Interactions between Imidazolium Based Ionic Liquid and Deep Eutectic Solvents

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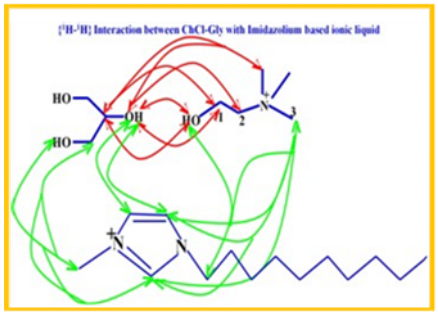
The present study investigates the effects of deep eutectic solvents (DESs) on the micellization behaviour of long chain imidazolium based ionic liquid (IL) i.e., 1-decyl-3-methylimidazolium tetrafluoroborate [Dmim][BF_4] in aqueous media. The DESs synthesised is composed of 1 : 2 mole ratio of choline chloride and glycerol/urea and furthermore characterized by FTIR and ^{1}H-NMR spectroscopic techniques. The intermolecular interactions in IL with Gly/urea based DESs solutions are investigated by various techniques including the FTIR, ^{1}H-NMR, and 2D NOE spectroscopy. FTIR spectroscopy was used to study the [Dmim][BF_4]-DES interaction that leads to tune the micellar structure of the [Dmim][BF_4] within the Gly/Urea based DES solution. ^{1}H-NMR and 2D NOE spectroscopic methods are further employed to strengthen our claim on the feasible structural arrangements within the aqueous [Dmim][BF_4] -DES self-assembled structures. The present results are expected to be useful for colloidal aspects of DES and their mixtures with water. Key words: Ionic liquid, Deep eutectic solvent, Molecular interaction, Spectroscopy.



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AO-18

Palladium-Catalyzed Ortho-Benzoylation Of Sulfonamides Through C–H Activation: Expedient Synthesis of Cyclic N-Sulfonyl Ketimines

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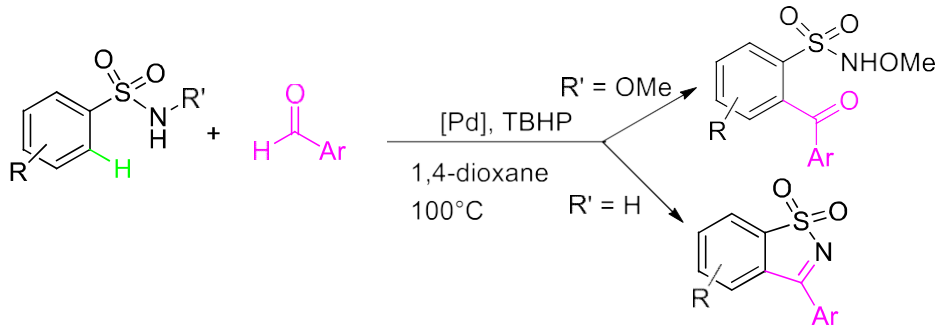
Being a ubiquitous functional group in biologically active compounds, aryl sulfonamides possess a variety of pharmaceutical activities.[1] Sulfonamides also serve as a versatile synthon to access a myriad of S- and N-containing molecules.[2] Recently we have developed a Pd-catalyzed protocol for the ortho-carbonylation of sulfonylarenes by non-hazardous aryl aldehydes as a carbonyl precursor by revealing the directing potential of the sulfonamide group for C-H activation under ligand-free conditions.[3] Deuterium labeling experiment and KIE study suggested that the initial C- H activation step is an irreversible process and is also the rate determining step. The scope of this strategy has been extended to the one-pot two-step synthesis of cyclic N-sulfonyl ketimines. Mild reaction conditions and the simple experimental procedure for C- H activation make the process interesting and could be a preferred route to access cyclic N-sulfonyl ketimines over the reported multistep approaches involving the use of highly reactive organolithium or Grignard reagents.

Scheme 1



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AO-19

A novel approach towards expanding the utility of Deep eutectic solvents as a biocompatible co-solvent for α-chymotrypsin

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Since the introduction of deep eutectic solvents (DESs), numerous reports have surfaced describing its tunable properties and environmentally benign nature. Due to such favorable properties of DESs, they have found a wide variety of applications. Moreover, in order to harness the potential of proteins in numerous industries, there is an emergent need to find a suitable cosolvent that is biocompatible with protein and is also environmentally safe. In this context, this work presents a systematic evaluation of effect of two deep eutectic solvents (DESs), namely, choline chloride-urea (ChCl-urea) and choline chloride-glycerol (ChCl-gly) on the structural and thermal stability along with activity of enzyme α-chymotrypsin (CT) using circular dichroism (CD), UV−visible, steady state, and thermal fluorescence spectroscopy. It was observed that the presence of DESs does lead to enhancement in the thermal stability of CT along with the preservation of activity. The enzymatic activity was well maintained in both the DESs, and the deleterious effect of urea was overcome by ChCl-urea on the enzyme. Thus, the negative outcome of urea was overpowered by the combination of ChCl and urea. Overall, both the DESs can be described as potential biocompatible, sustainable, and promising cosolvents for CT with enhanced structural and thermal stability along with preservation of its activity.

AO-20

Nanostructures of Diphenylalanine-Nucleopeptide: Their morphological characterization and applications as new materials for biosensors

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The hierarchical architectures induced by self-assembly of peptides have paved a new path for novel applications in biomaterial and material sciences. Nanostructures originating from the supramolecular assembly of peptides have wide range of applications in tissue engineering, drug delivery and nanoelectronics.[1] The unique mode of peptide self-assembly is an ideal tool for effective bottom-up approach towards nanomaterial architecture.[2] The discretely well-organized structures of diphenylalanine observed single crystal X-ray diffraction[3] and their wide range of applications have inspired many scientific achievements in the field of biomaterial, bio-sensing and nanotechnology.[4]

From our laboratory, we have established hitherto unknown effects of additional stacking and H-bonding with C-terminal ligands such as purine and pyrimidine nucleosides on the morphological features of the Phe-Phe dipeptide.[5-7] The nanostructure of Phe-Phe based nucleopeptide produced a wide range of spherical nanoparticles which was utilized for encapsulation and external stimuli triggered release of small molecules carboxyfluorescein. It is therefore envisaged that simple hybrid peptides can be used as a scaffolds in biology, nanotechnology, and materials science which include viral capsids, certain enzymes, ion channels, and the pores of ultrafine separation systems.

Nanostructures have inherent properties to create the platform for nanotechnology and self- assembly of diphenylalanine (Phe-Phe) has been widely used at its mesoscopic to nano-metric level. Excellent stability and unique self-assembly of modified peptides under a wide range of conditions inspire to investigate their possible semiconducting behavior. Hydrophobic surface of Torey carbon electrode coated with nucleopeptides are expected to retain their self-assembly and consequently exhibit enhanced conductive nature depending on the substituents. Furthermore, Phe-Phe can be further modified attaching with disulfide bond containing lipoic acid to study their redox activity on gold electrode through self-assembled monolayer (SAM). Modified electrodes thus obtained, can effectively be used for selective detection of bio-analytes uric-/ascorbic acids, glucose and transition metal ions. These nanostructures generated from the modified Phe-Phe motifs will be utilized for various practical applications viz., bio-sensing, catalytic activity, semiconducting materials and as vehicle for hydrophobic drugs. Diphenylalanine and its derivatives attached with electronically rich ferrocene moiety would make conductor / better semiconductor which can be used to fabricate modified electrodes for water splitting.

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AO-21

Structural and Opto-electronic Study of 2D Black Phosphorus

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In order to understand the structural stability of layered BP flake, High-Pressure Raman spectroscopy of a few-layer BP flake has been carried out. The extensive study of Raman spectra under applied pressure confirms the structural stability of BP flake for mechanically harsh conditions as high as ~ 5.9 GPa. At applied pressure of ~ 4.2 GPa, an orthorhombic to rhombohedral phase transition has been observed, which is simultaneously reversible and partial. The phase transition pressure has been identified experimentally from the abrupt change in blueshift to redshift of in-plane Raman vibrational modes (B2g and A2g). The experimental results confirm the coexistence of both the crystal phases (orthorhombic and rhombohedral) is possible over the transition pressure (> 4.2 GPa) and reveals the possibility of a metastable state.

Apart from mechanical stability, it is also necessary to understand the behavior of BP flake upon optical exposure to explore its possible opto-electronic applications. In order to understand the light to matter interaction, the effect of laser irradiation on BP flake has been investigated by acquiring the Raman spectra with the variation of laser power and laser energy. The variation in laser power produces a similar kind of shift in Raman vibrational modes, as observed in the conventional electrostatic field gating effect, which is as effective as conventional electrostatic gating effect.

Role of Metal Centres in the Catalytic Activity of DapE Enzyme from QM/MM Approach

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Due to the increase in the number of bacterial infections and bacterial resistance to antibiotics, novel drug discovery constitutes an important research effort [1]. DapE enzyme is a safe antibiotic target whose potential in the field of antibiotics is not fully explored. In the dinuclear Zn (II) form obtained from haemophilus influenzae, the dimeric DapE enzyme requires two Zn (II) ions per mole of polypeptide for enzymatic activity [2]. Recent studies have also shown metal promiscuity in enzyme activity of DapE. We have used QM/MM methods to carry out the binding affinity of substrates in the presence of different metal centres. In this work, we will present our ongoing research on the role of metal centres in substrate binding and catalysis by DapE enzyme.

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AO-23

Exploring structural requirements for the selective inhibition of tumor associated human carbonic anhydrase IX: a comparative in silico study

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Human carbonic anhydrase IX (hCA IX) is overexpressed in many tumor types and serves as an important target for the discovery of novel anticancer agents. However, developing compounds that can selectively inhibit hCA IX over the widespread cytosolic isoform, human carbonic anhydrase II (hCA II), is a major challenge. Hence, efforts need to be focused on developing selective hCA IX inhibitors. This work focuses on recognising structural features of hCA IX receptor that would help in achieving its selective inhibition. Protein structure alignment have been performed to map the structural differences between the receptors. Further, rigid as well as flexible docking followed by density functional theory calculations and molecular dynamics simulations on SLC-0111, a selective hCA IX inhibitor, have been carried out for both the isoforms and the receptor-ligand interactions responsible for selective inhibition have been characterized. Based on this, residues responsible for these interactions have been marked. Molecular docking and binding energy calculations for three different series of SLC-0111 analogues have been carried out and their interactions with the hCA II and hCA IX receptors have been established. Thus, based on receptor-ligand interactions, molecules showing high potency and selectivity toward hCA IX have been identified.

AO-24

Surfactant Induced Thermal Lensing Effects in Alcohols

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Alcohols are widely used in the industry depending upon their physical and chemical properties as a solvent, ingredients in cosmetics, medicine & fuel. Time-resolved thermal lens spectroscopy is a highly sensitive spectroscopic method for investigating the photo-thermal properties of chemicals.[1] Its principles are based on the localized heat accumulation due to the contactless heating by a laser beam. The laser-induced heating effectively modulates the refractive index inside the sample and makes it act like a lens.[2] Mode mismatched Pump-Probe spectroscopic method was employed the thermally induced nonlinear optical properties of methanol and its surfactant (oleic acid) loaded mixtures. As found, Methanol has a much higher Thermal signal (TL) as compared to oleic acid (OA). Due to its unique characteristic, Methanol is found to be capable of rapid convective heat transfer.[3] We study the variation of TL signal of Methanol with different loading ratios of (OA) surfactant in the mixtures. Experimental findings indicate that the TL signal of the mixture significantly increases to up to an optimum loading of OA. This was attributed to the increased ratio of the OA (bigger size molecule compared to Methanol) in the mixture. The easily drifting of methanol molecules is restricted due to the induction of bigger surfactant molecules, which eventually leads to an increasing TL signal.

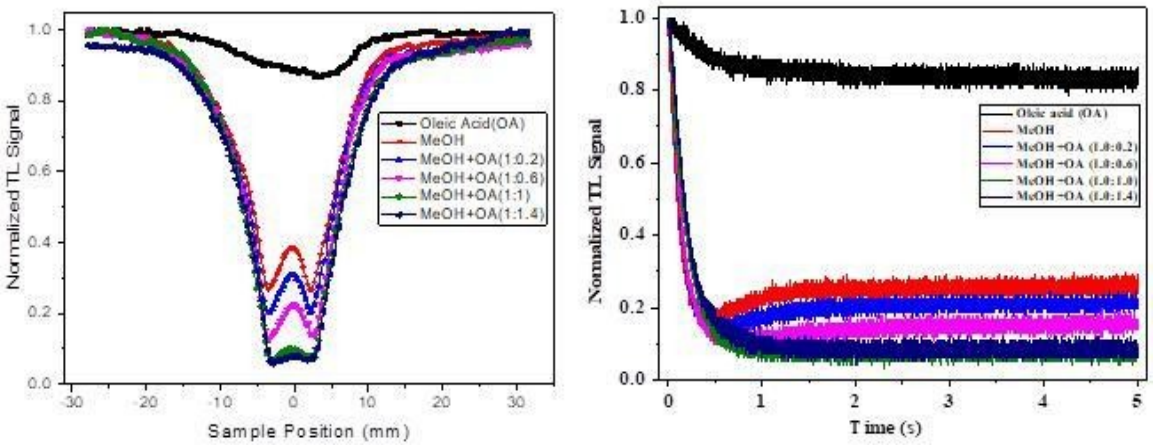

Fig. 1: TL Signatures of methanol and surfactant loaded mixtures

Keywords: Thermal Effects, Photothermal Spectroscopy, Femtosecond Laser, surfactants

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AO-25

Correlation Effects in the Photoelectron Spectrum and Photoionization Dynamics of OsO_4

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The experimentally recorded photoelectron spectra of OsO_4 exhibit five distinct bands with varying intensities. Correct assignment of these vibronic bands requires an accurate treatment of the electronic structure and correlation in the cationic species. In this presentation, we would present a comparative account of different electronic structure methods (such as, EOM-CCSD and CASSCF) in the presence of spin-orbit coupling to provide an assignment of the experimental photoelectron bands. While both EOM-CCSD and CASSCF methods could describe the low-lying electronic states of the cation accurately, the high- energy excited states demand a multi-reference treatment with an expanded active space. That apart, the origin of spin-orbit coupling in different electronic states and their consequence in the experimental spectra will be discussed. By analysing the state of the ejected photoelectron, the photoionization cross-sections have been calculated for all photo- ionization channels that adequately explain the variation of cross-section with photon energy and the resonant structures in the experimental findings. The resonant structures have been explained by calculating the asymmetry parameters and from the wave function analysis of the ejected photoelectron. It will be shown that the resonant structures are prominent when the molecular orbitals are contributed by both metal and ligand orbitals.

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AO-26

Supercooled Liquid Inside Confined Environment

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The inhomogeneous behavior of water in confined environment presents an interesting field of scientific investigation because of its relevance with various biological systems and its application in the field of desalination processes, flow sensing and drug delivery system [1].

In this work we have studied the property of Water using TIP4P/2005 water model confined inside the arm-chair carbon nanotubes using Classical MD Simulation. This study includes the structural morphism that water shows inside the tube with varying diameter and temperature that ranges from 350K down to 100K. We have observed that water shows structural morphism for nanotubes greater than 1.2 nm but no specific structure was observed for tube greater than 1.2 nm at higher temperature as the hydrogen bonding is dynamic and the structure is not specific but absolutely there is pattern in the arrangement of water molecule which it follows once inside the tube and is dependent over the tube diameter, which on lowering the temp shows more of orderness leading towards structural refinement. Along with it, we have also observed drying transition at subzero temperature in a CNT of diameter greater than 1.2 nm that has been reported earlier via experiment [2].

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AO-27

Isothermal compressibility of basic α-Amino Acids in aqueous salt solutions at different temperatures.

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Density and speed of sound data have been employed for the calculation of isothermal compressibility values (κT) by using Mc-Gowan's relation. The κT values of (L-leucine / L- isoleucine / L-glutamine / L-alanine / glycylglycine + 0.512 mol·kg^{-1} aqueous K_2SO_4) solutions are less than those of (L-leucine / L-isoleucine / L-glutamine / L-alanine / glycylglycine + 0.512 mol·kg^{-1} KNO_3) solutions at all temperatures of study. The decrease in κT values with an increase in solute concentration seems to be a result of a corresponding decrease in free volume and the average kinetic energy of constituents of solutions. The internal pressure (Pi), solubility parameter (δ) and pseudo-gruneisen parameter (Γ) values also have been computed by using the values of κT obtained from Mc-Gowan's relation.

Keywords: Amino acids, salt effect, internal pressure, speed of sound.

AO-28

A computational investigation on the role of nitro group in quenching the fluorescence of some highly fluorescent molecules through analysis of the non-radiative decay paths

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In coment times, synthesis and spectroscopic studies on a series of substituted dibenzodioxins [1-6] have been performed by the experimental group of Banerjee.Computational studies on these systems were performed by Chattopadhyay and co-workers. These systems include the fluorescent dibenzodioxinswhere the dioxin ring is attached toaterephthalonitrile(1,4-dicyanobenzene) moiety on one side[1]. These moietie scan form donor-acceptor based fluorophores. Our studied terephthalonitrile compounds attached to cyclic diamine groups are found to be highly fluorescent. In fact, their attachment with the benzodioxinring also forms strongly fluorescent compound. However, introduction of a nitro group in the benzene ring (attached to dioxin) makes it almost non-fluorescent in spite of the presence of theterephthalonitrile moiety with attached cyclic amine group. Our computational studieshave revealed the presence of two different singlet excited state (S1) minima of the nitro compounds, one with a planar geometry and the other with a twisted-NO_2 group. In the planar excited state, the charge cloud in LUMO

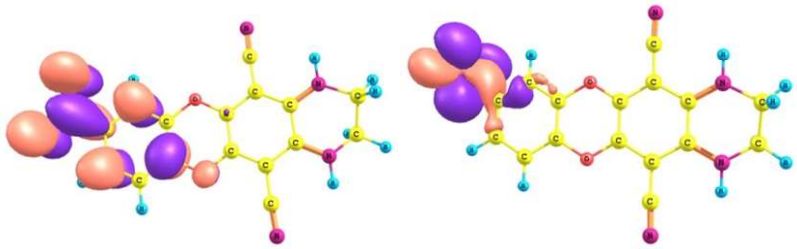

Figure 1. LUMO at the planar excited state (S1) geometry (left) and LUMO at the NO_2-twisted excited state (S1) geometry (right) is shifted (Figure 1) towards the nitrobenzene ring while in the twisted –NO_2 excited state geometry, the charge is completely shifted towards the nitro group. The latter geometry is characterized by low energy gap between the S1 and S0 states, indicating an internal conversion channel (IC) which is likely to be responsible for its non-fluorescence property. The transition state connecting these two geometries has been optimized and it shows that the energy barrier to form the twisted-NO_2 minimum is around 7 kcal/mol. We have also investigated the possible role of intersystem crossing (ISC) along the nitro twisting coordinate of the S1 state.Interaction of the triplet states with the S1 state along the nitro twist path (<C-C-N-O dihedral angle) starting from the planar geometry has been noticed. This

indicates a possible population transfer to the triplet states from the S1 state and thereby reducing the fluorescence.

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AO-29

Responses of Oryza sativa L. towards azo functionalised Schiff base Cu(II) complexes and $CuSO_4$: A comparative morphological and biochemical study

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Azo fuctionalised Schiff base ligands having N_2O_2 donor binding sides are capable of forming metal complexes and can be used as potential plant micronutrient supplier. Two different ligands and their copper complexes were synthesised by conventional protocols and then characterised by both spectroscopic and elemental analysis. Investigations were done by taking rice seeds as plant material. Various growth and biochemical parameters were monitored by taking different concentrations of $CuSO_4$, prepared ligands and Cu(II) complexes. Analysis of various biochemical results reveals that Schiff base Cu(II) complexes have less toxic effects than copper sulphate on rice seedlings and thus facilitates better tolerance to copper toxicity than copper sulphate.

Keywords: Plant growth; Cu(II) chelates; copper toleranc; azomethine group.

AO-30

Remarkable Photocatalytic Activityof Mesoporous Titania-Carbon Hybrids: A Study of Pharmaceutical PollutantDegradation in Aqueous Solution

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There is a growing concern that the presence of pharmaceuticals in water bodies and in drinking water adversely affect thehealth and behaviorof human and wildlife, including insects, fish, birds, and more.[1] They have become the chemicals ofan emerging threat to the public. While wastewater treatment plants would normally take care of such a situation but pharmaceuticals, in general, pass through. In this regard, extensive research efforts have been focused on improving existing water treatment technologies and developing new advanced oxidation technologies. Although semiconductor photocatalysts, e.g., titania, showing potential for such purpose, they suffers from high electron-hole recombination rate, low surface area, and limited light absorption properties. On the otherhand, photoexcited titania in contact with carbon displays efficient charge separation by sinking photogenerated electrons.[2] In this context, ordered porous titania (TMP-123) with their unique textural, electronic, and optical properties is highly relevant[3,4] and thatthe titania-carbonnanocomposites exhibiting 2D-hexagonal mesoporous framework structure (Fig. 1 a-d) and high surface areashow much promise compared to the commercial titania (P-25) which exhibits particulate-like morphology (Fig. 1e). Thus, we observedan excellent degradation efficiency (DE) of famotidine (FAM) by the integrated titania-carbon photocatalysts (Fig. 1g), which is further confirmed by HPLC studies (Fig. 1h). The catalyst, viz., TMP-123/CMK-3, is superior to all others in terms of FAM mineralization, which could be attributed to excellent electron sinkbehaviour of CMK-3, i.e., low charge transfer resistance deducedfrom Nyquist plot (Fig. 1i) and facile interface characteristics of titania-carbon composite as inferred from Mott–Schottkyplot (Fig. 1j).

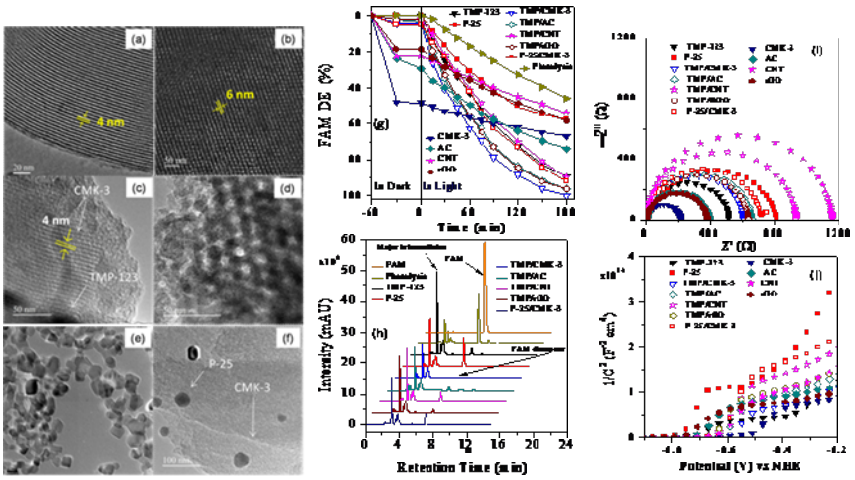

Fig. 1. TEM images of CMK-3 (a), TMP-123 (b), TMP-123/CMK-3 (c & d), P-25 (e), and P-25/CMK-3 (f). Potocatalytic degradation of FAM (g). HPLC profiels at 180 min (h). Nyquist plot(i). Mott–Schottkyplot (j).

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AP-1

Award Poster

An Intrinsically Disordered Protein in F127 Hydrogel: Fluorescence Correlation Spectroscopy and Structural Diversity of Beta Casein

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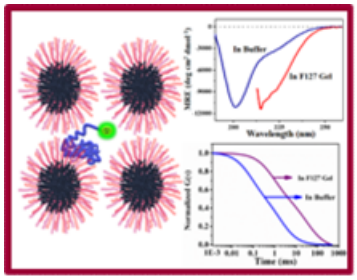
Intrinsically Disordered Proteins (IDPs) can acquire one of the many possible local minima due to their rapid conformational fluctuation which prevents them from folding and functioning. Thus IDPs have a flat free energy surface and hence they cannot be crystallized.[1] However, many experimental and theoretical findings reported that macromolecular crowding (~400 mgL^{-1})can trigger the disorder-to-order transition depending on the 'metaphysics' of IDPs.[2] Pluoronic copolymer F127 can act as 'smart polymer' and is used often as crowding agent to create cell like milieu.[3] To observe the dynamics inside the crowding hydrogel, we covalently probed an IDP bovine beta-casein (β-CN) with Alexa488. The conformational analyses by Circular Dichrosim (CD) revealed that β-CN has become ordered inside hydrogel. Fluorescence Correlation Spectroscopy (FCS) suggestedthe structural fluctuationbetween a highly extended state (radius 34.5 nm) and a highly collapsed state (radius 1 nm).[4] Moreover, we showed that inside the crowding environment, β-CN is located at the corona region of the spherical micellar aggregates by exposing to the void region of the gel with translational viscosity 10-16 times higher than buffer.The local rotational viscosity in the corona region of F127 gel is ~2-times higher compared to the buffer as obtained from anisotropy studies.[4]



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AP-2

Synthesis of Dual Reactive Hollow Micron/ Sub-micron Capsules

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Multilayered microcapsulestailored with different desired chemical functionalities are of particular interest due to their potential application in confining various cargo, liquid crystal, and bioactive enzymes for the various relevant applications. One of the promising methods for the fabrication of hollow microcapsules is layer-by-layer (LbL) assembly of multilayer films onto colloidal particles followed by selective core removal. Among the available fabrication methods, this method hasthe advantages of precise control over the size, shape, wall thickness, composition, and functions of the resulted hollow microcapsules. Mostly, weak hydrogen bonds, disulfide bonds, and electrostatic interactions between two distinct polymers wereused in synthesizing multilayered microcapsules. In our approach, a single polymer derived covalently crosslinked microcapsule loaded with dual-reactive residual functional groups-acrylate and amine, is synthesized by a facile LbLdeposition process and a catalyst-free 1,4-conjugate addition reaction at ambient condition. Further, this single polymer derived microcapsule is tailored with different desired functionalities using various selected nucleophiles and electrophiles, following two independent reaction pathways at ambient conditions.[1]

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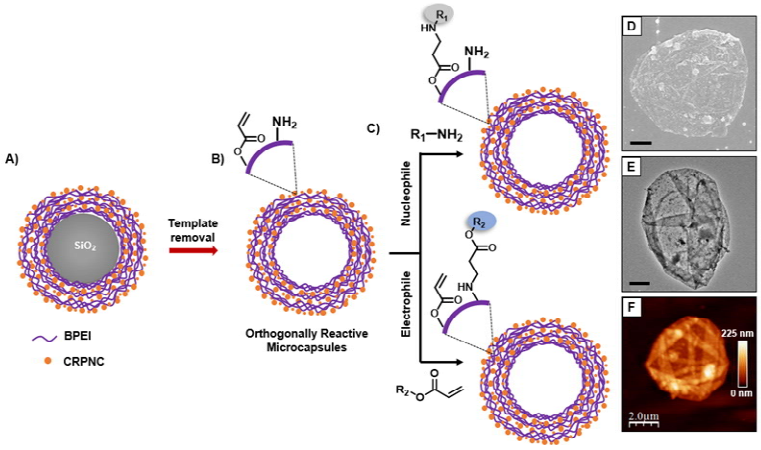

Figure 1. (A-C) Schematic representation of (A) CRPNC/BPEI coated silica microparticles, (B) dual reactive microcapsules of CRPNC/BPEI loaded with residual acrylate and amine groups after core dissolution. (C) reaction of residual acrylates and amines with nucleophiles and electrophiles,

respectively. (D-F) FESEM (D), FETEM (E) and AFM (F) images of microcapsules made of multilayers (5 bilayers) of CRPNC/BPEI. Scale bar = 1 μm for D and E

AP-3

A theoretical investigation of the structural, electronic and optical properties of the retrochalcones isolated from liquorice

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Retrochalcones are known to exhibit a wide range of biological applications. The present work reports the theoretical investigation of six retrochalcones, namely echinatin, licochalcone A, B, C, D and E, isolated from liquorice. All the calculations have been performed using density functional theory at the B3LYP/6-311++G** level in the gas phase and in aqueous solution. The non-linear optical properties were computed and compared with the standard molecules, urea and *para*-nitro aniline. Further, the mono, di and tri-anionic forms have also been studied to find out the sequential pK_a values corresponding to each hydroxyl group present in the considered compounds. Moreover, frontier molecular orbital analysis and molecular electrostatic potential maps were analyzed for a better understanding of the electro-optical properties of the compounds under study. Additionally, a number of global chemical reactivity descriptors have also been calculated.

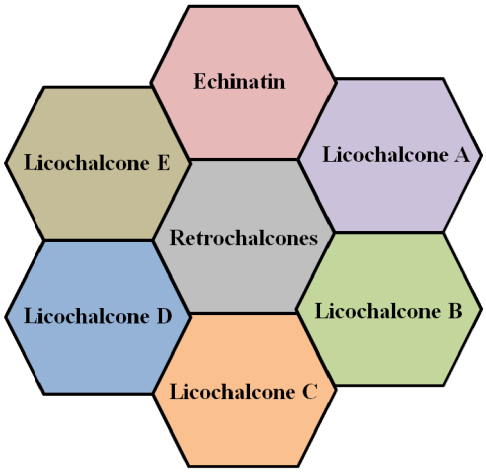

Figure: Six retrochalcones isolated from liquorice

AP-4

Effect of Surface Charges on Nanoparticle (NP) -induced Molecular Reorganization of interfacial water at Model Cell Membrane

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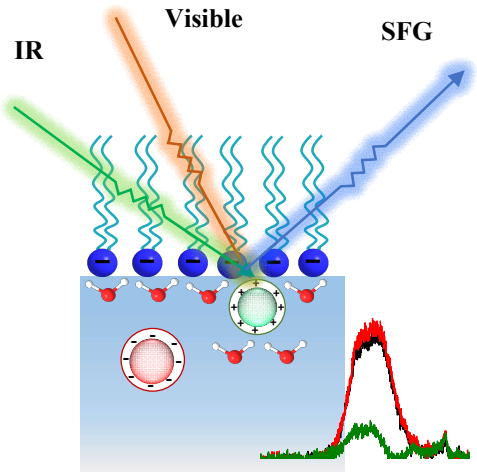
A depth understanding of NPs-cell membrane interaction is a key challenge because one has to probe the infinitesimally thin region comprising NPs and cell membranes. We have examined the role of electrostatics experimentally by using positively and negatively charged Au NPs, binding with negative charge lipid DPPG with vibrational sum frequency generation spectroscopy (SFG), a sub monolayer surface-/interface-sensitive techniqueand theoretically by molecular dynamicssimulation. After the injection of 15 nm anionic NPs to DPPG monolayer, SFG intensity of interfacial water molecules remain same whereas, injection of cationic NPs the intensity is abruptly decreases due to electrostatic attraction between cationic NPs and DPPG monolayer results in the replacement of some of interfacial water molecules from the interface to the bulk. Simulations results also support the experimental results. These results provide an overview of the interaction of NPs with lipid membranes which helps to evaluate the parameters that control the NPs membrane surface interactions for the design and application of NPs in future drugs and medicines.



AP-5

Study of Fluorescence Interaction and Conformational Changes of Bovine Serum Albumin with Histamine H_1-receptor–Drug Epinastine Hydrochloride by Spectroscopic and Time-Resolved Fluorescence Methods

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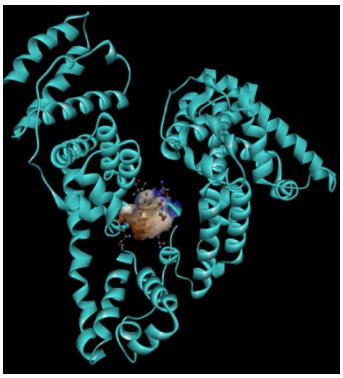
The fluorescence, ultraviolet (UV) absorption, time resolved techniques, circular dichroism (CD), and infrared spectral methods were explored as tools to investigate the interaction between histamine H_1 drug, epinastine hydrochloride (EPN), and bovine serum albumin (BSA) under simulated physiological conditions. The experimental results showed that the quenching of the BSA by EPN was static quenching mechanism and confirmed by lifetime measurements. The value of *n* close to unity indicated that one molecule of EPN was bound to protein molecule. The binding constants (K) at three different temperatures were calculated (7.13×10^4, 5.53×10^4, and 3.93×10^4 M^{-1}). Based on the thermodynamic parameters (ΔH^0, ΔG^0, and ΔS^0), the nature of binding forces operating between drug and protein was proposed. The site of binding of EPN in the protein was proposed to be Sudlow's site I based on displacement experiments using site markers viz, warfarin, ibuprofen, and digitoxin. Based on the Förster's theory of non-radiation energy transfer, the binding average distance, *r* between the donor and acceptor was evaluated and found to be 4.48 nm. The UV–visible, synchronous fluorescence, CD, and three-dimensional fluorescence spectral results revealed the changes in secondary structure of the protein upon its interaction with EPN.



Keywords: spectroscopic methods; epinastine hydrochloride; bovine serum albumin; time resolved fluorescence; circular dichroism

AP-6

Molecular Dynamics Simulation of 6-Hydroxy-2-Thioxocoumarin Bound Human Carbonic Anhydrase II

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Inhibition of the metalloenzyme carbonic anhydrase (CA) has a wide range of pharmacological applications. The molecular mechanism of inhibition of CAs is qualitatively understood for different classes of inhibitors binding to the metal centre. We focus in this work on a novel coumarin-based inhibitor, 6-hydroxy-2-thioxocoumarine (FC5, Figure 1) that does not bind to the metal centre. Instead, it has been reported experimentally to anchor to the zinc bound water (Zn-wat) molecule/hydroxide ion, leading to a high inhibition constant, $K_I > 100$[1]. However, the entry/exit mechanism of the ligand to/from the binding site of the enzyme is relatively unexplored. We report here computer simulation studies to identify the ligand unbinding path from the active site of the enzyme to the bulk solvent. Out of the six potential pathways identified for the unbinding of FC5 from the active site of HCA II, the ligand is found to unbind through the cleft formed by the loops between βC, βc and αC, αD. Our results resolve important enthalpic and entropic contributions of the protein during this unbinding process.

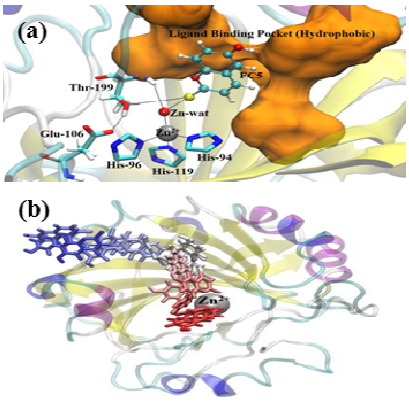

Figure 1.(a) Binding site of the ligand (FC5) which anchors to the zinc water/hydroxideion (PDB id: 4wl4[1]). Also shown are FC5 (CPK) in its binding pocket (shown in orangesurface) formed by Leu-198, Pro-202, Phe-131 and Val-121, Zinc ion (in gray colour), Zn-wat (red sphere) and Glu-106, Thr-199, three histidine residues bound to zinc (Licorice). (b) Unbinding pathway of FC5 from the active site of HCA II from SMD simulation.

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General Presentation

OP-1

Oral Presentation

Spectroscopic determination of proton affinities of Reserpine by Charge-Transfer complex formation

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From the charge transfer absorption spectra of a series of molecular complexes of reserpine (methyl-11,17α-dimethoxy-18β-[(3,4,5-trimethoxybenzoyl)oxy]-3β,20α-yohimban-16β-carboxylate) with*o*-chloranil, *p*-chloranil and DDQ, the individual proton affinities of its two N atoms have been determined in aqueous medium(containing 0.1%ethanol v/v). Variation of the CT spectra with pH was noted for this purpose. Necessary working formula was derived and utilized in the determination. The two proton affinities were also determined directly from the UV-vis absorption spectra of reserpine itself. The determined values were also checked by noting the variation of fluorescence intensity of reserpine upon addition of acid and base; the fluorescence spectrometric results agreed almost completely (within the limits of experimental error) with the absorption spectrometric results.

Keywords: Reserpine, Charge-Transfer Complex, Proton affinity.

OP-2

Future and Recent Trends in Chemical Sciences

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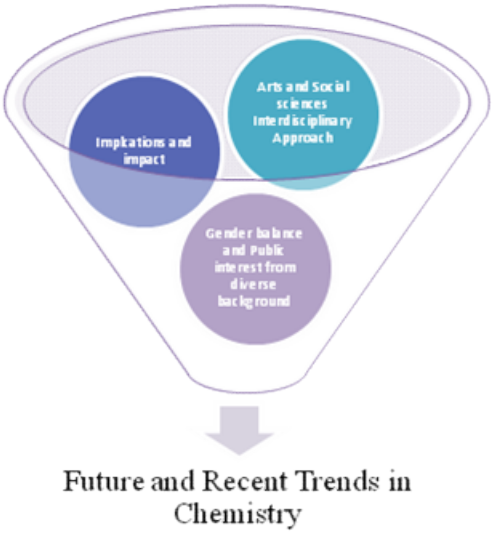
The recent trends in innovation, and the challenges presented by the modern world, suggest that the word "pure" from "IUPAC" should be replaced. Chemistry can't be pure, and it needs to evolve – not only with its counterparts from the scientific domain, but also with arts and social sciences. This interdisciplinary involvement shall help identify new challenges, design new manufacturing processes, and understand the implications of Chemistry, hence making it a much more impactful subject.

The study of social trends - such as gender balance in chemical science education, interest from diverse backgrounds, inventions in chemical sciences, and the related challenges and opportunities - shall all help in the development of a new Chemistry community.New education policies will help universities to break boundaries and will incorporate the connection between different aspects of Chemistry and the traditionally transferable skills.



The role of chemical science should be to solve future challenges in cleanliness, food production, renewable energy, climate changes, drug discovery, and pharmacy; and also in building infrastructures. Education, training, social awareness, interdisciplinary approach, community building, gender equality, and overarching support from common people will hence make chemical science an influential toolin our quest to improve the everyday lives of people.

OP-3

Effect of Plant Extract Composition on Green Synthesis of Silver nanoparticles

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In the past few years a lot of research has been done on the green synthesis of the silver nanoparticles using different plant extracts. In the present paper we focus our study on the synthesis of AgNPs by using *Glycyrrhiza glabra* and *Phaseolus vulgaris* extracts. The extract of roots of *Glycyrrhiza glabra* mainly contains saponin and plantestrogens while the seeds of *Phaseolus vulgaris* mainly contain proteins. Same method was adopted for the synthesis of AgNPs by these twoextracts.

Figure 1: Schematic presentation of green synthesis of AgNPs

It was observed that the both extracts are capable to reduce silver ions and synthesis of AgNPs took place with both the extracts. But the X-Ray diffraction studies reveals variation in size and phases of the synthesized AgNPs in eachcase.

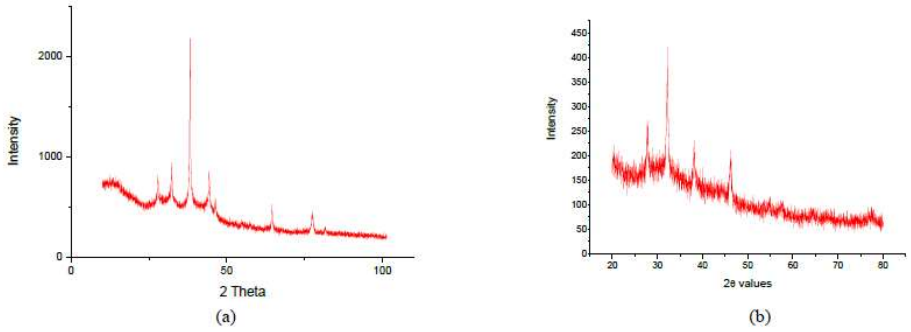

Figure 2: XRD Patterns of AgNPs synthesized by (a)*Glycyrrhiza glabra* and (b) *Phaseolus vulgaris* extracts respectively

The variation in the XRD patterns indicate that the chemical composition of plant extracts greatly affects the size and phases of the AgNPssynthesized.

Acknowledgement: The authors are grateful to TEQIP-III Rajasthan Technical University, Kota for providing financial assistance for this research work and also thankful to UGC-DAE-CSR Indore centre for providing XRD studiesfacility.

OP-4

Green Chemistry: Way of Sustainable Development

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Basic Science in all its forms is elementary for human continued existence and growth. In particular, chemistry has always been connected with food chemistry, oils and paints, chemicals (for a variety of uses like cleaning products, leather processing, detergents, polymers, paper manufacture, printing, dyeing and much more). Above all chemistry serves as a common interface between practically all of the other sciences. This is the reason why green chemistry has been chosen to preserve the sustainability of all the processes. Sustainability largely depends on continuous consumption of large amount of natural resources, chemicals and energy, all these are largely non-renewable resources. Later along with the desired product, a large amount of waste is generated which is needed to be dumped and the best we can do is to dump it somewhere on land or in sea. But repeated consumption of resources and dumping of this waste is creating a serious problem to the sustainability of these production processes and ultimately to the survival of human race. Green chemistry is a very broad term that covers all the processes starting from fundamental research to production, to be done environmentally sustainable way and it protects our environment without harming growth and development. Howsoever beneficent green chemistry principles could be to sustainability, the sensible implementation in large production plants may be a daunting task, because it demands an enormous change in industrial setup, machinery and pilot plants. Awareness of a problem and controlling it is in itself the big leap required in implementing new policies. Under these circumstances there's a requirement to take care of balance between supporting new developments in chemistry and bringing the previously established chemical change under greener and sustainable purview. It is hoped that very soon a trend may get firmly established wherein most of the existing chemical processes could become greener and sustainable.

OP-5

Adsorptive Separation of Quercetin and Rutin using Ion Exchange Resins: Experimental and Molecular Modeling study

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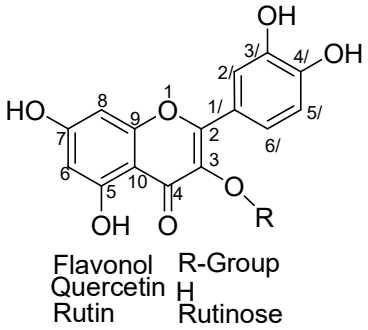
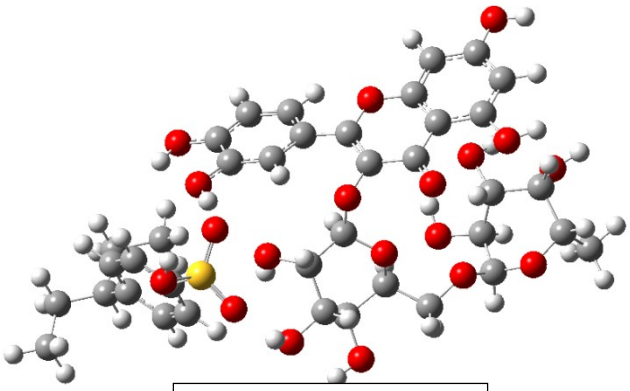
Two ion exchange resins, Dowex 1X4 chloride and Dowex 50WX8 are evaluated for selective adsorption or enrichment of flavonoid molecules such as quercetin and rutin from aqueous solution. These two flavonoids usually occur as mixtures in different plant resources, also commercially obtained rutin is contaminated with nearly 1 to 3% of quercetin. High purity rutin and quercetin are significantly required in pharmaceutical and food industries. It is observed that anion exchange resin has higher adsorption selectivity for quercetin over rutin. The effect of pH analysis confirms that a combined effect of molecular adsorption and ion exchange mechanism has taken place under alkaline conditions (at pH 11) but under acidic conditions (at pH 3) molecular adsorption is the only process of flavonoids uptake. Molecular modeling studies have supported the experimental observations on selective adsorption of quercetin and rutin from aqueous phase.



Flavonol	R-Group
Quercetin	H
Rutin	Rutinose



Rutin-Resin Interaction

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OP-6

Solvation dynamics in solvent free protein – polymer surfactant biomolecular assemblies

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Solvent-free proteins have attracted tremendous attention in recent times, due to its potential use as a green, nonaqueous solvent with low-volatility, for the synthesis of organic and inorganic compounds, as electrolytes, catalysis, etc.[1,2] While dynamics of dye-labelled HSA has been reported,[3] we focus on solvation dynamics of solvent-free protein, labelled with CPM (7-dimethylamino-3-(4-maleimidophenyl)-4-methyl-coumarin) dye to understand bound water dynamics. This study has been done using Fluorescence correlation spectroscopy (FCS) with a conformational dynamics model of data analysis and a comparative examination of hydrodynamic radii of different CPM labelled HSA modified systems. Solvent free causes blue shift in the emission maxima from CPM covalently bound to HSA. The average solvation time is increased from 700 ps (CPM bound to HSA) to 2 ns in the presence of solvent free CPM labelled HSA. FCS suggest that in a solvent free system, diffusion coefficient decreases, and hydrodynamic radius increases which implies larger protein size.

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OP-7

Morphology of ZnO triggered versatile catalytic reactions towards CO_2 fixation and acylation of amines at optimized reaction conditions

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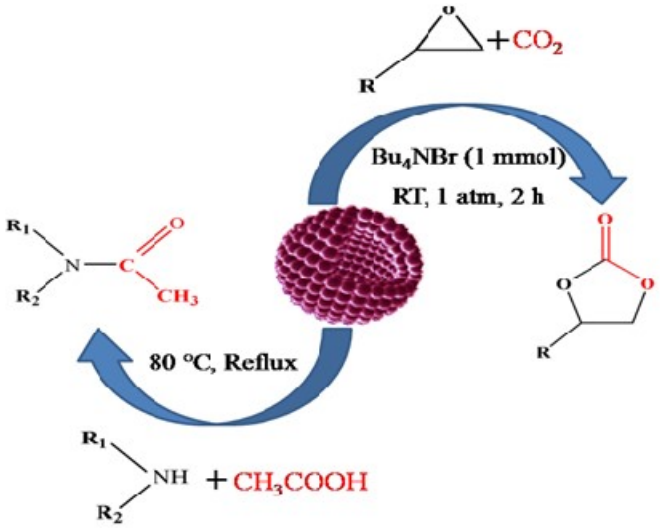
Hollow spherical ZnO particles with porous exterior surface are successfully synthesized and employed as a cost effective heterogeneous catalyst for CO_2 fixation in a wide range of epoxides at atmospheric pressure and room temperature to form cyclic carbonates. In fact, conversion of carbon-di-oxide into value aided chemicals is one of the major areas of contemporary research. This versatile material is also capable to catalyze acylation of amines in solvent free condition. The end products of both the reactions i.e. cyclic carbonate and N-acylated amines have huge industrial importance. The pristine ZnO nanomaterial without incorporation of metal nanoparticles has shown excellent reusability up to five consecutive reaction cycles without considerable loss in its efficiency which is quite encouraging for industrial realization.



OP-8

Order of kinetics computation for DTA (Differential Thermal Analysis) curve of some compounds using the concept of skewness

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Qualitative identification of organic and inorganic compounds can be made by using Differential Thermal Analysis (DTA) technique. Different kinetic parameters, like order of kinetics, activation energy and pre-exponential factor can be determined from the curves obtained from differential thermal analysis for different compounds. Order of kinetics, one of these important kinetic parameters, is related to the symmetry of a DTA curve. Symmetry of DTA curve which should be determined by using the longer portion of the curve, can be described by the skewness ( ) of the peaks. Skewness indicates the degree of asymmetry of distribution, value of which may be positive, negative or zero depending on the nature of distribution. Negative skewness is observed in first order DTA peaks whereas positive skewness is noticed in second order peaks. Skewness, therefore, can act as a good indicator of the order of kinetics of DTA peaks. In the present study, skewness of DTA curves resulted from kinetic order model (KOM) has been investigated. A novel attempt has been made to relate the skewness of a DTA peak with its order of kinetics. Finally, the present technique is applied to compute the orders of kinetics of some reported DTA curves of the compounds namely Georgia kaolinite, Eureka halloysite, RDX and TNT. The values of the orders of kinetics obtained in this method are found in fair agreement with those reported in literature.

OP-9

Surfactant and Polymer induced AIEE towards White Light Emission and Lipid Droplet Imaging

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Dimethyl-2,5-bis(4-methoxyphenylamino)terephthalate (DBMPT) is a water-insoluble fluorogenic molecule, which has been rendered water-soluble in physiological conditions, by the addition of nonionic triton X-100 (TX-100) and triblock copolymers (TBPs), P123 and F127. In the presence of TX-100DBMPT exhibits unidirectional aggregated growthto produce highly luminescent nanorods, the dimensions and emission intensities of which are controlled by concentration of DBMPT. Interestingly, shapes of the aggregates formed with the two TBPs are found to be very different, even though they differ only in the length of hydrophilic blocks. DBMPT-P123 aggregates are micrometer-sized and spherical, while DBMPT-F127 aggregates form nanorods.

Energy transfer from perylene-3,4,9,10-tetracarboxylic acid dianhydride (PTAD) to the nanorods formed in the presence of TX-100 in aqueous medium produces pure white light emission with the CIE chromaticity coordinates (0.33, 0.36) and a significantly high quantum yield of 35%. Gelation of the system with agarose yields a bright white light emitting gel, demonstratingit's excellent potential towards light harvesting and in organic electronic devices.

In case of DBMPT-F127 nanorods excellent cell permeability is observed, in contrast to DBMPT-P123 microspheres. These fluorescent nanorods exhibit the ability to mark lipid droplets within the cell and hence bear the promise for application in intracellular imaging.

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OP-10

Effect of cetyl trimethyl ammonium bromide and sodium dodecyl sulphate on oxidation of indigo carmine with potassium peroxy diphosphate- A Kinetic and Mechanistic study

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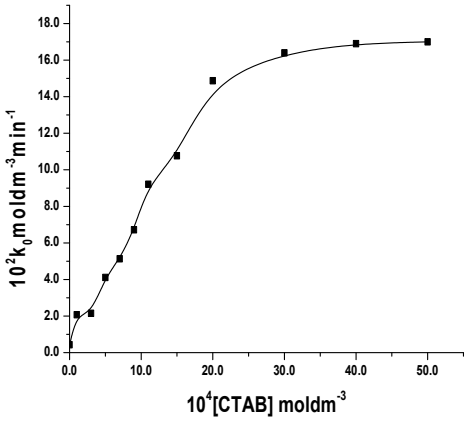
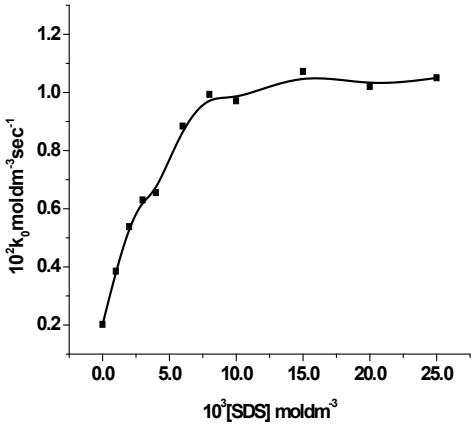
The oxidation of indigo carmine(IC) with potassium peroxy diphosphate (PDP) in absence and presence of cationic CTAB and anionic SDS micelles is investigated. The investigation is done in aqueous sulphuric acid medium by maintaining the ionic strength at 3.0 moldm^{-3} .The stoichiometry of the reaction is reported as 1:1 using mole ratio method. The pseudo zero order constant is determined from the linear plots of absorbance versus time under the conditions [IC] < [PDP].The reaction shows zero order kinetics with respect to varying[IC], first order kinetics with respect to varying [H^+] and [PDP] in absence and in presence of micelles. The reaction rate is accelerated with varying [CTAB] and [SDS] and reached a limiting value. The rate [surfactant]-profile has limiting nature which shows that the reaction is unimolecular micellar reaction.The binding constant of peroxy diphosphate is determined with CTAB and SDS micelles by applying Berezin treatment to the kinetic data. The kinetic equation in aqueous medium is reported as

$$-\frac{d[IC]}{dt} = k_1 K_2^1 [PDP]_t [H^+]$$



Effect of [CTAB] micelle on rate



Effect of [SDS] micelle on rate

OP-11

Molecular Interactions of L-Aspartic Acid and L-Glutamic Acid in Aqueous Benzyl Tri-Methyl Ammonium Chloride Ionic Liquid Solutions at Different Temperatures

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L-Aspartic and L-Glutamic acid (two solute molecules) interact with an ionic liquid (Benzyl tri-methyl ammonium chloride) in aqueous medium. The interactions have been explained on the basis of parameters (apparent molar volume, viscosity B-coefficient, molar refraction, specific conductance) at different temperatures and different concentrations from density, viscosity, refractive index, conductance measurements, respectively. Using Masson equation, the experimental slopes and the limiting apparent molar volumes are obtained which explain the solute-solute and solute-solvent interactions. Viscosity parameters, A and B obtained from Jones-Doles equation explained the solute-solute and solute-solvent interactions in the solution. Molar refraction has been calculated from the Lorentz-Lorenz equation. The specific conductance also explained the interaction properties.

It provides the information about ion-dipole interaction and show that the solute-solvent interaction between BTAC ionic liquid and L-Aspartic acid and L-Glutamic amino acid systems is higher than the solute-solute interaction. This is resulted by hydrophobic interactions which lead to volume contraction. The physico-chemical methodologies, describes the mode of interaction in solution. The values of $(\delta\Phi E0/\delta T)P$ and (dB/dT) have been calculated to provide the information that the solute–solvent interaction is structure-making. The extent of solvation is found to be highest in L-Glutamic acid at 0.05m 313K and lowest in L-Aspartic acid at 0.01m 293K.

OP-12

Kinetics and mechanism of the oxidation of some α-hydroxy acids by 2-picolinium chlorochromate

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The oxidation of glycollic, lactic, malic and a few substituted mandelic acids by 2-picolinium chlorochromate (PICC) in dimethylsulphoxide (DMSO) leads to the formation of corresponding oxoacids. The reaction is first order each in PICC. Michaelies-Menten type of kinetics is observed with respect to the hydroxy acids. Reaction is failed to induce the polymerisation of acrylonitrile. The oxidation of α deuteriomandelic acid shows the presence of a primary kinetic isotope effect (k_H/k_D = 5.79 at 298 K). The reaction does not exhibit the solvent isotope effect The reaction is catalysed by the hydrogen ions. The hydrogen ion dependence has the form: $k_{obs} = a + b [H^+]$. Oxidation of p-methyl mandelic acid has been studied in 19 different organic solvents. The solvent effect has been analysed by using Kamlet's and Swain's multiparametric equations. A mechanism involving a hydride ion transfer via a chromate ester is proposed.

Keywords: Correlation analysis, dichromate, hydroxy acids, kinetics, mechanism, oxidation

OP-13

Correlation Analysis of Reactivity in the Oxidation of Some Vicinal and Non-Vicinal Diols by Morpholinium Fluorochromate

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The kinetics of oxidation of four vicinal, four non vicinal diols by Morpholinium fluorochromate (MFC) have been studied in dimethylsulphoxide (DMSO). The main product of oxidation is the corresponding hydroxycarbonyl compound. The reaction is first order each in MFC. Michaelies-Menten type of kinetics is observed with respect to the diols. The reaction is catalysed by hydrogen ions. The hydrogen ion dependence is taking the form: kobs = a + b[H^+]. The oxidation of [1,1,2,2 $2H_4$] ethanediol exhibits a substantial primary kinetic isotope effect (k_H/k_D = 5.73 at 298 K). The reaction has been studied in nineteen different organic solvents and the solvent effect has been analysed using Taft's and Swain's multiparametric equations. The temperature dependence of the kinetic isotope effect indicates the presence of a symmetrical transition state in the rate determining step. A suitable mechanism has been proposed.

Keywords: Correlation analysis, Diols, Halochromates, Kinetics, Mechanism, Oxidation

OP-14

Oxidation of some Unsaturated Acids by Pyridinium Dichromate: A Kinetics and Mechanistic Study

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The oxidation of maleic, fumaric, crotonic and cinnamic acids by pyridinium dichromate (PDC) in dimethylsulphoxide (DMSO) leads to the formation of corresponding epoxide. The reaction is of first order with respect to PDC and the acid. Due to non-aqueous nature of the solvents toluene-p-sulphonic acid (TsOH) was used the source of hydrogen ions. The reaction is catalysed by hydrogen ions. The hydrogen-ion dependence has the form: $k_{obs} = a + b [H^+]$. The oxidation of these acids was studied in nineteen different organic solvents. The solvent effect was analyzed by Kamlet's and Swain's multiparametric equations. Solvent effect indicated the importance of the cation-solvating power of the solvent. A mechanism involving a three-centre transition state has been postulated.

Keywords: Halochromates, kinetics, mechanism, oxidation, unsaturated acids.

OP-15

Kinetics and Mechanistic Studies of Organic Acids by 2-Picolinium chlorochromate

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Kinetics and mechanism of oxidation of formic and oxalic acids by diethyammonium chlorochromate (PiCC) have been studied in dimethylsulphoxide. The main product of oxidation is carbon dioxide. The reaction is first order with respect to PiCC. Michaelis Menten type of kinetics was observed with respect to the reductants. The reaction is acid catalysed and the acid dependence has the form: $k_{obs} = a + b[H^+]$. The oxidation of α deuterio formic acid exhibits a substantial primary kinetic isotope effect (k_H/k_D = 5. 77 at 298 K). The reaction has been studied in nineteen different organic solvents and the solvent effect has been analysed using Taft's and Swain's multiparametric equations. The temperature dependence of the kinetic isotope effect indicates the presence of a symmetrical cyclic transition state in the rate determining step. Suitable mechanisms have been proposed.

Keywords: Acids, Dichromate, Kinetics, Mechanism, Oxidation

OP-16

Thermodynamic, Kinetic and Mechanistic Investigations of Ruthenium(III) catalysed Methylparaben Oxidation by Diperiodatocuprate(III) in aqueous alkaline medium

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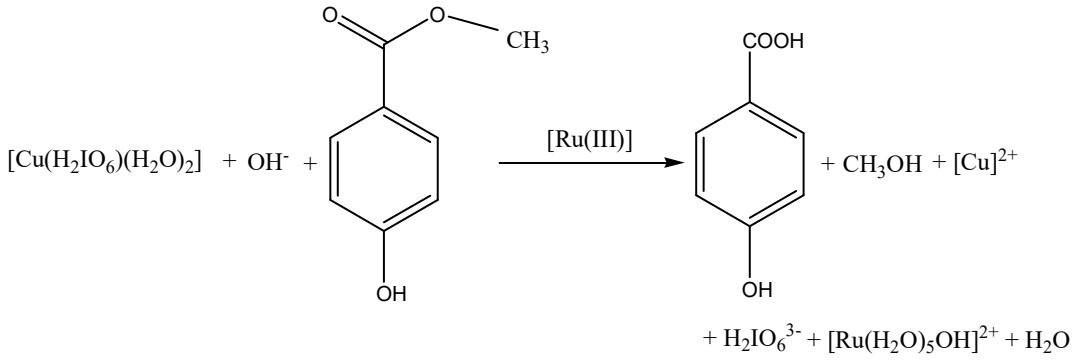
The kinetics of ruthenium(III) catalysed degradative oxidation of methylparaben by the copper complex, diperiodatocuprate(III) in alkaline medium is studied at 298 K and at a ionic strength of 8.0×10^{-2} mol dm^{-3}. In the presence of catalyst ruthenium(III), the reaction between methylparaben and diperiodatocuprate(III) in aqueous alkaline medium exhibits 1:1 stoichiometry. The oxidation products were identified by UV-visible, GC-MS and IR spectroscopy. The reaction exhibited unit order in case of diperiodatocuprate(III) and ruthenium(III) concentrations, while less than unit order with respect to methylparaben and alkali concentrations. The added periodate retard the rate of reaction. The effect of added products, ionic strength and dielectric constant on the rate of the reaction were studied. The active species of diperiodatocuprate(III) and ruthenium(III) in alkaline media are $[Cu(H_2IO_6)(H_3IO_6)]^{2-}$ and $[Ru(H_2O)_5(OH)]^{2+}$ respectively. The activation parameters with respect to the rate determining step and the thermodynamic quantities with respect to the equilibrium steps are evaluated and discussed. The plausible mechanism in consistent with the experimental results is proposed and discussed in detail.

Keywords: Kinetics, oxidation, diperiodatocuprate(III), ruthenium(III), methylparaben

Graphical Abstract:



OP-17

Oxidation Kinetics and Mechanistic Studies of Oxalic and Formic Acids by Diethylammonium Chlorochromate

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Kinetics and mechanism of oxidation of formic and oxalic acids by diethyammonium chlorochromate (DEACC) have been studied in dimethylsulphoxide. The main product of oxidation is carbon dioxide. The reaction is first order with respect to DEACC. Michaelis Menten type of kinetics were observed with respect to the reductants. The reaction is acid catalysed and the acid dependence has the form: $k_{obs} = a + b[H^+]$. The oxidation of α deuterio formic acid exhibits a substantial primary kinetic isotope effect (k_H/k_D = 5. 79 at 298 K). The reaction has been studied in nineteen different organic solvents and the solvent effect has been analysed using Taft's and Swain's multiparametric equations. The temperature dependence of the kinetic isotope effect indicates the presence of a symmetrical cyclic transition state in the rate determining step. Suitable mechanisms have been proposed.

Keywords: Acids, Dichromate, Kinetics, Mechanism, Oxidation

OP-18

Studies on the Oxidation of Aliphatic Primary Alcohols by Quinolinium Dichromate: A Kinetic and Mechanistic approach

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The oxidation of nine aliphatic primary alcohols by quinolinium dichromate (QDC) in dimethylsulphoxide leads to the formation of corresponding aldehydes. The reaction is first order with respect to QDC. A Michaelis-Menten type kinetics is observed with respect to alcohols. The reaction is promoted by hydrogen ions; the hydrogen-ion dependence has the form k_{obs}= a +b[H^+]. The oxidation of [1,1-$^2H_2$]ethanol ($MeCD_2OH$) exhibits a substantial primary kinetic isotope effect (k_H/k_D = 5.70 at 298K). The reaction has been studied in nineteen different organic solvents. The solvent effect was analysed using Taft's and Swain's multiparametric equations. The rate of oxidation is susceptible to both polar and steric effects of the substituents. A suitable mechanism has been proposed.

Keywords: Alcohols, dichromate, quinolinium, kinetics, mechanism, oxidation

OP-19

Unactivated Aziridination of Alkenes

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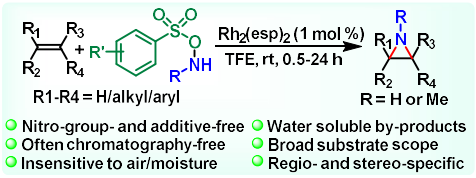
Unactivatedaziridines are fascinating sub-structures in a plethora of bio-active natural products, as well as these molecules undergoes various transformation as ring opening with different nucleophiles under mild reaction condition and furnished several important synthetic intermediates like amino-alcohol, di-amines, and azido-amines. Unlike activated aziridines, Synthesis of unactivatedaziridines is far more challenging task for the organic chemists. Herein we describe the direct methods for the synthesis of unactivated (N-H/N-Me) aziridines from alkenes, using *O*-(Sulfonyl)hydroxylamines as the aminating agent, Rh(II) catalyst in 2,2,2-trifluroethanol (TFE) as a solvent (Scheme 1).[1]



Scheme 1: Aziridination of olefins using *O*-(Sulfonyl)hydroxylamines

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OP-20

Molecular Water Oxidation Catalyst(s): An Approach for Predicting the Efficiency

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In the global scenario, energy crisis is one of the major concern. Although many renewable and non-renewable sources of energies were there, but they were not sufficient to meet the global energy demand. Given the abundance of sunlight and water and following its effective utilization, harvesting of water is one of the possible solution to fulfill energy demands in the presence of catalysts. The efficiency of the catalyst is the prime factor for delivering the higher conversion. With the aim of doing so, in this work, we developed a method theoretically, involving thermodynamic and kinetic study to predict the efficiency of molecular water oxidizing catalysts (MWOC) that corroborating to the previous experimental results. We hope, our method will help the scientific community to predict the efficient catalyst before proceeding to the mechanistic details.

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OP-21

Different α-Hydroxy Acids Oxidation By Benzimidazolium Fluorochromate: A Kinetic And Mechanistic Study

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The oxidation of glycollic, lactic, malic and some substituted mandelic acids by benzimidazolium fluorochromate (BIFC) was studied in dimethylsulphoxide (DMSO). Main product of oxidation was the corresponding oxoacids. The reaction was first order in relation to the BIFC and exhbited Michaelies-Menten type kinetics with respect to hydroxy acids. The polymerisation of acrylonitrile showed no effect on the reaction rate. The oxidation of α-deuteriated mandelic acid has been showed the presence of primary kinetic isotope effect i.e. (k_H/k_D = 6.15 at 25ºC). The solvent isotope effect has not been observed. The hydrogen ions were used to catalysed the reaction. The form of hydrogen ion dependence was: $k_{obs} = a + b\,[H^+]$. The multiparametric equations of Kamlet's and Swain's have been used to analysed the solvent effect. Mechanism involving the transfer of hydride ion via chromate ester has been tried to propose.

Keywords: BIFC, α-Hydroxy acid, Kinetics, Oxidation and Mechanism.

OP-22

DNA binding studies of Tetrahydrocannabinol (Active Principle of Cannabis) using computational approach

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Tetrahydrocannabinol (THC) is the most abundant and major psychoactive drug present in Cannabis sativa. It is known for their anti-cancer effects. In this paper, we have attempted to identify and compare any possible binding interactions of THC with normal and methylated DNA sequences. This work has the potential to contribute in the fight against antiviral, antibacterial and many other diseases. The study has revealed that THC binds in the minor groove of both normal and methylated DNA. On comparing their binding energy, it is demonstrated that the binding energy with normal DNA is $\Delta G = -6.28$. Whereas, the binding energy with methylated DNA is $\Delta G = -6.07$. The binding of THC with normal DNA is found to be higher than that of methylated DNA. The structural details of binding of THC have also been disclosed which includes multiple hydrogen bonds, Vander Waal interactions, etc.

Keywords : DNA interaction, Drug - DNA binding, THC, Molecular docking.

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OP-23

Modeling Single-Nanoparticle Catalysis

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Nanoparticle catalysis is intrinsically heterogeneous, and hence challenging to study in ensemble measurements. Single-molecule detection of fluorogenic reactions in which a catalytic conversion of non-fluorescent substrates (off states) to fluorescent products (on states), occurring one at a time on the surface of a single nanoparticle, captures intrinsic heterogeneity in catalytic cycle in terms of stochasticity in the waiting times between two consecutive off and on signals [1-4]. In this work, we show how a unified theoretical framework, based on the chemical master equation (CME), provides a novel way to infer catalytic mechanisms and rate parameters from different, seemingly unrelated, measures introduced in a series of experimental studies on single-nanoparticle catalysis [1-4]. Building on aprevious work [5], we find that a Langmuir-Hinshelwood (LH) like mechanism is consistent with experimental data, provided it includes two important aspects ofintrinsic heterogeneity at the single-molecule level, namely, fluctuations due to surface restructuring dynamics and multiplicity of catalytic sites [6]. For this, we propose a parallel-pathway LH mechanism with replicas. This mechanism, in its minimal form, provides excellent quantitative agreement with experimental data, and shows how the sign and magnitude of waiting time correlations between consecutive turnovers provides a sensitive indicator of intrinsic heterogeneity. Our work establishes that the statistical dependences of off and on signals in a single turnover, and temporal correlations between consecutive turnovers are crucially linked with multiplicity of catalytic sites. Thisrules out all previous single-site models of single-nanoparticle catalysis in which statistical independence of off and on signals is implicitly assumed [1-5].

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OP-24

Solid State Synthesis Characteriation Surface and Catalytic Properties of (Pr_2CoO_4 and Pr_2NiO_4) catalyst

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The most interesting non-stoichiometric oxides are found in transition metal and rare earth oxides at higher temperatures. The role of solid State properties in the catalysis using mixed metal oxide as catalyst have wide application In fertilizer, Petro-chemical , Pharmaceutical, cosmetic, paint detergents, plastic and food-stuff industries and these are also resistive towards acids and alkalies [2-6] The use of catalyst has opened up new process routes or revolutionsed the existing process in terms of economics and efficiency and has radically changed the industrial scenario. The use of catalyst is so pervasive today that nearly 70% of modern chemical processes are based on it at some stage or other and 90% new processes developed are catalytic nature. A series of non-stroichiometric spinel type of oxide catalyst of Praseodymium with cobalt and nickel were Synthesized by their oxalates through Solid State reaction technique at different activation temperatures i.e. 600, 700, 800 and 900°C. The characterization of catalyst was done by XRD. FTIR and ESR methods. X-ray powder diffraction study shows that catalysts are made up of well grown crystallinities decomposition of oxalate ion from the Catalyst. The kinetic decomposition of Urea was employed as a model reaction to study the catalytic potentiality of different catalysis. Surface and catalytic Properties of catalytic were measured. A relation between activation temperature and surface properties like excess surface oxygen (E.S.O.) Sutface aciditu and Surface area was observed. A Linear relationship between the surface area od the catalyst and the amount of ammonia gas evoled per gm of the sample was observed also. Nickel containing catalysts were found a bit more catalytic active in comparison to cobalt oxide catalysts. Transition metal ions (i.e. Ni(2+) & Co(2+) ions) are mainly responsible for catalytic potentiality of the catalysts. The Presence of transition metal ions in divalent state (+2 state) is confirmed by ESR study. Inner transition metal ion i.e. pr^{3+} ion moderates the catalytic activit. Frequency factor and activation energy involved in the process were also determined.

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OP-25

Photogalvanic cell based on mixedPhenyl (Fast Green)-Phenothiazin (Azur B) dyes to exploit and promote electrical energy through optimum photochemical conversion of solar energy

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Phenyl (FG) and Phenothiazin (AB) dyes were used to study and designed for exploit and promote electrical energy through optimum photochemical conversion of solar energy by newly developed system AB-FG-EDTA. Reductant- EDTA on oxidation shown an important role for mixed Phenothiazin (AB) – Phenyl (FG) dyes in basic medium in excess of hydroxyl ion for enhancing and conversion solar energy.Developed new system based on photochemical conversion and utilization of solar radiation by FG-AB-EDTA. Effect of different parameters on dyes, reductant, pH, area of Pt electrode, i-v characteristics, diffusion length was studied on this developed new system. To exploit and promote efficient enhancing electrical energy output through optimum photochemical conversion of solar radiation determined and reported for new system FG-AB-EDTA.Conversion efficiency, fill factor, and storage capacity are respectively 0.73%, 0.44 and 57 minutes.photocurrent and photopotential shown by FG-AB-EDTA system were 866.0 mV & 125.0 µA respectively. This new Photogalvanic device can be used in dark at its power point for 57 min. The mechanism of photocurrent generation has also been proposed.

Key words: Azur B, Fast Green, Fill factor,Conversion efficiency,Power point.

Mechanism:

Illuminated chamber

$h\nu$

$$FG + AB \longrightarrow FG^* + AB^* \quad (1)$$

$$FG^* + AB^* + 2R \longrightarrow FG^- + AB^- + 2R^+ (2)$$

At electrode

$$FG^- + AB^- \longrightarrow FG + AB + 2e^- (3)$$

Dark Chamber

$$FG + AB + 2e^- \longrightarrow FG^- + AB^- (4)$$

$$FG^- + AB^- + 2R^+ \longrightarrow FG + AB + 2R \quad (5)$$

Where FG+ AB, FG* + AB*, FG^-+ $AB^-$and R & R^+ are Azur B+ Fast Green, their excited forms, theirleuco or semi leucoforms, the reductant and the reductant's oxidized forms, respectively.

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OP-26

Expired Drugs: Eco-friendly Corrosion Inhibitors for different metals and alloys

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Eco-Friendly approach in industries and research is the demand of current time. Expired drugs can play an important role in this context. After passing the expiry date, drugs are disposed off and causes the environmental pollution. However many researchers found that expired drugs are excellent corrosion inhibitors for different metals. Potentiodynamic polarization, Electrochemical Impedance Spectroscopy (EIS) and weight loss studies found Paracetamol, Tramadol, Moxifloxacin, Betnesol and many more with greater corrosion inhibition efficiency for different metals and alloys. It is interesting to know that some drugs retain their molecular integrity upto 10 years even after the expiry date. Hence the recycling of expired drugs could be economic and environment friendly for corrosion inhibition as well as for other research purposes.

Keywords : Drugs, Corrosion, Inhibitors, Potentiodynamic Polarization, EIS, Weight Loss

PP-1

Poster Presentation

Electroorganic syntheses: an alternative method for preparation of copper salicylate

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Electroorganic chemistry is a combination of two major branches of chemistry, namely electrochemistry and organic chemistry. It is a unit process in which complex is synthesized from electron transfer reactions across the electrode /solution interface. The electroorganic synthesis of copper salicylate is a green methodology to evaluate their coordination and biological activity. This methodology emphasis advantages over conventional chemical method because of its product specificity, high yielding and using current as cheapest of other energy source. It makes use of the universal chemical reagent- the electron which is contributes to control pollution.

In this study it evaluates the synthesis and characterization of copper salicylate which is prepared by electrochemical method. Copper salicylate are well known class of drugs that are antiviral, analgesic, antiproliferative, antipyretic and anti-inflammatory agent. It is used in clinical practice of inflammatory disorders including cancer, arthritis as well as for prevention of myocardial infraction. Over the past few years, there have been many reports on their application in radiopharmaceutical drugs. Organic electrosynthesis has been recognized as new reactor for industrial revolution in recent years.

PP-2

Study On Reaction Between Lauric Acid And Lauryl Alcohol Catalysed By Molecularly Imprinted Polymer

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Molecular imprinting is now becoming an emerging technology for preparation of polymers with specific molecular recognition properties. Molecularly imprinted polymers have catalytic active sites for which these polymers possesses the enzyme like catalytic behavior and can catalyze a large variety of reactions. In order to understand the enzyme like catalytic behavior of molecularly imprinted polymers, the esterification reaction between lauric acid and lauryl alcohol was carried out by systematic variation of substrates and polymer. The molecularly imprinted polymer used in this study is based on cross-linked polymerization of methacrylic acid with 4-aminopyridine as the template molecule and ethyleneglycoldimethacrylate as cross-linker. The polymer prepared was characterized for structural feature by FTIR and the thermal behavior by TGA. The kinetics of the reaction was found to follow by the so-called Ping-Pong-Bi-Bi mechanism. The kinetic parameters were determined by non-linear regression analysis and was obtained as Vmax = 0.692 mmol/min g, Km (alc) = 66.3 mM, Km (acid) = 1.52 mM and Ki = 60.0 mM.

Keywords: Molecularly imprinted polymer, esterification

PP-3

A Novel idea of Calculating Madelung Constant through Schottky defect with the help of Poisson distribution

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Defects in ionic solid are very much common, which is increased with the increase in temperature. It causes the change in the value of many physical properties and varieties of physical parameters and the Madelung constant is one such parameter to control the structure of the crystals. Considering the loss of ions from lattice points as random, the examination of each of the defects individually is going to be unpredictable, thus leading to almost unattainment of the correct crystal structure with the theoretical calculations applying for available models. Here, in this present work, we have used some statistical methods and probabilistic approximation to introduce a novel idea of calculating the Madelung constant, analytically. To make the understanding more lucid, we have taken one of the very simple crystals, very popular for the crystallographic people, too, a 6:6 crystal (NaCl), for which a considerable number of Schottky defects are observed. During this study, we are bound to assume the random distribution of defects as Poisson distribution to calculate the Madelung Constant.

PP-4

Unimolecular Dissociation of γ-Ketohydroperoxide via Direct Chemical Dynamics Simulations

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Hydroperoxides (molecules containing -OOH group) are important in the gas and liquid phase oxidation of organic compounds. Organic hydroperoxides play a central role in the atmospheric ox- idation reactions and their degradation in troposphere results in low vapor pressure polyfunctional species that lead to the formation of secondary organic aerosols. The O-O bond in these compounds is weaker than C-C or C-H bonds and responsible for the formation of radicals. γ-ketohydroperoxide [3-(Hydroperoxy)propanal] is an important reagent in synthetic chemistry and in particular, oxidation reactions. It is considered to be a precursor for secondary organic aerosol formation in troposphere. Due to enhanced reactivity and limitations associated with analytical techniques, theoretical methods have been employed to study the unimolecular reactivity of hydroperoxides. A number of auto- mated reaction discovery techniques have been used to study the reactivity of γ-ketohydroperoxide and a large number of reactions have been reported in such studies. In the present work, we have investigated the unimolecular reaction dynamics of this molecule using electronic structure theory calculations and direct chemical dynamics simulations to assess the relevance of different reaction pathways. Classical trajectories were launched from the reactant well with fixed amounts of total energies and integrated on-the-fly using density functional B3LYP/6-31+G* model chemistry. Three dissociation channels among the previously reported reactions were identified as important. Korcek decomposition, which was proposed earlier as a source of carbonyl compounds from thermal decom- position of of γ-ketohydroperoxide, was not observed in the present high temperature simulations. However, trajectories showed formation of carbonyl compounds such as aldehydes via other path- ways. Results are compared with previous studies and detailed atomic level reaction mechanisms are presented. Further, Rice-Ramsperger-Kassel-Marcus (RRKM) rate constants were computed and compared with the trajectory data.

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PP-5

Accelerated microdroplet synthesis of benzimidazoles by nucleophilic addition to protonated carboxylic acids

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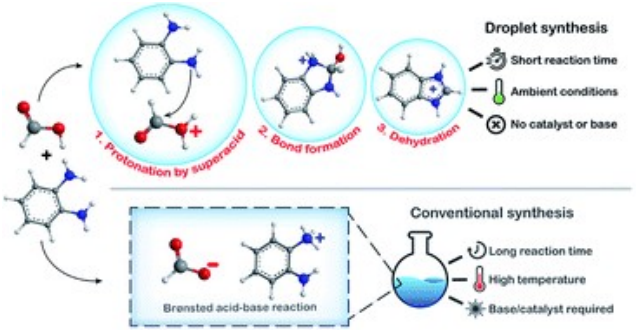
We report a metal-free novel route for the accelerated synthesis of benzimidazole and its derivatives in theambient atmosphere. The synthetic procedure involves 1,2-aromatic diamines and alkyl or aryl carboxylicacids reacting in electrostatically charged microdroplets generated using a nano-electrospray (nESI) ionsource. The reactions are accelerated by orders of magnitude in comparison to the bulk. No other acid, base or catalyst is used. Online analysis of the micro droplet accelerated reaction products is performedby mass spectrometry. We provide evidence for an acid catalyzed reaction mechanism based on identification of the intermediate arylamides. Their dehydration to give benzimidazoles occurs in a subsequent thermally enhanced step. It is suggested that the extraordinary acidity at the droplet surface allows the carboxylic acid to function as a C-centered electrophile. Comparisons of thismethodology with



data from thin film and bulk synthesis lead to the proposal of three key steps in thereaction: (i) formation of an unusual reagent (protonated carboxylic acid) because of the extraordinary conditions at the droplet interface, (ii) accelerated bimolecular reaction because of limited solvation atthe interface and (iii) thermally assisted elimination of water. Eleven examples are shown as evidence ofthe scope of this chemistry. The accelerated synthesis has been scaled-up to establish the substituent dependence and to isolate products for NMR characterization.

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PP-6

Ultrasonic Speed and Related Thermo-acoustical Parameters of Solutions of 1, 10-Bis(3-methyl-4-ethoxyacetylphenoxy)cyclohexane at Four Different Temperatures

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The density (ρ), viscosity (η) and ultrasonic speed (U) of the pure solvents: 1,4-dioxane (DO), ethyl acetate (EA), tetrahydrofuran (THF) and solutions of the biologically active 1,10-bis(3-methyl-4-ethoxyacetylphenoxy)cyclohexane were investigated at four temperatures: 298, 303, 308 and 313 K over a wide range of concentrations (0.1–0.01 moldm-3) to understand molecular interactions in these solutions. Various acoustical and thermodynamic parameters such as specific acoustical impedance (Z), isentropic (adiabatic) compressibility (κs), Rao's molar sound function (Rm), van der Waals constant (b), internal pressure (π), free volume (Vf), intermolecular free path length (Lf), classical absorption coefficient {(α/f2)Cl}, viscous relaxation time (τ), Gibbs energy of activation (ΔG*), enthalpy of activation (ΔH*) and entropy of activation (ΔS*) were determined using the ρ, η and U data. A good to excellent correlation between a given parameter and concentration (C) is observed at all temperatures (T) and solvent systems studied.

PP-7

Synthesis, physico-chemical and dynamic DSC curing kinetics studies of unsaturated polyester polyol of multifunctional epoxy resin containing s-triazine ring and its jute/glass composites

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The conventional epoxy resins are inefficient to satisfy the required properties in the field of advanced materials, which require high thermal and flame resistance. The properties of epoxy resins can be improved by modifying of epoxy backbone or using curing agents of different structures. Multifunctionalepoxy resins have attracted interest of researchers and producers.

2,4,6-Tris(4-hydroxyphenyl)-1,3,5-triazine was synthesized by cyclotrimerization of 4-cyanophenol using trifluromethanesulphonic acid as a catalyst at room temperature. Unsaturated polyester polyol of 2,4,6-tris (4-hydroxyphenyl)-1-3-5-triazine (ETPUP) was synthesized using alkali as a catalyst at 60 ◦C for 1 h and styrene was added as a reactive diluent (ETPUPSt). The structure of ETPUP was supported by FTIR and ^{1}H NMR spectroscopic techniques. Epoxy resin was cured by DSC at multiple heating rates under nitrogen atmosphere by using 20 % of 4,4'-diamino diphenylsulphone, 4,40-diaminodiphenylether, and 4,4'- diaminodiphenylcyclohexane as hardeners. Cured and uncured reins were also analyzed by TG analysis. Kinetic parameters were determined and discussed in light of nature of curing agents. Thermal decomposition behavior of the samples is also discussed in detail. Both the composites may be useful for load bearing housing units, and in electrical, electronic, and marine fields.

PP-8

Molecular memory and dynamic cooperativity in monomeric enzymes

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The classical Michaelis-Menten (MM) equation[1], represents a non-cooperative kinetic response of enzymes with either a single or non-interacting multiple binding site(s). The mean catalytic rate of several monomeric enzymes, however, shows deviations from this classical behavior. [2] This effect, termed as dynamic cooperativity, is believed to be associated with molecular mechanisms, stochastic reaction networks, that include enzymatic conformational fluctuations in product formation pathways. In spite of the latter, however, the present understanding of dynamic cooperativity is confined to mean kinetic measures, obtained from deterministic rate equations, which cannot account for fluctuations. Here, we consider a stochastic reaction network for a special class of monomeric enzyme, called mnemonical enzymes, which are known to exhibit both positive and negative (dynamic) cooperativity. We model their kinetics using the chemical master equation (CME) [3] to show how the emergence of dynamic cooperativity, at the molecular level, is inextricably linked to the multiplicity of monomeric enzyme numbers, enzymatic conformational fluctuations and molecular memory. Our results show that dynamic cooperativity is a transient phenomenon, which emerges due to temporal correlations between enzymatic turnovers, and vanishes as these correlations decay and molecular memory fades.[4]

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PP-9

Mechanical and electrical properties of Jute-Biomass-Styrenated MethacrylateEpoxy Resin sandwich composites

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Sandwich composites of jute-biomass (banana, sugarcane, coir, wheat husk and groundnut)–styrenated methacrylateepoxy resin of 1,1'-bis(4-hydroxyphenyl) cyclohexane have been fabricated by compression molding technique at 110 °Cand 2 Bar pressure for 5 h. J-EBCMASt., J-B-EBCMASt, J-SC-EBCMASt, J-CO-EBCMASt, J-W-EBCMASt and J-GN-EBCMASt showed respectively tensile strength of 34.5,17.1, 11.4, 11.9, 20.7 and 13.1 MPa, and flexural strength of 32.3,21.6, 28.3, 11.2, 52.1 and 22.1 MPa, electric strength of 1.6, 1.2, 1.5, 1.3, 1.3 and 1.4 kV/mm and volume resistivity of 5.9 X 1012, 2.5 X 1012, 4.7 X 1011, 5.3 X 1012, 3.2 X 1012 and 2.3 X 1012 ohm cm. Considerably lower mechanical and electricalproperties of sandwich composites are due to different nature of biomass and random orientation. The composites may beuseful for low load bearing housing and electrical applications.

PP-10

Kinetic and Mechanistic Studies in the Oxidative Regeneration of Carbonyl Compounds from Oximes by Quinolinium Dichromate

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The oxidative deoximination of several aldo- and keto-oximes by quinolinium dichromate (QDC), in dimethylsulphoxide (DMSO), exhibited a first order dependence on QDC. A Michaelis-Menten type kinetics was observed with respect to oximes. The oxidation of ketoximes is slower than that of aldoximes. The rates of oxidation of aldoximes correlated well in terms of Pavelich-Taft dual substituent-parameter equation. The low positive value of polar reaction constant indicated a nucleophilic attack by a chromate-oxygen on the carbon. The reaction is subject to steric hindrance by the alkyl groups. The reaction of acetaldoxime has been studied in nineteen different organic solvents.

The solvent effect has been analysed by multiparametric equations. A mechanism involving the formation of a cyclic intermediate, in the rate-determining step is suggested.

Keywords: Carbonyl compounds, Dichromates, Kinetics, Mechanism, Oxidation, Oximes.

PP-11

Kinetics and Mechanism of the Oxidation of Lower Oxyacids of Phosphorus by Quinolinium Dichromate

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Oxidation of lower oxyacids of phosphorus by quinolinium dichromate (QDC) in dimethylsuloxide (DMSO) leads to the formation of corresponding oxyacids with phosphorus in a higher oxidation state. The reaction exhibits 1:1 stoichiometry. The reaction is first order with respect to QDC. A Michaelis-Menten type of kinetics was observed with respect to the reductants. The reaction does not induce polymerization of acrylonitrile. Reactions are catalyzed by hydrogen ions. The hydrogen-ion dependence has the form: $k_{obs} = a + b[H^+]$. The oxidation of deuteriated phosphinic and phenylphosphinic acids exhibited a substantial primary kinetic isotope effect. The oxidation was studied in nineteen different organic solvents. The solvent effects were analysed in terms of Taft's and Swain's multiparametric equations. The effect of solvent indicates the solvent polarity plays a major role in the process. It has been shown that the penta-coordinated tautomer of the phosphorus oxyacid is the reactive reductant and it has been concluded that tri-coordinated forms of phosphorus oxyacids does not participate in the oxidation process. A mechanism involving transfer of a hydride ion in the rate-determining step has been proposed.

Keywords: Dichromate, Kinetics, Mechanism, Oxidation, Phosphorus oxyacids.

PP-12

Influence of Solvents on the Oxidation of Lower Oxyacids of Phosphorus by Quinolinium Dichromate

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Oxidation of lower oxyacids of phosphorus by quinolinium dichromate (QDC) in dimethylsuloxide (DMSO) leads to the formation of corresponding oxyacids with phosphorus in a higher oxidation state. The reaction exhibits 1:1 stoichiometry. The reaction is first order with respect to QDC. A Michaelis-Menten type of kinetics was observed with respect to the reductants. The reaction does not induce polymerization of acrylonitrile. Reactions are catalyzed by hydrogen ions. The hydrogen-ion dependence has the form: $k_{obs} = a + b[H^+]$. The oxidation of deuteriated phosphinic and phenylphosphinic acids exhibited a substantial primary kinetic isotope effect. The oxidation was studied in nineteen different organic solvents. The solvent effects were analysed in terms of Taft's and Swain's multiparametric equations. The effect of solvent indicates the solvent polarity plays a major role in the process. It has been shown that the penta-coordinated tautomer of the phosphorus oxyacid is the reactive reductant and it has been concluded that tri-coordinated forms of phosphorus oxyacids does not participate in the oxidation process. A mechanism involving transfer of a hydride ion in the rate-determining step has been proposed.

Keywords: Dichromate, Kinetics, Mechanism, Oxidation, Phosphorus oxyacids.

PP-13

Imidazolium ionic liquids towards the Mg/S batteries

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Rechargeable magnesium (RMB) battery has been promising candidate1,2 for future battery generation due to its safety Mg anode. In this combination sulphur cathode is one of the safe, low-cost and high volumetric electrochemical storage system.3,4 Electrolyte is one of the challenging task in this system due to Mg compatibility and sulphur (polysulfide) solubility.1 Common anion used in electrolyte system provides fast movement of $[Mg^{2+} (BF_4)_n]$ and $[(Mg_{2+} (TFSI^-)_n]$ adduct as well as suppress the polysulfide solubility due to anion concentration. Effectively the passivation of Mg^{2+}, intercalation into electrodes and transportation get enhanced. These effects truly exist into Mg^{2+} kinetics in the Mg/S batter cycling and conductivity results. The BF^{4-} and $TFSI^-$ WCA (weakly coordinating anion) tuned with imidazolium ionic liquid and common anion $Mg (BF_{4-})_2$ and $Mg (TFSI^-)_2$ into Mg/S battery with sulphur cathode material. The fluorinated anionic ionic liquid is suppressing polysulfide shuttle effect than the localized negative charge anionic ionic liquid. This is shown by various techniques.

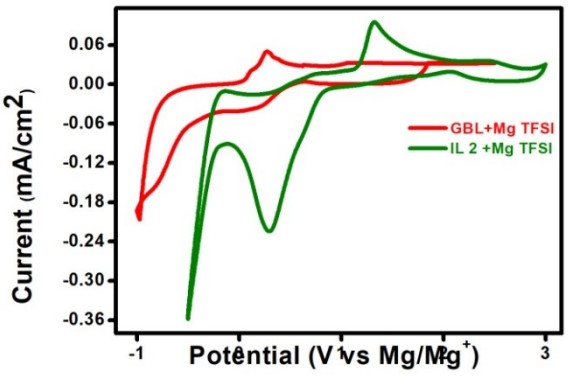

Figure 1. Electrochemical performance in Mg Salt in IL and Organic solvent GBL electrolyte

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PP-14

Kinetics and Mechanism of the Oxidation of DL-Methionine by 2-Picolinium Chlorochromate

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The oxidation of methionine (Met) by 2-picolinium chlorochromate (PICC) in dimethylsulphoxide (DMSO) leads to the formation of corresponding sulphoxide. The reaction is of first order with respect to PICC. Michaelis-Menten type kinetics was observed with respect to methionine. The reaction is catalysed by hydrogen ions. The hydrogen-ion dependence has the form: k_{obs} = a + b $[H^+]$. The oxidation of methionine was studied in nineteen different organic solvents. The solvent effect was analyzed by Kamlet's and Swain's multiparametric equations. Solvent effect indicated the importance of the cation-solvating power of the solvent. A suitable mechanism has also been postulated.

Keywords: Halochromate, kinetics, mechanism, methionine, oxidation

PP-15

Investigation of Gas Phase Kinetics of Phenyl Radical, the Simplest Aromatic Radical with Model Biofuels Using Cavity Ring-down Spectroscopy and Theoretical Methodologies

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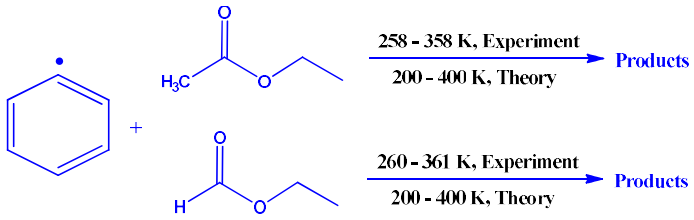
Phenyl radical ($C_6H_5^\bullet$) is one of the most reactive intermediates responsible for the production of soot and polycyclic aromatic hydrocarbons (PAHs) during a combustion process[1]. Being one of the major constituents of automobile emissions, kinetic investigation of $C_6H_5^\bullet$ reactions are essential not only to understand the environmental impact of vehicular emissions but also for designing more efficient and clean practical combustion engines in the future. Using our in-built cavity ring-down spectroscopy (CRDS) set-up[2], kinetics of the reaction of $C_6H_5^\bullet$ has been investigated in the temperatures and pressures of atmospheric interest, with ethyl acetate (EtOAc, EA) and ethyl formate (HCO_2Et, EF) which are considered to be potential biofuels and used widely in various applications of daily life such as food flavourings, confectionaries, in perfumes and printing industries[3]. Atmospheric oxidation of EA and EF by oxidants like phenyl radicals has the potential to contribute to regional as well as global air qualities.



CRDS was used to measure the absorption cross section of phenyl radicals at 504.8 nm ($^2B_1 \leftarrow ^2A_1$ transition) using nitrosobenzene (C_6H_5NO) as the radical precursor at 248 nm and it was measured to be: σ_{phenyl} (504.8 nm, 298 K) = (5.55 ± 1.34) × 10^{-19} cm^2 $molecule^{-1}$ which was found to be independent of the pressure (40-200 Torr in N_2). Moreover, the absolute rate coefficients for the reaction of $C_6H_5^\bullet$+EA and $C_6H_5^\bullet$+EF were measured over the temperature range of 258-358 K and 260-361 K respectively at (40±2) Torr of total pressure with N_2 using CRDS at a laser repetition rate of 2 Hz. The temperature dependent rate coefficient for the reaction $C_6H_5^\bullet$+EA over the studied temperature range was obtained to be k_{expt}(258-358 K) = (9.33 ± 0.11) × 10^{-16} exp [(883.7 ± 181.2)/T] cm^3 $molecule^{-1}$ s^{-1} with a rate coefficient of k (T)= (2.20 ± 0.12) × 10^{-14} cm^3 $molecule^{-1}$ s^{-1} at 298 K whereas the same for the reaction of $C_6H_5^\bullet$+EF was measured to be k_{expt}(260-361 K) = (1.20 ± 0.16) × 10^{-13} exp [-(435.6 ± 50.1)/T] cm^3 $molecule^{-1}$ s^{-1} with a room temperature rate coefficient of k (298 K)= (4.54 ± 0.42) × 10^{-14} cm^3 $molecule^{-1}$ s^{-1}. In both the cases, the effect of pressure and photolysis laser fluences were found to be negligible within the

experimental uncertainties for the studied range. In addition, to complement our experimental findings, the T dependent rate coefficients for the title reactions were investigated at CCSD(T)/cc-pVDZ//B3LYP/6-31+G(d,p) level of theory using canonical variational transition state theory in combination with small curvature tunnelling (CVT/SCT) corrections. At room temperature the reactivity of EF towards phenyl radicals was found to be ~2 times higher than that for EA.

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PP-16

Hot Electron Transfer from CdTe QD to Porphyrin & Ultrafast Electron Transfer from Porphyrin to CdTe QD in QD-Porphyrin Nanocomposites

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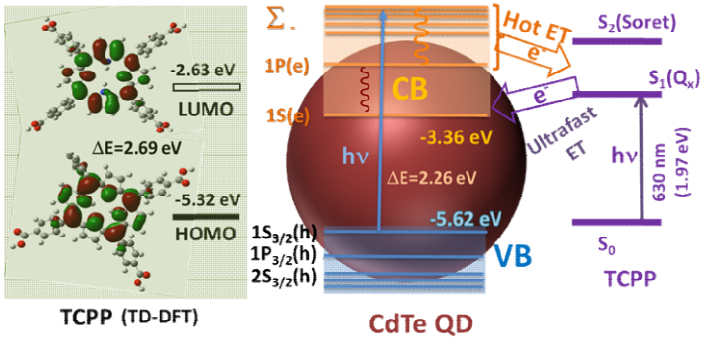
Understanding of exciton dynamics in semiconductor quantum dots (QDs) is of great importance due to their immense application potential on various photonic devices. In this work, we demonstrate hot electron transfer (HET) from higher excited states of cadmium telluride quantum dot (CdTe QD) to tetrakis (4-carboxyphenyl) porphyrin (TCPP) and ultrafast electron transfer from photoexcited TCPP to CdTe QD in a newly prepared CdTe QD- tetrakis (4-carboxyphenyl) porphyrin nanocomposites (CdTe QD-TCPP NCs), where TCPP is noncovalently attached to CdTe QDs, by employing steady state, time-resolved emission and femtosecond transient absorption spectroscopic techniques. The observation of efficient quenching of the photoluminescence (PL) of CdTe QDs with little/negligible change in photoluminescence (PL) decay profiles in nanosecond time regime (TCSPC method) of CdTe QD-TCPP NCs predominantly indicates static interaction between these two interacting species, CdTe QD and TCPP. Excitation wavelength as well as excitation intensity dependent femtosecond transient absorption studies of CdTe QDs and CdTe QD-TCPP NCs confirm the hot electron transfer (HET) from higher excited states (Σ-/1P(e)) to TCPP. Analysis of growth kinetics of band-edge or 1S bleach amplitude of band-edge bleach signal strength at initial stage after excitation allow us to estimate 30-40 % quantum efficiency (φ_{HET}) of HET when CdTe QD-TCPP NCs are excited at higher excited state (~390 nm). In contrast, no electron transfer was observed when CdTe QD-TCPP NCs are excited at the vicinity of band-edge (1S) exciton. In other instance, femtosecond transient absorption studies upon 630 nm excitation at the Q band of TCPP in CdTe QD-TCPP NCs suggest the occurrence of ultrafast electron transfer (<250 fs) from photoexcited TCPP to CdTe QDs in CdTe QD-TCPP NCs. The charge separation and charge recombination dynamics in CdTe QD-TCPP NCs are explored in details. The fundamental understanding of this to and fro photo-induced electron transfer dynamics in CdTe QD-TCPP NCs opens up new possibilities to design an efficient light-harvesting system based on inorganic-organic hybrid systems.



PP-17

Theoretical and Computational Investigation of the Excited State Dynamics of the Green Fluorescent Protein and its variants

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Green Fluorescent Protein (GFP) is a protein extracted from the body of jellyfish called Aequorea Victoria which exhibits green colour when exposed to light[1]. Over the past few decades, GFP and its structural analogous has become one of the most widely used tool in molecular biology, medicine and cell biology as a unique fluorescent biological label[2-6]. GFP and its variants have been extensively used throughout the cellular biology because of its stability and due to the fact that it can generate a highly visible efficiently emitting internal fluorophore. The fluorophore is formed by the tripeptide 65SYG67 sequence which proceeds without the need of external co- factors. This led the researchers to use the GFP in living organisms and it has appeared that the fusion of GFP to a protein in living cells does not alter the function and location of the protein respectively[7]. Following the success of GFP as a biological fluorescent marker, various research groups has been involved worldwide on the wild-type GFP and its variants[7-9]. There has also been a very concerted research effort in both experimental and computational research areas into engineering new fluorescent proteins (FPs) with more enhanced properties since the wild type GFP is not very easily available[9,10]. Therefore, it is our purpose here to investigate the various properties and mechanisms of the experimentally synthesized fluorescent protein (FP) with enhanced properties which are the analogue of Green Fluorescent Protein (GFP) chromophore as well as various studies related to the wt-GFP.

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PP-18

Bactericidal Activity of Mono-2-Methyl-4-Nitroaniline Phosphate Ester

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Mono-2-methyl-4-nitroaniline phosphate has been synthesized by the reaction of 2-methyl-4-nitroaniline, with phosphorylating agent P_2O_5. Characterization is done by elemental and IR spectral analysis. Resistance in some pathogenic bacterial strains to conventional antibiotics has initiated to search for effective treatments against microorganisms. In this context, bactericidal activity of synthesized phosphate ester has been tested by determining the zone of inhibition of bacterial growth. Different concentrations of phosphate ester in DMSO were applied to examine their bactericidal activity against gram positive and gram negative bacteria by paper disc diffusion method. Zone of inhibition was observed and measured in mm. Results indicated that the test compound, Mono-2-methyl-4-nitroaniline phosphate has demonstrated significant antibacterial activity against all selected gram positive and gram negative bacteria.

Keywords: Mono-2-methyl-4-nitroaniline phosphate, bactericidal activity, paper disc diffusion method, zone of inhibition.

PP-19

Computational investigation on water exchange rates of different Stereo-isomers of Lanthanides complexes

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The Application of Lanthanide series complexes in biomedical and medical field has emerging contribution in recent years[1,2]. Due to the presence of high magnetic moment (s=7/2) of gadolinium, Gd-baesd complex are ideal for use as a MRI contrasting agent[3]. Modulation of water exchange in Gd (III) complexes has been studied widely in the last few years[4,5]. The water exchange in the lanthanide series complexes is very sensitive to ligand stereochemistry. A few authors has reported there in the orientation of ligand relative to the inner-sphere Ln (III) ion bound water molecule[6]. The current study investigate the effect of R and S stereochemistry of methyl group in the complex of the ligand(S)-6,6′-(1-carboxyethylazanediyl) bis (methylene) dipicolinate[7,8,9] and ligand(R)-6,6′-(1-carboxyethylazanediyl)bis(methylene) dipicolinate[10]. The three water molecules present in the complex possess different water exchange property along the lanthanide series, but the change of Ligand stereochemistry does not show any effect on the water exchange property.

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PP-20

Adsorption of Individual CO gas molecule on graphene: A Computational Investigation

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Detection of toxic gases is critical for environmental issues, associated risk to the ecosystem and chemical process control[1]. Among them CO is extensively studied gas since it is highly toxic to the blood, nervous system, and the main reason of air pollution1,[2]. Therefore, development of highly sensitive, selective & effective gas sensor is utmost important [3,4].

Graphene and their composites are considered as a promising material for gas sensing application. Adsorption of gas molecule affected the charge carrier concentration and hence the electrical properties. Moreover, as compare to the conventional metal oxide based sensors, graphene-based sensor showed improved sensitivity, reversibility and limit of detection etc[5-9].

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PP-21

Effect of transition metal oxide dopant on corrosion protecting behavior of polypyrrole

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Polypyrrole and polypyrrole composites of titanium dioxide of 5%, 10% concentrations are electropolymerized on the surface of stainless steel surface by cyclic voltammetry technique. The corrosion protecting behavior of polypyrrole and polypyrrole-titanium dioxide composites of different concentrations in 1M HCl was evaluated by Electrochemical impedance spectroscopy and potentiodynamic polarization techniques. From the EIS measurement, it is observed that the Rct value of Polypyrrole-TiO_2 composites of different concentrations is higher than pure polypyrrole. The double layer capacitance Cdl of all composites is lower than pure polypyrrole. So corrosion protection efficiency of Polypyrrole- TiO_2 of different concentrations are better than pure polypyrrole on stainless steel surface. The higher values of Rct for Polypyrrole- TiO_2 composites can be explained by the building up of a primary protective passive layer. From the polarization analysis, it was observed that pure polypyrrole coated steel possessed a lower Ecorr and higher Icorr value than polypyrrole-TiO_2 composites which indicated that polypyrrole composites give better corrosion protection on the stainless steel surface. From the EIS and polarization analysis, it was confirmed that polypyrrole-TiO_2 composites give better corrosion protection on stainless steel surface than pure polypyrrole coating.

PP-22

Kinetics and Mechanism of the Oxidation of Lower Oxyacids of Phosphorus by Quinolinium Dichromate

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Oxidation of lower oxyacids of phosphorus by quinolinium dichromate (QDC) in dimethylsuloxide (DMSO) leads to the formation of corresponding oxyacids with phosphorus in a higher oxidation state. The reaction exhibits 1:1 stoichiometry. The reaction is first order with respect to QDC. A Michaelis-Menten type of kinetics was observed with respect to the reductants. The reaction does not induce polymerization of acrylonitrile. Reactions are catalyzed by hydrogen ions. The hydrogen-ion dependence has the form: $k_{obs} = a + b[H^+]$. The oxidation of deuteriated phosphinic and phenylphosphinic acids exhibited a substantial primary kinetic isotope effect. The oxidation was studied in nineteen different organic solvents. The solvent effects were analysed in terms of Taft's and Swain's multiparametric equations. The effect of solvent indicates the solvent polarity plays a major role in the process. It has been shown that the penta-coordinated tautomer of the phosphorus oxyacid is the reactive reductant and it has been concluded that tri-coordinated forms of phosphorus oxyacids does not participate in the oxidation process. A mechanism involving transfer of a hydride ion in the rate-determining step has been proposed.

Keywords: Dichromate, Kinetics, Mechanism, Oxidation, Phosphorus oxyacids.

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DEPARTMENT OF SCIENCE AND HUMANITIES

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PREFACE

The maiden proceedings of MSAJCE- ICRTSH-2020 'International Conference on Recent Trends in Science and Humanities' is the collection of selected project papers of technological advances and research results in the Recent Trends in the departments of Chemistry, Physics, Mathematics and English which is held on September 23rd 2020 , organised by Department of Science and Humanities.

The conference acts as a major forum for the presentation of innovative ideas, trends, approaches and research projects. The Papers with innovations in Electro, Environmental, Medicinal ,Nano, Polymer and Green Chemistry; Crystal growth, Laser, optical, Nano structured, Magnetic, Semi conducting and Nano materials; Statistics, Fuzzy modelling, Graph Theory, Fluid Dynamics and Analysis in Mathematics; Challenges in teaching and developing English, Significance of Communication and Soft skills and Teaching strategies from researchers, faculties and students illustrate analytical research results, projects and academic experiences describing significant advances in the areas related to the relevant themes and tracks of the conferences.

The papers are reviewed based on their technical content, originality and clarity. Out of 55 submissions, 40 papers are selected and 10 abstracts for oral presentation at the conference and subsequent publication. Surely, the conference will be a source of powerful influence as it draws upon the expertise from various disciplines and bring academicians, researchers, scholars and students together for focusing on new trends in the fields of science which create a cross disciplinary summit that transcends departmental, institutional, public and private research organisations to integrate the research and education in the fields of science and humanities.

We extend heartiest and warm welcome to the distinguished delegates and participants of the conference and we aspire that you find an interesting and thought-provoking experience.

Finally, we thank all the authors who contributed to the success of the conference. We sincerely wish that all attendees will be benefited academically from the conference and wish them every success in their research Endeavour. We look forward to seeing all of you next year at the ICRTSH 2021.

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Alhaj Janab SM Yousuf

Chairman, Mohamed Sathak AJ College of Engineering, Chennai

Message

I am indeed elated to note that the Department of Science & Humanities of Mohamed Sathak A J College of Engineering is organizing First "International Virtual Conference on Recent Trends in Science and Humanities" (ICRTSH20) on 23rd September, 2020.

The function of education is to teach one to think intensively and to think critically. Intelligence plus character - that is the goal of true education. I am sure that this conference will provide a unique platform for academicians and researchers for fruitful deliberations and exchange of ideas in the emerging areas of Science & Humanities. The galaxy of expert present will enormously benefit young researchers attending the conference from every corner of the country.

I take this opportunity to congratulate the faculty members and students of Mohamed Sathak AJ College of Engineering for taking this extraordinary venture to conduct the International Conference resourcefully. To mark this occasion, the college has come out with proceedings. I congratulate once again for the team effort and I wish them all success in their academic endeavors.

Prof. Ramesh L. Gardas

Professor, Department of Chemistry, IIT Madras

Message

It gives me an immense pleasure to observe that the Department of Science and Humanities of Mohamed Sathak AJ College of Engineering is organizing an International Conference on "RECENT TRENDS IN SCIENCE AND HUMANITIES (ICRTSH2020)"

I do believe that this International Conference will provide attractive platform for interaction among the versatile professionals, eminent academicians and erudite research scholars of various field from both academia and industry and help them to elevate the society by sharing the knowledge of **"RECENT TRENDS IN SCIENCE AND HUMANITIES".**

I congratulate the Management, Principal, HOD, Faculty members, organizing committee for their sincere efforts in making this programme a grand success.

Dr. B. Sundaravadivazhagan

Professor, University of Technology & Applied Science, Al Musanna, Sultanate of Oman

Message

I take immense pleasure in being a part of the International Conference on Recent Trends in Science and Humanities (ICRTSH) team of Mohamed Sathak AJ College of Engineering. The maiden effort taken by the department in noteworthy.

In recent times through technology plays a vital role globally. Humanities and Science provide contribution in engaging learners in thinking analysing and questioning uniquely. Also allows learners to successful productive members of society.

Researcher plays the main role for development in the field of education. Now I am very happy to see this conference focusing different core areas namely physics, mathematics, Chemistry, Biology, English, Management and other humanities subjects.

I wish all the participants good luck and I congratulate the conference team for organizing such wonderful event

Prof. Roseline Jesudas
Prof. of Linguistic English, Northern Border University, Arar, Kingdom of Saudi Arabia

Message

"Science is the collection of nature's answers; the Humanities the collection of men's thoughts." - Sir Gavin de Beer

The humanities and science are not in inherent conflict but have become separated in twentieth century. Now their essential unity must be re-emphasized so that 20th century multiplicity may become 20th century unity - Lewis Mumford

The current digital scenario demands the change in the students' profile attributes, students pursuing science and technology careers should augment their education with a strong foundation in the humanities. Since the Humanities enhance the students' social and cultural responsibilities, allows them to think creatively and critically, strengthen the students 'communication skills, provides the opportunities to the students to move across the discipline more freely.

It is time for everyone to realize that the Humanities are not just an aesthetic luxury course taught in the classrooms of Engineering Courses. It is an indispensable part of our education system. Why the Humanities are more important than ever? The 21st century answers that Humanities will provide new lances to the students to see the world differently and allow us to take a correct angle and turnaround from our daily, point, and swipe lives. This Conferences shed a light on new trends in science and humanities and I believe it will bring a fruitful output which is a need of an hour.

I believe that the paper presenters and participants of this International Virtual Conference on New Trends in Science and Humanities will have a chance to learn about the latest trends, discuss common challenges, and brainstorm creative solutions.

I would like to congratulate the Management, Principal, and Administration, organizing, and technical support team in particular for the excellent arrangements for this International Virtual Conference. I hope all the participants will really enjoy presenting their paper at this remarkable conference. Best wishes to all the paper presenters and participants.

Best Wishes

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Eco- friendly Corrosion Inhibitor for Carbon Steel in Acid media

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ABSTRACT

Corrosion inhibitors are commonly used for the protection of metal surfaces against corrosion. The effectiveness of an inhibitor depends on its ability to react with the surface of a metal to form a protective film and thereby reducing or providing protection against corrosion. In many cases, the highly efficient inhibitors are very toxic and, therefore, are a high risk to health and to the environment. There is a great demand for new, low cost, environmentally safe and high performance corrosion inhibitors. The main aim of this study is to examine a new class of natural corrosion inhibitors. The use of extracts of inhibitors from natural products is the best alternative because it does not contain heavy metals and is nontoxic, environmentally friendly, biodegradable, easy to obtain, inexpensive and available in large quantities. This study involved the application of eco-friendly, green corrosion inhibitor extract from *Eclipta prostrata stem* to explore its anticorrosive action on carbon steel, using mass-loss method, thermometric method and surface analysis technique. Results of weight loss method indicated that inhibition efficiency (IE) increased with increase of inhibitor concentration. The effect of temperature on the corrosion rate in the absence and presence of the extract was investigated and the adsorption parameters were calculated. The adsorption process was found to be spontaneous and it follows Temkin, Langmuir adsorption isotherms. The adsorbed film over the carbon steel surface was confirmed by Scanning Electron Microscopy (SEM) technique. These results indicate that the *Eclipta prostrata* stem extract is efficient in preventing the corrosion of carbon steel in the acid media.

Keywords: Carbon steel, Eclipta prostrata, Physisorption, SEM

1. INTRODUCTION

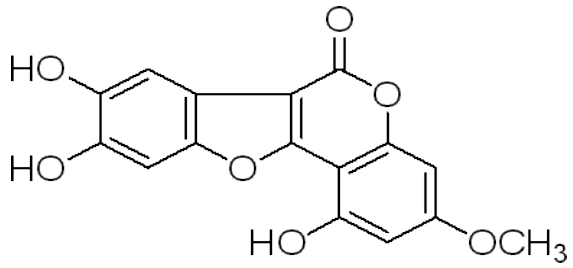
Corrosion is a natural phenomenon widely defined as degradation of metal surfaces in contact with an aggressive environment [1]. Carbon steel is widely used in industries due to its great mechanical properties. Corrosion studies have become important due to increasing awareness of the need to conserve the world's metal resources [2]. Corrosion has a major impact on the economy of a nation [3]. Approximately one third of the cost of corrosion is avoidable and could be saved by using corrosion resistant materials and application of state of the art corrosion control technologies. Among the acids, hydrochloric acid (HCl) is one of the most widely used agents in several industries for the removal of undesirable oxide films and corrosion products of the surface of steel [4]. The use of corrosion inhibitors constitutes one of the most economical ways to mitigate the corrosion rate, and protect metal surfaces against corrosion and preserve industrial facilities [5, 6]. Inhibitors are quietly required to preserve metals and alloys against acid attack by reducing the corrosion rate of metals and alloys. Corrosion inhibitors are compounds that are added in small quantities to an environment to prevent corrosion of

metals [7]. The known hazardous effect of most synthetic corrosion inhibitors has encouraged scientists to use natural products as corrosion inhibitors as they are inexpensive, readily available and renewable sources of materials, environmentally friendly and ecologically acceptable [8, 9]. The present review exclusively focuses on the use of plant extracts as green inhibitors in hydrochloric acid medium for carbon steel in the recent years by the researchers which discloses the potential of the green inhibitors for further research. Thus the present study is an effort to use ethanol extract of Eclipta prostrata stem as a green inhibitor for the carbon steel in acid solutions in different concentrations. The corrosion behavior of carbon steel in hydrochloric acid solution with and without the plant extract was studied using weight loss measurements, thermometric method, effect of temperature and surface analysis technique. The surface morphology of the carbon steel was characterized using SEM.

2. EXPERIMENTAL

2.1 Preparation of Eclipta prostrata stem extract (Inhibitor)

Ethanol extract of *Eclipta Prostrata stem* was prepared by refluxing 10g of the stem powder with 100 ml of ethanol for 3 hours. The refluxed solution was filtered, and the liquor was evaporated. 1g of the sample was accurately weighed and dissolved in 1000 ml of double distilled water made in 1000 ml standard flask. The thousand fold dilution of stock solution (1000 ppm). This extract was used as corrosion inhibitor in the present study. The major constituent of the ethanol extract is Wedelolactone.



Molecular structure of wedelolactone

2.2 Preparation of the carbon steel specimen

Carbon steel specimens of dimensions 1.0 cm × 4.0 cm × 0.2 cm (surface area 10 cm^2) and the density 7.87 g/cm^3,were polished to a mirror finish and degreased with acetone and used for the weight loss method and surface examination studies. The surface of the electrode was polished to a mirror finish and degreased with acetone.

2.3 Weight loss method

The weight loss techniques are the conventional and simplest of all corrosion techniques. Carbon steel samples were completely immersed in 100 ml of the solution of acid media of normality (0.5N and 0.3N HCl) containing various concentrations of the inhibitor (PE) for a period of 3 hours. After 3 hours of immersion the specimens were taken out, washed in running water, dried and weighed. The corrosion inhibition efficiency (IE) was then calculated using the equation

$$IE\ (\%) = \frac{W_0 - W_1}{W_0} \times 100$$

where,W_1 is the corrosion rate in the absence of the inhibitor

W_2 is the corrosion rate in the presence of the inhibitor

Corrosion rate is calculated assuming uniform corrosion over the entire surface of the sample. corrosion rates (CR) are calculated from weight loss method using the formula

$$CR = \frac{534\ W}{DAT}\ \text{Mils per year (mpy)}$$

where,W = weight loss in milligrams

D = density of specimen g/c = 2.70 gm/cm^3

A = area of specimen in square inches = 1.395

T = exposure in hours = 3 hours

The degree of surface coverage (θ) was calculated from the weight loss measurement results using the following formula,

$$\text{Surface coverage} = \frac{W_0 - W_1}{W_0}$$

Where,W_0 is the weight loss in the absence of inhibitor

W_1 is the weight loss in the presence of inhibitor

2.4 Thermometric measurement

In the thermometric technique, 0.5N HCl was used as the corrodent. The volume of test solution used was 50 ml. The carbon steel specimens were carefully dropped in the test solution and quickly closed using cork. The initial temperature in all experiments was kept at 30 °C. The progress of corrosion reaction was monitored by determining the changes in temperature with time using a calibrated thermometer (0-100 °C) to the nearest ±0.05 °C.

The temperature variation on thermometer was monitored at 5 minutes interval until maximum temperature was reached and recorded. The experiment was repeated in the presence of different concentrations of studied inhibitor.

This method enabled the computation of the reaction number (RN) defined as:

$$RN\ (^{\circ}C\ min^{-1}) = \frac{T_m - T_i}{t}$$

Where T_m and T_i are the maximum and initial temperatures, respectively and t is the time (min) taken to reach the maximum temperature. The inhibition efficiency (IE %) was evaluated from percentage reduction in the RN namely,

$$IE\ \% = \left[\frac{RN_{aq} - RN_{wi}}{RN_{aq}}\right] \times 100$$

Where RN_{aq} is the reaction number in the absence of inhibitors (blank solution) and RN_{wi} is the reaction number in the presence of the corrodent containing the PE.

2.5 Effect of temperature

The polished and pre – weighed specimens were suspended in 100 ml of the test solution without and with the addition of various concentration of the PE for 3 hours in the temperatures range of 303 – 323K using water thermostats. The specimens were removed from the test solution after 3 hours and washed with distilled water, dried and weighed. The inhibition efficiency was calculated from the weight loss.

2.6 Scanning Electron Microscopy (SEM)

The effect of inhibitor on corrosion process of carbon steel was examined using SEM. The surface analysis of the carbon steel for fresh, inhibited and uninhibited systems was investigated. The carbon steel immersed in blank and in the inhibitor solutions for a period of 3 hours was removed, rinsed with double distilled water, dried and observed under scanning electron microscopy to examine the surface morphology. The morphology measurements of carbon steel were examined using a JEOL model 6390 computer controlled SEM.

3. RESULTS AND DISCUSSION

3.1 Weight loss study

Corrosion inhibition efficiencies (IE%) and the corresponding corrosion rates (CR) in mills per year (mpy) of Carbon steel in *Ethanol Extract of Eclipta Prostrata Stem* in different acid solutions (0.5N and 0.3N) HCl are discussed below

The weight - loss method was done for carbon steel in 0.5N and 0.3N HCl with various concentrations of PE ranging from 50 ppm to 300 ppm and the corresponding values of IE and CR are given in Table 1. It was observed that in all the systems the IE increased up to 250 ppm and then it decreases. It was observed from the table 1 that the CR decreased and thus IE increases with increasing concentration of PE. The maximum IE of about 99.8 % was achieved at 250 ppm of PE. This result indicated that PE could act as potent corrosion inhibitor [10, 11].

Table 1: Corrosion inhibition efficiency (IE) and the corresponding corrosion rates (CR) in mills per year (mpy) of carbon steel in different acid solutions in the absence and presence of PE

PE in ppm	0.5N HCl		0.3N HCl	
	IE (%)	CR (mpy)	IE (%)	CR (mpy)
0	0	7088.8	0	6899.7
50	51	3497.1	48	3591.6
100	67	2315.6	59	2835.5
150	82	1228.7	66	2362.9
200	91	614.3	89	708.8
250	**99.8**	**14.17**	**91**	**614.3**
300	84	1134.2	83	1181.4

3.2 Influence of Immersion Period

The effect of inhibitor on the corrosion of carbon steel was studied at various exposures time periods. The influence of immersion period on the IE of PE is shown in Table 2. Maximum IE for 0.5N HCl was found to be 99.8% at 3 hours with 250 ppm concentration of the inhibitor respectively, and then it was found to decrease. It was found that as the immersion period increases, the IE decreases. This is due to the fact that, as the period of immersion increases, the protective film formed on the carbon steel surface was broken by the continuous attack of other ions present in the medium, and the film was broken, and hence, IE decreases as the immersion period increases. It was observed that IE increases up to 3 hours of exposure period, and then it was found to decreases. Hence it was found that the protective film was stable up to 3 hours [12, 13].

Table 2: Influence of immersion period on the IE % of PE in 0.5N HCl

Time (h)	Immersion period				
	1	2	**3**	4	5
IE%	47	76	**99.8**	63	51

3.3 Thermometric Measurement Corrosion Analysis

Thermometric methods have proved to be of considerable value and help in studying corrosion behavior of a number of metals and alloys in various corroding environment. The technique is also useful in evaluating the IE of a number of organic substances [14]. Corrosion reaction was also investigated through thermometric readings obtained by inserting a thermometer in the test solution in the absence and presence of studied inhibitor.

The experiment revealed that the maximum temperature T_m was attained at a very short time (t) by the solution and the IE increased with increase in inhibitor concentrations as shown in Figure 1.

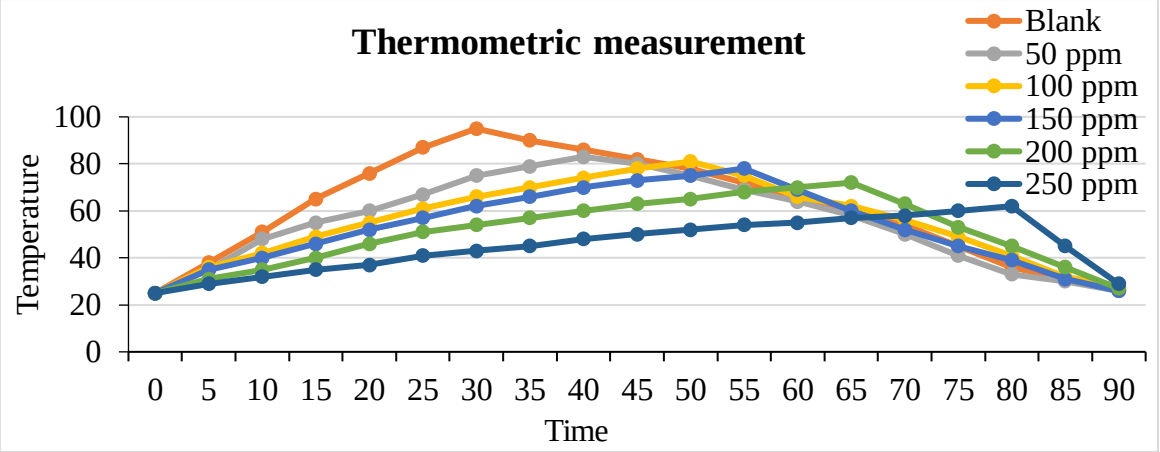


Figure 1: Graph of Temperature Vs Time curves for carbon steel corrosion in 0.5N HCl in the absence and presence of PE in different concentrations

The thermometric measurement revealed that on addition of the inhibitor, the maximum temperature attained decreases while the time required reaching it increases. This is an indication that PE inhibits the corrosion of carbon steel in the aqueous environment, probably by adsorption on the carbon steel surface. It shows that the inhibition process depends on the degree of surface coverage of adsorbed molecules on carbon steel.

Table 3 below gives the obtained corrosion parameters for the measurement. It was observed that the reaction numbers (RN) was decreased in the presence of the PE compared to the blank solution. It is clear that RN decreases and IE increases with increase in concentrations of PE and the IE increased to about 80% at 250 ppm of PE [15, 16].

Table 3: Corrosion parameters for thermometric measurement

PE in ppm	0.5N HCl	
	RN ($^oC\ min^{-1}$)	IE (%)
0	2.3	0
50	1.45	37
100	1.24	46
150	0.96	58
200	0.72	69
250	**0.47**	**80**

3.4 Effect of Temperature

Temperature has more pronounced effect on the rate of corrosion of metals. The effect of addition of PE at different concentrations on the corrosion behavior of carbon steel in 0.5N HCl was studied at different temperatures like 303K, 313K, 323K for 3 hours of immersion period. The value of IE, CR and the surface coverage (Θ) are tabulated in Table 4. As observed from the table, a remarkable decrease in carbon steel

corrosion rate was obtained in the presence of PE compared with the one in the blank solution at each temperature under study. Further, the inhibition efficiencies are observed to decrease with increasing temperature [17]. This is mainly because of the fact that the adsorbed film is unstable and easily damaged at high temperature. The decrease of inhibition efficiency with respect to temperature is due to desorption of inhibitor molecules from carbon steel surface at elevated temperatures [18]. As the temperature was increased from 303 K to 323 K, the IE was found to decrease, this shows that the adsorption of PE on the metal surface may be due to physical adsorption.

Table 4: Effect of temperature on the IE of PE

PE in ppm	303K			313K			323K		
	IE (%)	Ɵ	CR (mpy)	IE (%)	Ɵ	CR (mpy)	IE (%)	Ɵ	CR (mpy)
0	0	0	7684.2	0	0	8629.4	0	0	8960.2
50	45	0.45	4361.9	38	0.38	5349.6	35	0.35	5831.7
100	50	0.50	3804.3	45	0.45	4749.5	40	0.40	5359.0
150	67	0.67	2410.1	61	0.61	3407.3	54	0.54	4092.6
200	73	0.73	2036.8	65	0.65	3005.6	59	0.59	3681.4
250	91	0.91	723.0	83	0.83	1483.9	78	0.78	1975.4

3.5 Thermodynamic Parameters

Activation Energy

The activation energy (E_a) for the corrosion of carbon steel in the presence and absence of PE is calculated using the following Arrhenius Equation (1) and (2).

$$CR = A \exp\left[\frac{-Ea}{RT}\right] \qquad (1)$$

$$\log\left[\frac{CR_2}{CR_1}\right] = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right] \qquad (2)$$

(Where CR_1 and CR_2 are the corrosion rate at the temperature T_1 and T_2 respectively, E_a is the activation energy and R is the universal gas constant). The value of activation energy (E_a) for the blank (9.64 KJ/mol) is lower than in the presence of PE (Table 5). This observation clearly indicates that the adsorption process is Physisorption.

Heat of adsorption

The heat of adsorption on the surface of carbon steel in the presence of PE in aqueous environment is calculated by the equation (3).

$$Q_{ads} = 2.303\ R\ \log\left[\left(\frac{\theta_2}{1-\theta_2}\right) - \log\left(\frac{\theta_1}{1-\theta_2}\right)\right] \times \left[\frac{T_2 \times T_1}{T_2 - T_1}\right] \qquad (3)$$

(Where R is the gas constant, θ_1 and θ_2 are the degree of surface coverage at temperatures T_1 and T_2 respectively).

The calculated Q_{ads} values (Table 5) are range from -36.11 to -19.64 KJ/mol for PE. The negative Q_{ads} values indicate adsorption and hence IE decreases as temperature increases, supporting the earlier proposed physisorption mechanism.

Free energy of adsorption

The equilibrium constant of adsorption for PE on the carbon steel is related to the free energy of adsorption ΔG_{ads} by equation (4).

ΔG_{ads}=- 2.303 RT log (55.5 K) ---------- (4)

(Where R is the gas constant, T is the temperature, K is the equilibrium constant of adsorption)

The free energy of adsorption ΔG_{ads} were all negative in the temperatures under study. The negative value of adsorption showed (Table 5) the spontaneity of adsorption of the PE on the carbon steel surface. This adsorption of inhibitor on the surface of carbon steel may be physical adsorption (ΔG_{ads}< 40 KJ/mol). Generally, the values of ΔG_{ads} around -20 KJ/mol or less negative are consistent with physisorption while those around -40 KJ/mol or more negative values involve chemisorption [19].

Table 5: Thermodynamic parameters for the corrosion of carbon steel in 0.5N HCl containing various concentrations of PE at different temperature

PE in ppm	Activation energy, E_a(KJ/mol)	Heat of adsorption Q_{ads} (KJ/mol)	Free energy change ΔG_{ads}(KJ/mol) of adsorption at 303K	Free energy change ΔG_{ads} (KJ/mol) of adsorption at 313K
0	9.64	0	0	0
50	16.96	-36.11	-5.55	-4.83
100	18.44	-52.16	-4.31	-3.81
150	28.77	-54.27	-5.08	-4.42
200	32.33	-18.38	-5.07	-4.13
250	59.76	-19.64	-7.83	-6.0

3.6 Adsorption Studies

Adsorption isotherms are commonly used to understand the inhibition mechanism of the inhibitor molecules at the metal surface [20]. In order to appreciate the mechanism of adsorption, adsorption behavior of organic compounds described using adsorption isotherm. The values of surface coverage at different concentrations of PE in acid medium in the temperature range (303K – 323K) have been used to explain the best isotherm to determine the adsorption process.

Temkin adsorption isotherm

The degree of surface coverage (θ) was related to the inhibitor concentration (C) according to the equation:

$$\theta = \frac{2.303 \log K}{2a} - \frac{2.303 \log C}{2a}$$

where

K is the adsorption equilibrium constant

a is the attractive parameter

The plot of θ versus log C of PE was shown in Figure 2. From the figure it was noted that there exists a linear relationship with $R^2 > 0.90$ in 0.5 N HCl, reveals that the adsorption data fitted to Temkin adsorption isotherm [21].

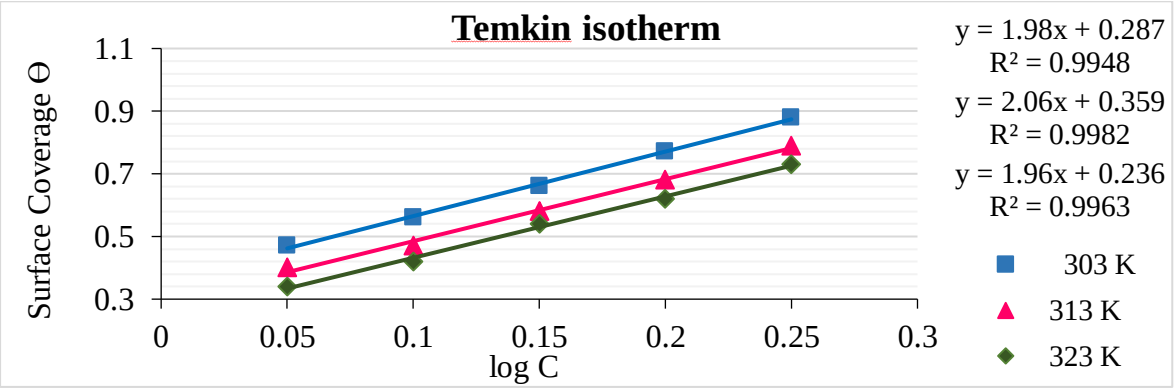


Figure 2: Temkin adsorption isotherm plotted as "θ" versus "log C" for carbon steel corrosion in 0.5N HCl containing various concentrations of PE at 303 K to 323 K

Langmuir adsorption isotherm

The Langmuir adsorption isotherm was related to the equation

$$\frac{C_{inh}}{\theta} = \frac{1}{K_{ads}} + C_{inh}$$

where

K_{ads} is the adsorption constant

C is the concentration of the inhibitor

θ is the degree of surface coverage of the inhibitor

The plot of C_{inh} versus C/θ of gives the Langmuir adsorption isotherm, which is shown in Figure 3. From the plot it was observed that there exists a linear relationship. The linear correlation coefficient, R^2 value is found to be closer to 1 in 0.5N HCl. This confirms the adsorption of PE on the carbon steel surface and obeys Langmuir adsorption [22].

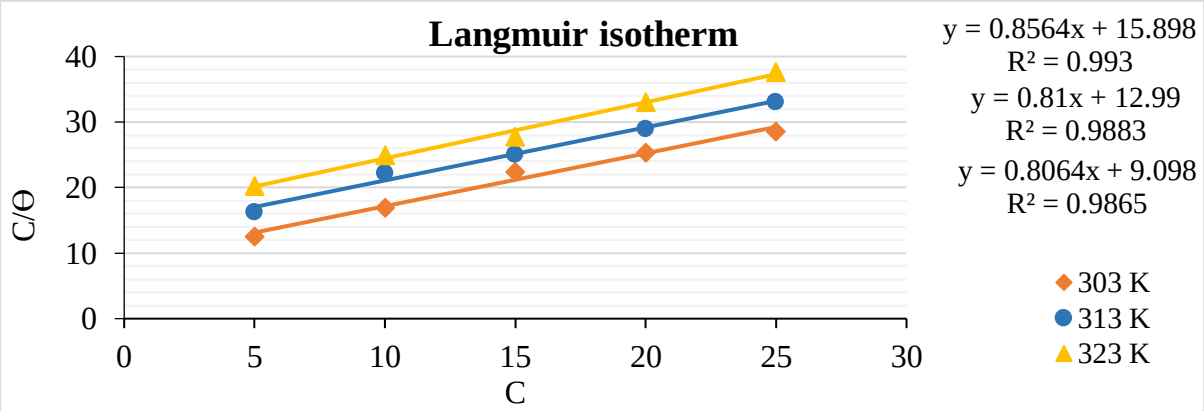


Figure 3: Langmuir adsorption isotherm plotted as "C/θ" versus "C" for carbon steel corrosion in 0.5N HCl containing various concentrations of PE at 303K & 323K

3.7 SEM Analysis of Metal Surface

SEM provides a pictorial representation of the surface. SEM photographs were taken to show that the corrosion inhibition is owing to the formation of an adsorptive film on the steel surface.

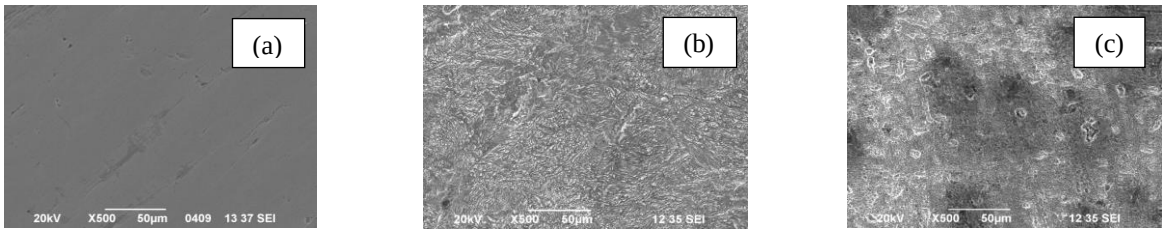


Figure 4: SEM micrographs of

a) **Polished carbon steel (control)**
b) **Carbon steel immersed in 0.5N HCl**
c) **Carbon steel immersed in 0.5N HCl containing 250 ppm of PE**

The SEM micrograph of the polished carbon steel surface shown in figure 4 (a). It shows the smooth surface of the steel and absence of any corrosion products on the surface of the steel. The SEM micrograph of the carbon steel surface immersed in 0.5N HCl was represented in figure 4 (b). The image revealed that the

surface was severely corroded due to the aggressive attack by HCl. Figure 4 (c) represents the surface analysis of the carbon steel immersed in 0.5N HCl in the presence of 250 ppm PE.

The analysis showed that the carbon steel surface was found to be smoother than the uninhibited surface. The improvement in the carbon steel surface was due to the adsorption of the inhibitor over the carbon steel surface. The adsorption of the inhibitor (PE) on the carbon steel acts as a good protective film on the surface which further reduces the CR [23].

4. CONCLUSION

The inhibitory influence of the *Eclipta prostrata* stem extract on carbon steel corrosion in 0.5N HCl solution was shown in the present work utilizing weight loss method, thermometric method, electrochemical studies, effect of temperature, surface analysis, leading to the following outcomes:

PE was found to be an effective inhibitor to prevent the corrosion of carbon steel in 0.5N HCl solution. The formulation consisting of 250 ppm of PE shows 99.8 % IE. The protective film formed on the carbon steel surface was able to withstand for 3 hours of immersion period. From thermometric studies highest IE was obtained with 250 ppm of the PE inhibitor. The formulation consisting of 250 ppm of PE has 80% IE. IE and degree of surface coverage decreases with the increase in temperature. Inhibition efficiency increases with the increase in the concentration of PE, but decreases with rise in temperature. Corrosion rates increases with increase in temperature and decreases with increase in inhibitor concentration. It obeys Temkin, Langmuir adsorption isotherms. E_a increases with the increase in concentration of the inhibitor suggests physisorption. The negative value of Q_{ads} indicates physisorption. The negative value of ΔG_{ads} shows the adsorption of inhibitor is a spontaneous process. SEM studies showed that the inhibited carbon steel surface was found smoother than the uninhibited surface due to the formation of protective film on the inhibited carbon steel surface. Therefore, the plant extract can be considered as an eco-friendly and effective green corrosion inhibitor for carbon steel in acid media.

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Treatment for removal of Cr (VI) wastewater by using Nanostructured NiO

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ABSTRACT

In this investigation, nanoparticle adsorption and attractive detachment were produced for the removal and recovery of Cr(VI) from wastewater. The nanoparticle was integrated, described and assessed as adsorbents of Cr(VI), different variables affecting the adsorption of Cr(VI) for example pH, introductory fixation and existing regular particles were considered. Adsorption achieved balance inside at some point and was autonomous of starting chromium (VI) focus. The adsorption information was examined and the adsorption instrument was explored utilizing X-beam Diffraction (XRD) and by SEM.

Keywords: Adsorption, Chromium (VI), Nickel oxide nanoparticles

1. INTRODUCTION

Water contamination is turning into the most vital issue that jeopardizing and impact on all living being and getting to be intense consistently. The impact of water contamination has consequences for the delicate equalization of nature. Substantial metals like mercury, chromium, nickel, lead, cadmium, copper present in the debased water, they present at the low focus in well parity water. Anyway, these are available at high focus as terms of debased water. Among these substantial metals chromium hexavalent is viewed as a need. Cr(VI) happen in the effluents deliver amid the calfskin tanning, color manure, electroplating, material assembling, rings water, steel creation manufacturing plants, and so forth The chromium hexavalent levels discharged may go from ten to a few mg/l are the most indispensable anthropogenic wellspring of chromium (VI) [1,2] Albadarin et al. (2011) have considered the ejection of Cr (VI) from the watery course of action by lignin. The chromium-containing wastewater can be treated by methods, for example, switch osmosis, electrodialysis, ultra-filtration, film division, particle trade, and adsorption. All the procedure are very effective in treating chromium-containing wastewater yet considering the economy and straightforwardness task, adsorption outscores the various procedures [3]. Chromium is a metal that is broadly dispersed in the world's hull, air, and water. Normally, happening chromium is has three stable isotopes 52Cr, 53Cr and 54Cr. It happens predominantly in the chromium(III) from as chromite mineral, which contains oxygen, chromium(III) and different metals. Chromium exists in air, water, and soil, for the most part in the trivalent chromium structure. This anyway just applies to trivalent chromium [4]. Hexavalent chromium is lethal to verdure. The component of poisonous quality is pH subordinate. It is just because of human exercises that

generous measures of hexavalent chromium end up present. Trivalent chromium mixes are not very dangerous and are a fundamental supplement that causes the body to utilize sugar, protein, fat, and so on and deficiencies may cause heart issues, interruptions of digestion systems and diabetes[5]. A few people are very touchy to hexavalent chromium of trivalent chromium. Unfavorably susceptible responses comprising of serious to redness and swelling of the skin have been noted. There are a few various types of chromium that vary in their belongings upon living beings. Chromium enters the air, water, and soil in the trivalent chromium and hexavalent chromium structure through normal procedures and human exercises [6]. Hexavalent chromium is imperative for its negative wellbeing and natural effect, and its extraordinary lethality. Unending inward breath of hexavalent chromium has been appeared to build the danger of lung disease and may likewise harm the little vessels in kidneys and digestive organs. Other antagonistic wellbeing impacts identified with hexavalent chromium presentation, as indicated by the National Institute for Occupational Safety and Health(NIOSH) [7,8], incorporate skin bothering, hypersensitive contact dermatitis, nasal ulceration, punctured nasal septa, nosebleed, respiratory disturbance, nasal disease, eye aggravation and harm, kidney harm, aspiratory blockage and edema, epigastric agony, and disintegration and staining of one's teeth. It causes unfavorably susceptible responses, is cancer-causing and is a large number of times as harmful Cr(III). Wellbeing impact identified with Cr(VI) presentation incorporates stomach and intestinal bleedings, liver, and kidney harm. Cr(VI) has a mutagenic impact. Harmful impacts are passed on to kids through the placenta. Cr(VI) oxide is a solid oxidant. Upon disintegration chromic corrosive is shaped, which firmly influences the organs. Most nations apply a reasonable farthest point of 50 ppb chromium in drinking water. A specific disease in chromium ventures is chromium bruises upon skin contact with chromates [9,10]. Negative Gibb's free vitality esteems demonstrated the plausibility and the unconstrained idea of the adsorption procedure. The execution of artificially actuated Syzygiumjambolanum nut carbon was contrasted and a business initiated carbon [11]. The effect of various procedure parameters, for instance, structure pH, ionic quality, beginning center, adsorbent estimations, the closeness of various metals (Zn and Cu), and proximity of salts were inspected. The perfect pH for the departure of Cr (VI) was seen to be 7. The most extraordinary metal take-up procured using Dubinin-Radushkevich and Khan isotherms for Cr (VI) ejection are 31.6 and 29.1 mg/g independently. It was contemplated that the adsorption instrument incorporates the interest of both hexavalent chromium (anionic) and trivalent chromium (cationic) onto the outside of lignin [12].

2. MATERIAL AND METHOD

Every one of the synthetic compounds utilized in this examination was of expository review and secured from E-Merck India Ltd and Aldrich. The imperative synthetic concoctions utilized were Nickel (II) Chloride Hexahydrate ($NiCl_2.6H_2O$), Absolute Alcohol, NaOH (Pellets), Ethanol, and Distilled Water of most elevated immaculateness was utilized all through the examination. 1.5 gm of $NiCl_2.6H_2O$ was exchanged to 250 ml round base flagon at room temperature. At that point 70 ml outright liquor was included the carafe. The Solution was exposed to consistent blending. 0.5 gm

NaOH was broken up in 100 ml supreme liquor in another measuring glass. This Solution was included $NiCl_2.6H_2O$ arrangement dropwise. It was blended for 2 hours. Light green shaded Gel was shaped following two hours. The gel was kept for three hours. Separated and washed with water and Ethanol. Light green-hued accelerates shaped. The ppt. was Oven-dried at 100^0C for 2 hours. The fine green powder was exposed to calcination at 290^0C for 30minutes. Darkly shaded nanopowder of NiO was arranged. The evolution of 220 UV-Visible spectrophotometers is used for analysis of a sample at a wavelength of 540 nm. The impact of starting Cr(VI) fixation on evacuation productivity was explored in the scope of 10-100 mg/l for Cr(VI). It is seen that the expulsion proficiency expanded with expanding convergence of Cr(VI) particles in the arrangement. As the focus was expanded, dynamic destinations of NiO were encompassed by the increasing number of metal particles bringing about increment of take-up of the particles. In the wake of achieving the balance, the take-up of particles ended up steady. The % Removal and uptake capacity calculated as follows

$$(\%\ \text{Removal}) = \left[\left(\frac{C_0 - C_t}{C_0}\right)\right] \times 100$$

$$\text{Uptake capacity} = (C_0 - C_t) \times \frac{V}{M}$$

Where,

C_0 =initial concentration of Cr(VI)

C_t = Concentration of Cr(VI) after adsorption

V = volume of adsorbent

M = mass of adsorbent

3. RESULT AND CHARACTERISATION

3.1 SEM micrographs of Nickel Oxide Nanopowder

The surface morphology of the material is examined by Scanning electron microscopy (SEM) is displayed in (Figure 1). The SEM is improved the situation understanding the surface morphology, from Figure that the material is having recognizable pores. It is done at 10.00kv and at 100000 amplification with around 4.4 mm thinness and 300-500 nm length. This, for the most part, demonstrates the pores structures where adsorption of nickel oxide nano powder can happen.

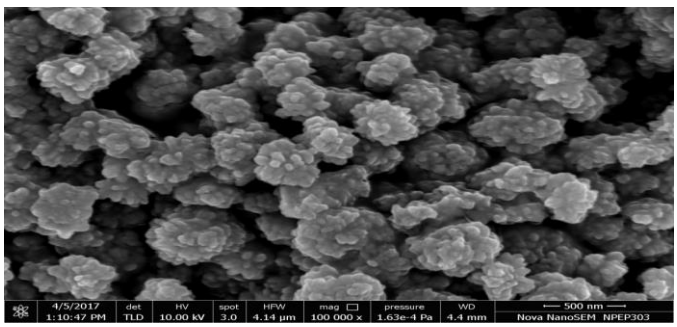

Figure 1: Scanning electron micrographs (SEM) of before adsorption

3.2 XRD analysis:

Powdered XRD of the material was gotten by utilizing PHILIPS X'PERT X-Ray Diffractometer with Cu kα radiation (35 kV and 30 mA) at a sweep rate of 20/min and was investigated utilizing standard programming furnished with the instrument. The XRD example of the example is exhibited in (Figure 2) couple of sharp pinnacles were gotten subsequent to stacking hexavalent chromium, showing the example was halfway formless in nature. XRD was broke down utilizing standard master high score. Figure 2 : Graph of XRD data for NiO . The average crystallite size is of 7nm.

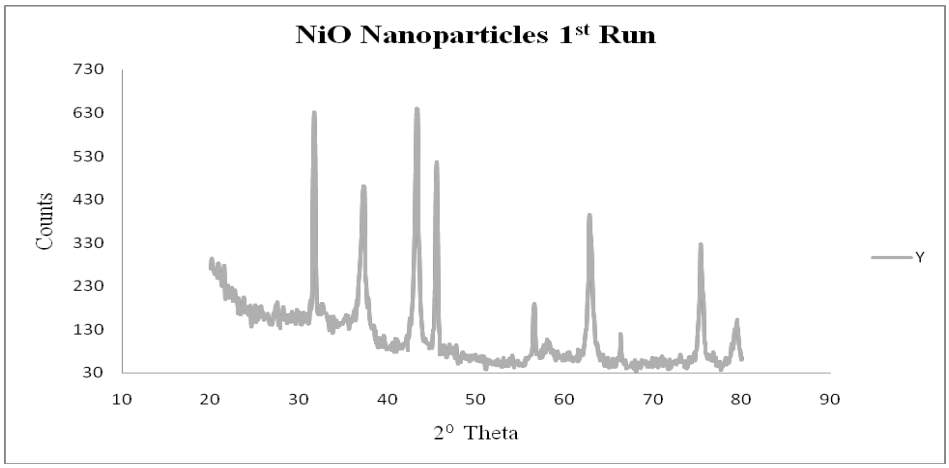

Figure 2: Graph of XRD data for NiO NP (I) run

3.3 Effect of adsorbent dose on the removal of Cr(VI) using Nickel Oxide nanopowder

The impact of the adsorbent portion on the expulsion of chromium(VI) is considered in nonpartisan condition (pH 7), at encompassing temperature (28±2ºC) and contact time of 30 minutes for starting chromium (VI) grouping of 100mg/l. The outcomes are appeared (Figure 3). It is obvious from the (Figure 3) that the expulsion of hexavalent chromium raises from 59% to 78.7%, for 0.1 g/100ml of Ceria nanopowder as a crossbreed material individually with introductory chromium (VI) convergence of 100mg/l. This results that as an adsorbent portion will build then rate evacuation will likewise increment. This % removal increases as the adsorbent dose is increased due to which surface area for removal is increases and get the high adsorption on the nanopowder.

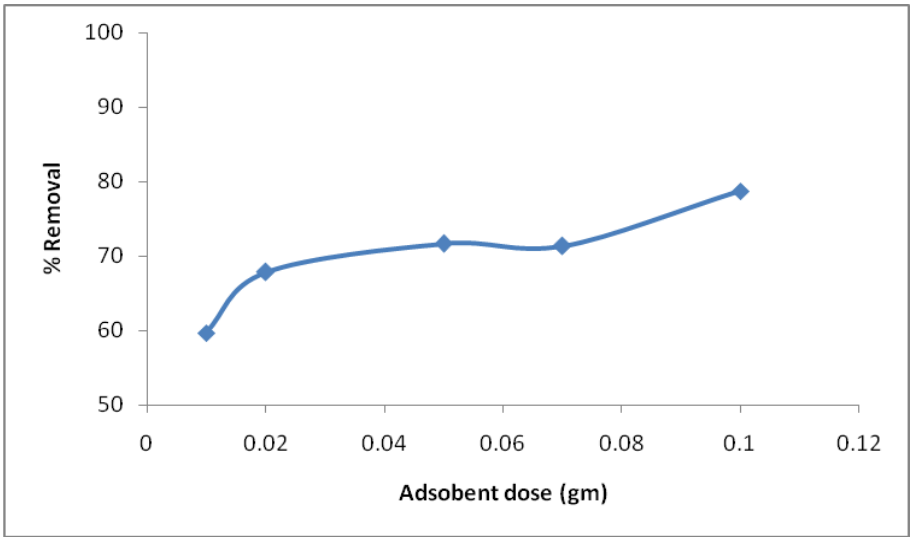

Figure3: Graph of %removal of Cr(VI) VS adsorbent dose of Nickel Oxide nanopowder at speed 300 rpm and pH 7, 30min

3.4 Effect of contact times on the removal of hexavalent chromium from contaminated wastewater

Batch investigation of chromium (VI) at various contact time is contemplated for beginning chromium (VI) convergence of 100mg/l at pH 7 and adsorbent portion of 0.01mg/l,0.02mg/l,0.05mg/l,0.07mg/l,0.1mg/l keeping every other parameter steady. The outcome is spoken to in (Figure 5). It is comprehended from the (Figure 4) that we get 78% removal at 130 min. This results that as time increment rate expulsion additionally increments.

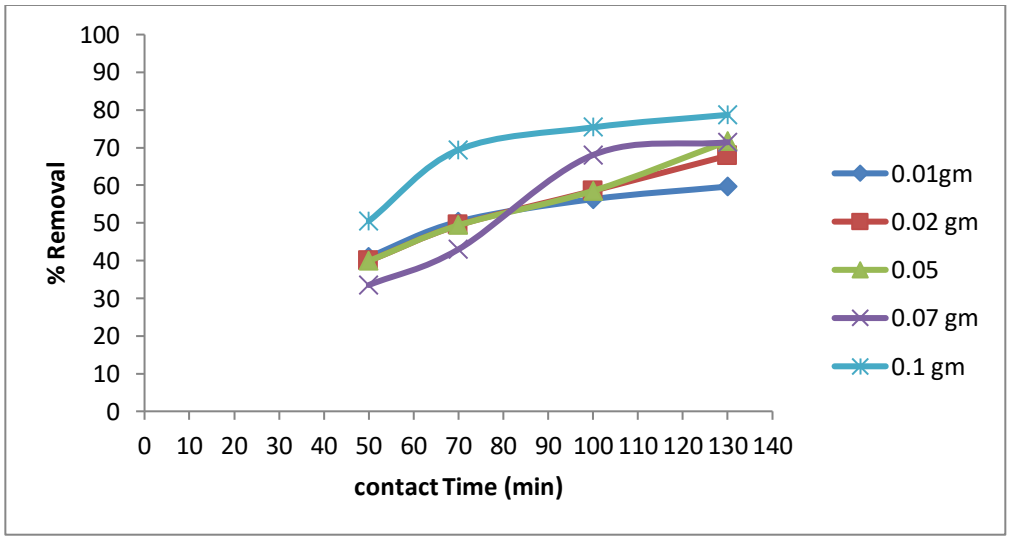

Figure 4: Graph of %removal of Cr(VI) VS contact time of Nickel Oxide nanopowder at 300 rpm speed and pH 7

3.5 Effect of uptake capacity on the concentration of hexavalent chromium from contaminated wastewater

The effect of adsorbent dose on the removal of chromium(VI) is studied in neutral condition (pH 7), at ambient temperature (28±2°C) and an adsorbent portion of 0.01mg/l,0.02mg/l,0.05mg/l,0.07mg/l,0.1mg/l keeping every other parameter steady. Initial concentration of Cr(VI) is 100ppm. Chromium uptake versus contact time is shown in the graph. From Figure 5 uptake capacity of 0.01 gm is higher than that of the other adsorbent dose. This is probably due to the larger surface area of the sorbent available at the beginning for adsorption of Cr(VI) ions. As the surface adsorption sites become exhausted, the uptake rate is controlled by the rate at which the adsorbate is transferred from the exterior to the interior sites of the adsorbent dose.

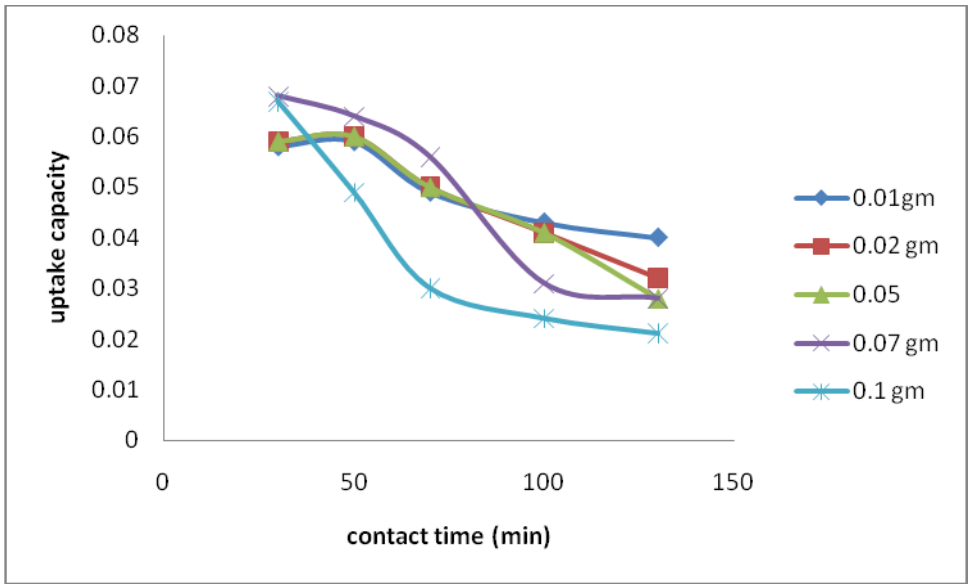

Figure 5: Graph of %removal of Cr(VI) and uptake capacity VS Adsorbent Dose of Nickel Oxide nanopowder at 300 rpm speed and pH 7

4. CONCLUSION

Nanoparticles of NiO were effectively arranged by SolGel strategy and arranged example was portrayed by XRD, methods. Results have appeared arranged example contains anticipated compound organization. Molecule size of the test was in Nano-Scale run. The hybrid material was found to have a maximum efficiency for the removal of hexavalent chromium with 77 to 79%, pH at 7, the adsorbent dose of 0.1 gm and temperature of 28±2^{0}C and initial concentration of 100 ppm. From all the above observations it may be concluded that the material is suitable to act as an adsorbent for the removal chromium (VI) from the water.

Acknowledgments:

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Challenges in Teaching English in a multicultural Education

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Abstract: The goals of multiculturalism education includes imparting more accurate and complete information about many cultures, reducing prejudice and fostering tolerance, improving the academic achievements of minority students, reaffirming our commitment to the American ideas of pluralism and democracy and helping to make those ideas a reality helping to make those ideals reality. Advocates of multicultural education say that these goals can best be reached not by adding separate units about various ethnic groups to our curriculum but transforming the whole curriculum to acknowledge diversity and honour multiple persons. Social studies, history and literature classes are the most fertile ground for this change, writes Scott Willis in a recent issue of Curriculum update.

Keywords: Democracy, Education, multicultural, prejudice, reaffirming etc.

Introduction: In the modern world where we are nowadays communication has changed. A work which takes days now takes a few second. Integrating culture teaching into the teaching of language can be most effective if taught through context, which means always giving examples of the target culture, providing pictures and videos from multimedia that represent the target culture. At least the five prominent ethnic groups in America- Native Americans, Latinos, Asians and Europeans-should be included in any effort at providing multicultural perspectives in curricula. Teachers should focus, in other words, on key ideas not on individual ethnic groups. Educators must help students see historical events from a variety of perspectives. This is a challenge that requires recasting the traditional curriculum. For example, the westward movement in this country must be seen not only as an expansion opportunity for Europeans but also as a displacement for Native Americans. The West itself reflects a European perspective. For Mexicans, the West was the North and for Chinese, the East and the Sioux it was the center of universe.

Teachers involved in multicultural education report that they try to show their students as many perspectives as they honestly can role-playing has approved to be a particularly powerful technique to help students gain an understanding of a different cultural experience. Teaching history as the story of people rather than an achievement of military or governmental leaders has enabled teachers to shift their focus more easily. Placing more emphasis on social, economic and cultural history as well as everyday life adds depth and richness to traditional curricula. Advocates of multicultural education believe it is important to get beyond victims and heroes when portraying in the history of cultural groups. But they also acknowledged that it is difficult to present history accurately.

Members of the minority groups sometimes wish to downplay the negative aspects of their history, such as slavery and poverty, out of a concern that will perpetuate stereotypes. Advocates of education say that children want to and should know the whole story. Avoiding stereotype, however, is another challenge. Using primary sources can

help teachers need to underscore the difference between the characteristics of a group and the behaviour of individuals. In addition, they need to emphasize that identities are complex and that class, gender, religion all influenced individuals. In reality, Asian Americans can only be Korean American, Chinese American Japanese Americans and so forth. Native American tribes are very different from one another. Generalizations can make studying a group easier, but teachers need to remind students that they are a generalization. Teachers can present different perspectives simply by choosing literature written by and about people from a variety of cultural groups. Children of various cultures need to recognize people like themselves in books it is important to attempt to provide all students with this experience. Fortunately, as children's literature becomes more and more multicultural.

Multicultural teaching emphasizes that is a need for teachers to educate themselves about multiculturalism. Educators, they remind us, are primarily white, middle-class and female, and they need to develop an understanding of diversity if they are to teach from a multicultural perspective. Besides, they argue a better understanding of our country. Multicultural heritage will put teachers in a position to understand the varied cultural backgrounds, attitudes and motivations of their students. It is the challenge for the teacher to help students work through conflict that arises when discussion about racism and oppression can be divisive and create conflict in the classroom. It has been experienced that young people are much more ready to talk about the issues of racism and more sensitive to one another than most adults realize. Sometimes moral judgment cannot be avoided. But teachers need to help students understand why they are making certain judgments, and that while we don't have to sanction all cultural practices, we do need to look at them in the context of the time and culture in which they occur.

Cultural differences extreme exemplified by the scene is anything but imaginary. Every day, teachers encounter similarly complex issues in their classrooms. The blend of ethnicities and value system often places teachers in a "cultural minefield" where they must navigate a careful path of trying to respect the sensibilities of many different groups. How, teachers ask, can they best manage the conflicting expectations prevalent in today's increasingly diverse classroom? "It's almost impossible for teachers to respond in culturally appropriate or sensitive ways to all the cultures they have in their classrooms". There may be a gap between the teacher and the community where they are teaching. They may not live in the same area, and by going through the experience of becoming educated, they have acquired a certain way of looking at issues. So there can be a gap there as well. Trumbell says help teachers interpret many of these behaviours they see in the classrooms. Experts cautions, however, that simply because a given culture is collectivistic does not necessarily mean that children in the same group will share the same traits and perspectives, "teacher needs to see people as individuals, "says Chisholm. " We should not assume that all members of a particular group are going to see things and act the same way," that individual distinction, Chisholm says, require a particularly careful approach when teachers interact with children. "It's not necessary equitable to treat everyone the same," she interacts with different children's. To better understand these kinds of differences, an expert suggests talking at great length with children's parents. These talks, they say, should go beyond the normal parent, "Chisholm says, "You need to get to know them over time just as you would any other person. It doesn't happen from just one visit; it takes continues communication.

Conclusion: Diversity issues teach educators is that the opportunity to learn does not end when one leaves school with a teaching degree. Rather, the chance to learn about other people is a lifelong process that is never really "finished". Every day, teachers encounter similarly complex issues in their classrooms. The blend of ethnicities and value system often places teachers in a "cultural minefield" where they must navigate a careful path of trying to respect the sensibilities of many different groups.

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Reading and Writing are these skills diminishing among students???

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Abstract:

"Tell me and I forget. Teach me and I remember. Involve me and I learn."

These are the words of Benjamin Franklin. In order to learn a language the person really need to get himself involved. Language plays a very vital role in our day to day communication. Language is seen as a tool that is used for the purpose of communication and in order to advance a language the person has to pay attention to the four most basic parts in the language and that is the LSRW skills (Listening, Speaking, Reading and Writing). In any language the role of Listening, Speaking, Reading and Writing play a major role. English is one such language which we the second language learners are trying to adapt for a very long time. Although we have been trying to adapt to the language are we developing all the four skills is the real question that we need to answer.

Introduction:

"Learn from yesterday, Live for today, hope for tomorrow". These are the words of the greatest scientist of all time Albert Einstein. Life is filled with hope.

The four skills that are involved in understanding and learning a language are the LSRW skills that are very much essential to understand any language. In these four skills Writing and Speaking are considered as Active skills and Reading and Listening are considered as passive skills. Usually the passive skills are usually given little importance in a classroom setting and the Active skills of Writing and Speaking is want is considered to be superior among the four.

Technology in today's World:

The world with technology has paved the way for the people to use lot of technology in our day to day life. Technology and education have always gone hand in hand with education but in todays criteria are we actually utilizing the skills to learn more? Or are we simply wasting our time? Knowledge is like an ocean and we have swim in that ocean to enhance ourself but are we literally doing that is the question we have to ask ourself.

What is Reading?

Reading is seen as a very important skill and we consider our self reading all the time. We read what is written on the board, we read a grocery list, we read face book memes and lots more but is that actual reading? What is actual reading? Reading a piece of article, a basic newspaper or evenreading a book is seen as out of fashion nowadays. What is the knowledge that we are get? We are now becoming fools by believing whatever that is told in the internet. We have become the slaves with the usage of smart phones. Even the basic details are not read by the students/ people. Reading even a school lesson is considered offensive nowadays as students do not try to read the actual material to gain knowledge but to simply grab marks they try to read and memories certain small short ideas that are explained very briefly in the internet. To understand any text you have to give your full

attention in reading a text. Even a literature major student do not read the actual text that is given to them but go for an abridged version or a summary from a local online guide to get the theme of the story. If a poem is not read to be enjoyed what type of work could a future poet or author of a book be able to deliver to us is the real question?

Importance of Writing

Writing is seen as the next important task and we (every one who has completed a basic education) feel that we would be able to write at least to communicate but is this actually the case? Writing is stated in education if we take a nation like India from the Primary age itself. A kinder Garden student is expected to learn to write words and sentences before he/she crosses the kindergarten school and crosses to primary education. In Primary, secondary, Bachelors Degree, Master Degree we are constantly wring we copy from the board, we write what is dictated, we write exams and lots more. Thus writing should be something every one should be well versed in but is it the case. An Ug or Pg student is personally not able to even write a leave letter on his/her own. They take help from friends, teachers or all time favorite internets to write a basic letter. Why is this case? A student who has so long been taught the art of writing should be able to write an artile or a piece of work with ease but that is not actually happening why is the real time question that we need to question ourself.

Role of Internet:

Internet is seen as a boon, as we can get everything at our finger tips but is this really boon or a curse upon humankind? A person who properly utilizes these technologies use it for his own good to improve onself or to educate himself what about the other 75- 80 % of lazy bones who just utilize it for them to be more comfortable and nothing more. In today's world if a person is not able to write a letter he could give the exact reason and he would be able to get 100 letters or even more as samples to guide him. A student is now days not able to write a correct sentence or use language effectively. They use slang language and short forms and calls that the advent of the present generation. Writing is facing a very serious damage as we see that students, youngsters and even kinder garden students are able to get what they want with just speaking skills a voice modulated kits like Alexa, Google assistant does not even require you to write a question to get the answer but just say out the words and it will capture and give you the related searches. Are these tools really helping us? May be a blind person could use it as a friendly helper but why should everyone be handicapped by the technology and the helping hand that it gives. Reading and Writing one Active and another Passive skill should never be left unattended. We should use all four skills Reading Listening, Speaking and Writing to develop the language that we study. All four skills should be utilized to the fullest to gain a lot of knowledge.

Conclusion:

Internet improves us a lot it is just not a piece of tool that should replace human intelligence. It is a mere tool that is created by a human to help other human to make life easier. This should not stand in the way or stop ourself from being educated or becoming learned in a field. We should prepare ourself so as to create tools to help human rather than being just a handicap using one.

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CAREER CHANGE THROUGH COMMUNICATION SKILLS

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Abstract:

Of the important 21st century skills, communication skills are remarkably required ones. Considered the key aspect of success, communication skills comprise many skills such as language, non-verbal skills, tone, attire and the like. People with effective communication skills have an edge over others in terms of employment opportunities, career advancements and pursuing higher studies. One who has the voice or language has the majority. To achieve the ladders of success, communication skills are considered the rungs. When the rungs are broken, going ahead in one's career becomes harder or difficult.

Keywords: communication skills, non-verbal skills, employment opportunities, career advancement.

Introduction:

The modern world demands very much from its citizens in a day in day out basis. The number of skills one needs to compete in today's world increases in tune with the necessities and lifestyle. The world today is ruled by technological advancements. Computers call the shots in successfully running the show. Unlike the demands put forth by the job market some decades back, the present era expects many more skills. Once, one's intelligent quotient remained important. Today, however, one needs more than intelligent quotient. Emotional quotient is highly required today to confront the delicate world.

Twenty First Century Skills

The terminology twenty first century skills is gaining popularity across the world. The modern world lists critical thinking, creativity, collaboration, communication, information and technology literacy, flexibility, social skills etc as twenty first century skills. These above-mentioned skills are given utmost importance in academia to prepare students for the job market. These skills help one further and succeed in one's career just like a walk in the park. The four Cs are deemed with much importance in academia and job market.

Communication skills, one of the four most important skills, are often talked about. They help one gain confidence, sociable skills and also get employment opportunities. In order to strive, survive, thrive, communication skills are essential. There are thousands of graduates in humanities and science and engineering seeking employment opportunities across the world. Lack of communication skills is a predominant reason why many could not get through interviews and entrance examinations.

There are further many stuck in a rut with their boring jobs. Switching over from one job to other is an uphill task for many as they lack communication skills. In spite of technical knowledge, many people could not go further up in their career in need of communication skills.

One of the most important reasons for the lack of communication skills among many is the fact that many are not aware of what constitutes communication skills. The latter is often taken only for English language skills. Both English and communication skills are treated synonymously. When the expression communication skills pops up in one's mind, one thinks of English knowledge.

The expression 'it is impossible not to communicate' quite sheds light on the importance of nonverbal cues and tone in an effective communication. More than verbal language i.e. English, nonverbal, otherwise known as body language, is essential. They constitute, in an effective communication, 58 percentage, while tone gets 35 percentage and language has only 7 percentage. This simply tells how body language and tone impact the way one communicates. It is famously said that the three Vs are important. They are verbal, vocal and visual. Body language comprises facial expression, eye contact, gestures, postures and proximity. While talking or giving a lecture to an audience, maintaining eye contact is essential. The reason is only when eye contact is made, the communication gets complete and effective. Moreover, eye contact improves one's confidence level to a greater degree. It should be very well remembered that communication is not only what is said but also what is not said (Fast 01).

Tone is the way one uses one's voice. In an effective communication, tone holds a remarkable position. This is because the way one uses the tone changes the meaning of the sentence. Same words used with different tones convey different meanings. During arguments, one should use the tone carefully as it changes the course of the argument and meaning.

Proximity is the use of space in communication. There are different zones one has to maintain in terms of distance with others. Social zone, public zone, intimate zone are what one has to be aware of when one is in a party, shopping etc. When someone pervades our zone, he/she is entering our zone. Communication takes place even without speaking anything except using one's space without permission.

In interviews, one's time starts when one knocks at the door to seek permission to enter the room. The way one knocks at the door talks a lot of the person's attitude. With the considerations of all the above-mentioned, language holds a minimum role to play. Only when someone speaks, his/her language is known, but body language talks volumes about one's attitude and decorum maintained.

According to Rai, non-verbal communication is independent of verbal communication (16). However, verbal communication needs the support of other means such non-verbal cues, tone etc in an effective communication. Therefore, it is imperative to know that communication skills comprise of all that are discussed here. The chances for a person with good communication skills to land in a job or for career advancement are high as against someone without the skills discusses.

Hence, it should be understood that communication takes place even when someone does not intent to. The way one eats, drinks and stands matter as far as body language and communication skills are concerned.

Conclusion:

Good communication skills help one to stand out from the crowd. Today, across the world, everyone seems to communicate but not everyone's mode is effective. Charlie Chaplin is known for his performances of non-verbal cues. Rogan Atkinson's Mr. Bean is popular across the world not because of his language but because of his body language with which he communicates humour to people across the age. Effective communication takes place not because of language but because of other means such as body language, tone and the like.

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LEGAL & MORAL ASPECTS OF HUMANITARIAN INTERVENTION IN INTERNATIONAL SYSTEM

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Abstract

Sovereign states are responsible to safe their citizens from harm and massacres. Any other state doesn't have the right to interfere in any other states' internal affairs. But sometimes either some states are not able to prevent their citizens from harms or they oppress on their citizens and violate the rights and freedoms of their citizens. In this case, either United Nation interferes in the issue or some other powerful states are willing to prevent the other societies from danger. So, what is the fact of intervention? Do the powerful states have the right to interfere in other states 'internal affairs in order to safe their citizens from killing or massacre? Who are responsible for this case?

The paper is trying to find the facts of the interventions, the intervention in Iraq, Syria, Rwanda and particularly in Afghanistan. No doubt some states are very interested to rescue the life of other states' citizens. How the other states kill their troops to safe the others citizens? Are they honest on their acts? We look forward to evaluate the aspects of such interventions.

Key Words: Humanitarian, Interventions, Human rights, Sovereignty principles.

Introduction

Humanitarian intervention poses a hard test for an international society built on principles of sovereignty. Nonintervention and the non-use of force after Holocaust, the international society approved laws prohibiting massacre or genocide imposing the mistreatment of civilians and recognizing basic human rights, but in fact all those humanitarians' principals after conflict with the principals of sovereignty and nonintervention.[1]

In these decades the changes which occurs in international system. Two customary principles (absolute in their own territory and nonintervention in the internal affairs of the states) which contains in the fundamental charter of United Nations has been changed. In this field violation of human rights, also commitment of crimes against humanity will force the international society to the more responsibilities. And united nation will understand the responsibility of humanitarian international intervention but on the base of international law in order to prohibit a state from the violation of its citizens' rights.

So, for humanitarian intervention in concerned the sovereign state is as guardians of their citizen in order protect their citizen rights and protect them in every aspects of their life. In here the question which a raised are as follows: If the sovereign state couldn't effort to observe its citizens rights and failed in this arena, so can the united nation intervene in the internal affairs of the state?

If the United Nations can intervene, is it possible for UN to intervene Multilateral and on the base of international law? In this research papers I will try my best in order to find legal answer for the above questions either I give legitimacy for such a kind of intervention or criticize this intervention.

I hope that I can clarify this topic well, because humanitarian intervention is so important and play a key role in today's international politics in, as most powerful countries seeks their own interest behind of humanitarian intervention by their unilateral activities.

Objectives of the study:

- To study the concept of Humanitarian Intervention.
- To find out the facts of Humanitarian Intervention that play key role in international politics.

[1]John Baylis ,Steve Smith, Patricia Owens ,The Globalization of world politics and introduction to International Relations, Fourth Edition, Oxford University Press 200

- To provide some acceptable suggestion for the United Nation.

Literature Reviews

The scholars like J.L. HOLZGREF and ROBERTO. KEOHAN on their book "Humanitarian Intervention. Ethical, legal and Political Dilemma" state that a state or a group of states use force to prevent the citizens of other states without permission. So, it's a kind of interfere as they argued. The writers of the book under the title "The Globalization of world politics and introduction to International Relations" Mr.John Baylis and others focused on the legal and moral base of the humanitarian intervention. They argued that there is no any legal base for the intervention but there is only moral base which mostly states bring moral arguments. The authors of the book bring very live example from the countries like Iraq, Afghanistan and Syria. Sean D Murphy on his book under the title "Humanitarian intervention, The United Nations in an evolving world order "arise the question how moral and legal are relevant with humanitarian intervention? However, the intervention is the action of the states. The author of the book argue that the moral and legal base of intervention is parse outside of any other country legal system. Mostly the values, law and culture of the countries are different.

The context of Humanitarian Intervention

The responsibility to protect (RtoP) is set of principle based on idea that sovereignty is not a privilege , but a responsibility to protect concentrated on prohibiting four crimes; genocide, war crimes , crimes against humanity and ethnic cleansing which it places under the generic umbrella term of 'Mass atrocity crimes.[2]

Actually, the responsibility to protect have three parts:

1- Every state has the possibility to protect its citizens from human right violations.
2- If a state is unable to protect its citizen. It is the responsibility of international society to assist the state by building its capacity.

[2]2005 world summit outcome Document.

3- If a state is completely failed to protect its population from massacre, the international society had the responsibility to intervene at first diplomatically then more coercively and as a last resort with military force.[3]

Following the genocide in Rwanda and the international community failure to intervene former UN secretary General kofi Annan asked the question, when does the international community intervene for the sake of protecting population?

The Canadian government established the international commission on intervention and state sovereignty (ICSS) in September 2000 in December 2001 the (ICISS) released its report. The responsibility to protect the report ideational that the international community is responsibility to protect Massacre and genocide etc. Through diplomatic engagement coercive actions and military intervention as a last resort also rebuild security and justice.

Definition of the Concept

As far as humanitarian intervention is concerned it is related with international law international relation political science and polity, for this reason many scholars in different books related to this field have been written diversity of definition which are as follows:

1- Adam Robert defines humanitarian intervention as a military intervention is a state without the approved of its authorities and with the purpose of preventing widespread suffering or death among the inhabitants.[4]
2- Humanitarian intervention is the treat or use of force across state borders by a state or group of states) aimed at preventing or ending wide spread and grave violations of the fundamentals human right of individual other than its own citizen without the permission of the state within whose territory force is applied.[5]

According to the above definition the state which have known their selves as a guardians of the citizens of other countries, intervene to the internal affairs of the sovereign state with different methods of interdict in consequent with military force for example in Kosovo, Iraq, Bosnia,

[3]Responsibility to protect, international commission on intervention and state sovereignty
[4]SABAN KARDA, Humanitarian intervention, The evolution of the idea and Practice, journal of international affairs, 2001,P 1
[5]J.L.HOLZGREF and ROBERTO. KEOHAN, Humanitarian Intervention. Ethical, legal and Political Dilemma, Cambridge University Press,2003 P18

Afghanistan and Libya, but without permission of the host state. So, are their acts legitimate or lawful according to international norms or not?

Since 2002 the European Union and America has intervened abroad in three different continents under doctrine of humanitarian intervention however there is no one standard or legal definition of humanitarian intervention.[6]

For approve and evaluation of the above argument I want to clarify the legitimacy of these humanitarian intervention and the objections which scholars' critics these interventions.

The legal and moral cases for a right of humanitarian intervention

Legal argument:

The legal argument which is called "counter restrictionism "rests on two claims: First the UN charter (1945) Commits states to protecting fundamental human right and the second there is a right of humanitarian intervention in customary international law.

Counter-restrictionist argues that human are so important like peace and security in UN charter the charters. The charter's preamble articles 1(3)'55' and 56 all highlight the identifies the protection of human right as one of the principle purposes of the UN system this has led counter-destructionists treat a humanitarian exception to the ban on the use of force in the UN charter .

Other counter-restrictionist argued that there is no legal basis for humanitarian intervention unilaterally in the UN charter by argued that it's permitted by customary international law. International lawyers describe this as Opinio Juris for rule to count as customary international law state must actually engage in the practice that is claimed to have the states of law and they must do so because they believe that the law permit this counter – destructionists countered that the customary right to humanitarian intervention preceded the UN charter evidenced by the legal argument offered to justify the British and French and Russian intervention in Greece (1827) and American intervention in Cuba(1898) they also point to British and French references to customary

[6]Wikipedia, the free encyclopedia, Humanitarian intervention, en, Wikipedia.org/wiki/humanitarian intervention.

international law to justify the creation of safe haven in (Iraq 1991) and Kofi Annan insistence that even unilateral intervention to halt the 1994 genocide in Rwanda would have been legitimate.[7]

The moral argument:

Many writers argue that irrespective of what the law says there is amoral duty to intervene to protect civilian from genocide and mass killing. They argue that sovereignty derives from a state's responsibility to protect its population and when a state could not effort to protect its citizens. So, it loses its sovereignty. For justification of this argument, there are different courses:

1- Common humanity : This idea argues that all individuals have basic human rights and duties to uphold the rights of others (Caney 1997:34 other argue that today's globalized world is so integrated which violation of human rights in one part of the world impact on others parts so, this create moral obligation (Blair 1999) .
2- Just war theory the idea of this theory argues that the duty to offer charity to those in need is universal (Ramsey 2002:35-6)
3- A further variety of this argument insists that there is moral agreement between the world major religions and ethical systems that genocide and mass killing are grave wrongs and that other have a duty to prevent than and punish the perpetrators (lepard:2002)

There are problems with this perspective too, granting states amoral permit to intervene, open the door to potential abuse. The use of humanitarian Arguments to justify wars that are anything but Furthermore those who advance moral justification for intervention run up against the problems of how bad a humanitarian crisis has to prevent a humanitarian emergency from developing in the first place.[8]

So far, we explained the legality and morality of humanitarian intervention, a primary question arises as to why and in what way law and morality are relevant to humanitarian intervention. Humanitarian intervention typically involves to decision by a state, group of states or

[7]John Baylis ,Steve Smith, Patricia Owens ,The Globalization of world politics and introduction to International Relations, Fourth Edition, Oxford University Press 2008.P 524
[8]Same

international organization to undertake violent actions. As such the issues of law and morality that arise are parsing outside any one national legal system and often outside any one community bound together through a cultural religious or philosophical value system.

Moreover, the violence inherent in both humanitarian intervention and the action justifying the intervention, reflecting respectively a disruption of transnational and national order, appears to defy the application of legal or moral norms.[9]

I. Objections to humanitarian intervention

Nicholas wheeler argued that anew norm supporting humanitarian intervention has developed in international society over the course of the last decade. In essence of this norm asserts that when all other diplomatic action have failed states have the right and responsibility to employ military force against another state in order to protect civilians in danger wheelers contention reflects in the language of international relation theory a solidarism understanding of the nature of international society its conditions for membership its normative depth and its capacity to engage in collective actions.

As the report of the International Commission on Intervention and State Sovereignty (ICISS) concludes: sovereign states have responsibility to protect their own citizens from avoidable catastrophe, But when they are unwilling or unable to do so, that responsibility must be borne by international community this part of topic argue that the most convincing objections to humanitarian intervention operate at this deeper, philosophical level.

The philosophical underlining objections to humanitarian intervention is essentially a philosophy of limits, limits on the consensus that exists international about the link between a state's legitimacy and its protection and advancement of human right limits on the willingness of intervening states to engage in long term address root causes; and finally limits on the degree to which we can say that humanitarian intervention have been taken in the name of international community. Indeed, those that have opposed instances of humanitarian intervention have frequently raised concerns about who is doing the intervening and on what grounds.

[9]Sean D Murphy, Humanitarian intervention , The United Nations in an evolving world order ,University of Pennsylvania Press, 1996,P.20

This philosophy limits is well captured ethical philosopher Tzvetan Todorov in his 2001 Amnesty lecture: individual human being still get much more as citizens of a state that they do us citizens of the world. The debate over humanitarian Intervention is not black and white one, between those who are concerned about human rights and those who turn a blind eye to human suffering. Rather it is a debate about the boundaries of moral community. The consequence of intervention and the density of values that underpin international society.[10]

On the base of the clarity of the above objections about humanitarian intervention's objections and in addition of that there are some other key objections to humanitarian intervention, have been advanced at various times by scholars, international lawyers and policy makers.

The following objections are not mutually incompatible and can be found in the writing of Realists, liberal, feminist, post-colonial theorists and others.

1- No basis for humanitarian intervention in international law.

Restrictionism international lawyers assume that unilaterally use of force should be band and it should be authorized by the United Nations Security Council. They argue that aside from the right of individual and collective self-defense enshrined in Article 51 of the UN charter, there are no other exceptions to article 2(4). They also point to the fact that during cold war, when states acting unilaterally could have plausibly invoked humanitarian claims.

The key cases India's intervention in East Pakistan in 1971 and Vietnam's intervention in Cambodia in December 1978 etc. They had chosen not to do so.

2- States do not intervene for primarily humanitarian Reasons.

No state wants to sacrifice its soldiers in order to protect the citizens of the other state. The powerful states have one aim self-interest and national interest and they pursue their interest.[11]

[10]Jennifer M.Welsh .Humanitarian intervention and international Relations ,Oxford University Press,2004, P 528,53
[11]John Baylis ,Steve Smith, Patricia Owens ,The Globalization of world politics and introduction to International Relations, Fourth Edition, Oxford University Press 2008.p 528

For example, interventions in Libya by US, France and Britain it's a kind of self-interest for these countries. There are so many countries around the globe which they abuse the rights of their citizens but no state care about them, because they don't have resources.

Britain and France approved in history that they seek interest around the globe. These two countries exploit and made colonial in the past and now with the assistance of US they exploit the countries, but with different method, they cover and mask their activities by human rights, humanitarian interventions, nuclear weapons, Terrorism, and weapons of Most Destruction. For example, in Iraq there was no WMD, but why US attack and dominate Iraq unilaterally?

3- States are not allowed to risk lives of their soldiers to save strangers.

Realist not only argues that states do not intervene for humanitarian purposes; their statist paradigm also asserts that states should not behave in this way. Political leaders do not have the moral rights to shed the blood of their own citizens in behalf of suffering foreigners.

4- The problem of abuse

In the absence of and impartial mechanism for deciding when humanitarian Intervention is permissible states to cover the pursuit of national self-interest. Creating a right of humanitarian intervention would only make it easier for the powerful to justify interfering in the affairs of the weak.

5-Selectivity of response

States always apply principles of humanitarian intervention selectivity, resulting in an inconsistency in policy. Because state behavior is governed by what government's judge to be in their interest, they are selective about when they choose it intervene. The problem of selectivity arises when an agreed moral principle is at state in more than one situation, but national interest dictates a divergence of responses .A good example of the selectivity of response argument that NATO's intervention in Kosovo could not have been driven by humanitarian concerns because it has done nothing to address the very larger humanitarian catastrophe in Darfur. Selectivity of response is the problem of failing to treat like cases alike.

6-Intervention doesn't wok

A final set of criticism suggests that humanitarian intervention should be avoided it is impossible for outsiders to impose human rights. Liberal argues that states established on the base of its citizens' consent. Thus, one of the foremost nineteenth century liberal thinkers. John Stuart Mill (1973:37-8) argue that democracy could only be established by a domestic struggle for liberty. Human rights cannot take root if they are imposed or enforced by outsiders.[12]

Recommendations

- There is United Nation Charter that the member states sign it. In this charter all states have equal rights.so, if a state dominates the others by the name of interventions it is a kind of violation of UN charter.
- Unilateral interference from any state don't have any legitimacy both on moral and legal base. The United Nations should prevent any superiority of powerful states.
- The member of Security Council can find their legitimacy of intervention only on the base UN charter and some other legal documents. No state has the right use their military and political dominate with the doctrine of international law.

Conclusion

Humanitarian intervention means the interfere of a state or international community for example United Nations Security Council in the internal affairs of a sovereign state or any other government which doesn't have any legal legitimacy, but act as government and rule on people of an entire population in a territory, this intervention act, in order to prevent or end wide spread and grave violations of the fundamental human rights of the citizens of another country.

Some states use humanitarian intervention to seek their own interest in other territories of the country with any legal legitimacy. It is a kind of violation of the international law and norms. For example, in intervention in Libya, Iraq and Syria were political intervention. The state doesn't sacrifice their military to safe the citizens of other country. How it is possible to expend resources in other countries without any benefit according to the realism theory of international relation.

[12] same

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COMPARATIVE ANALYSIS OF SPINNING PRODUCTIVITY AT PRE AND POST LOCK DOWN STAGE IN JUTE INDUSTRY

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Abstract: *Spinning department is the important area of Jute Industry. Yarn is the main production of this stage .Lower production, performance in spinning department gives impact on next production process of Jute industry. Day wise Coefficient of variation % of productivity of both the fine and coarse side of spinning department were higher in post lock down state compare to pre lock down states of BJCL unit .Spinning productivity in jute industry is highly affected due to impact of covid 19 situation. In post lockdown, CV% of day wise production of observed period was 33.07 % whereas in pre lock down, it was 5.84 %. The reasons were due to variation of number of machines run, uncertainty of labor, machine operators' availability. In post lock down period, lot of workmen were returned to their native state of Bihar, Odisha, and UP. Availability of machine operator is now problem in such industry. The CV% of actual efficiency% of spinning machines, production /winder in kgs . & production /day in kgs in fine side and coarse side of spinning department of BJCL in pre lock down state were much better compare to post lock down state. High variations of such parameters are not desirable in spinning department. High variation in productivity of the study period were due to shortage of machine operator, lower number of machines running, poor performance etc. are responsible. Top Management has taken several measures to overcome such problem.*

Key words: Productivity, Efficiency, Spinning, variation, Performance, Yarn

INTRODUCTION:

Jute Industry is a major industry in West Bengal. Jute fabrics, Bags, yarns are the traditional production in Jute mills in West Bengal. The products have a high demand in domestic and international market. Due to Nationwide lockdown, the production of finished goods and international dispatch are now challenging to the owner of the industry. The industry is now bound to deliver the domestic requirement of various states of India. Jute bags are procured by the government and used for packaging food grains. The supply backlog was 2.5 lakh bales till May. However, the industry is facing a shortage of labour as many workers have returned to their hometowns during the lockdown, causing production to be insufficient to meet the government demand. Though jute bags are costlier than their plastic counterparts, they are preferred because they are environment-friendly and the quality of the food grains remains unaffected over long time periods. The product has high demand in domestic market but the industry is facing problem due to nationwide lock down . The present study helps us to find out the impact of covid 19 on day wise productivity of yarn processing stage. Pre and post lockdown spinning productivity was comparatively analysed.

RESEARCH OBJECTIVES: The research objectives are stated below.

- To study the various spinning productivity parameters before and after lockdown stage.
- To analyses the collected data set of both the period.

- To find out the effect of lockdown, Comparative analysis of both the data sets are to be undertaken.
- Suggestive measure to overcome the situation**.**

STUDY AREA: To Observe the effect of Covid 19 situation in productivity of jute industry, Bally Jute Company Ltd. Is now selected . The unit is situated in the bank of river Hooghly(Ganga) in the district of Howrah and very near to Kolkata. The connectivity of Railway, Roadways are well with such unit. More than 3000 employees are directly linked with such unit. Another 5000 people are indirectly linked with such industry for various jobs in day wise pattern. Economy of the locality of Bally, Uttarpara, Belur , i.e., some parts of Howrah and Hooghly districts of West Bengal are dependent on such industry. Various Fine fabrics of Jute, Bags , yarn of various range of count are the main products of this unit . Due to lockdown the unit was closed from March 22 to 2nd week of May 2020. After that the unit was gradually start up to the normal. The daywise productivity of pre and post lockdown stages were studied and analyzed for observing the effect of Covid 19 on the spinning productivity of this unit. This unit is a representative of Jute industry.

RESEARCH METHODOLOGY:

Regarding pre lockdown stage the organization has registered book of production on spinning department. The day wise hardcopy of computer generated productivity report were available at the spinning department office. This data has been collected and tabulated. Post lock down data of 12 days were studied day to day and recorded in productivity report registered book. So the post lock down data were primary in nature .It was studied in day wise of three shifts in details. The hard copy of computer generated report were then collected and tabulated for analysis and comparative details with the pre lockdown stage. Both the productivity report of spinning department report are then analyzed statistically to observe the impact of lockdown on the spinning production. The Problems of lower productivity after lockdown stage and possible solution to overcome them are then evolved.

LITERATURE REVIEW:

Governments, businesses and communities are facing the brunt of coronavirus pandemic. As COVID-19 impacts more people every day, most sectors of the economy have been reduced to a standstill. Indian Textiles and Apparels (T&A) industry, accounts for approximately 4% of the global T&A market. The T&A industry is one of the largest and the most important sectors for the Indian economy in terms of output, foreign exchange earnings and employment. The industry contributes approximately 7% to industrial output in value terms, 2% to the GDP and 15% to the country's export earnings. T&A provides direct employment to over 45 million people but the nationwide lockdown has led to a temporary closure of factories and lay-offs have already begun among low wage workers [1]. The Covid-19 pandemic is primarily expected to adversely impact exports and with second order impact on the domestic markets with both exports as well as domestic sales falling. Additionally, domestic consumption is also getting impacted due to all India closure. New store openings have stopped and even domestic stores are facing an inventory build-up due to apparel sources for the upcoming summer season, Further, domestic prices could be negatively

impacted if exporters dump their inventories in the domestic market leading to even reduced margins. This could lead to short term blips such as reduced employment of casual labour (factory closures and people moving back to their home towns) and reduced consumption.
The demand for textile products abroad and domestic sales have come down to a grinding halt due to the panic situation created by the COVID-19 outbreak. Due to the lockdown, all sorts of textile-related factories are closed and it is tough to hazard a guess when those will be allowed to open. Workers have been running here and there amid all sorts of confusion. The business community is scared on account of cash crunch, supply chain disturbance and manpower-related issues. India has more than 2,000 spinning mills with different spindle capacity. Workers in big units controlled by corporations reside in labour colonies adjacent to the factory premises. The majority of workers are migrants from Bihar, Uttar Pradesh, Orissa and other states. At present they are being taken care of by the employers. Some workers were forced to stay back in the absence of means of transport following the lockdown. Once the lockdown is lifted, there is a possibility that many of them will rush to their hometowns or villages. At present, may be raw material and electricity expenses are not being incurred, but rest all expenses are a direct loss to mill owners. There are other issues like what will happen to goods under processing and whether those may be directed to factory seconds. All shipments are on hold and expiry of letters of credit may result in renegotiation of prices. It will definitely not be smooth and easy to restart operations after the lockdown [2],
The West Bengal government on Wednesday allowed the operation of jute mills with 15% staff who have been mandated to maintain social distancing norms. The development comes after a number of communications from the Ministry of Textiles including one during the day urging Chief Secretary to issue “necessary instructions to the mills to start operations for production of bags immediately.” Welcoming the decision, president of the Indian Jute Mills Association (IJMA) said this was peak season for orders for bags and in their absence plastics were being used. There are about 74 mills of which about 60 are in West Bengal along both the banks of river Hooghly[3].

RESULTS AND DISCUSSIONS:

Jute is a Bio Degradable Fiber. Products of Jute goods demand are now increasing due to Pollution free products. Jute goods have high demand in National and International Markets. Jute industry are now facing problem due to covid 19 situation .A Large number of people are engaged daily for the day wise productivity of the Jute Mill. Under this circumstance it is a challenging situation to the Management of Jute Industry to run the unit with maintaining of SOP of the WHO. Constant high demand of finished Jute products, either in Jute bags or Jute cloths are now important features of jute industry. .Bally Jute Company Ltd , Bally, Howrah is a pioneer Jute industry in West Bengal. More than three thousands employees are working directly in this unit . Average production of spinning in 100MT/ day . Due to Covid 19, situation, this industry is completely affected in productivity loss. Financial loss is associated with the loss in day wise productivity. Spinning is the heart of this industry. Higher productivity of Jute yarn, the end products of spinning process, yields biter productivity of the next process. We have studied the impact of Covid 19 on productivity of this unit. We have selected twelve days on each period of post lock down and pre lock down

period for observing the impact of Covid 19 on spinning production. In coarse side of this unit, 18 lbs. to 36 lbs. yarn are generally running.

Table 1 : Productivity Report of Spinning Department In Post Lock Down Period (From 15.7.20 to 26.7.20)

Date	Production in fine side						Production in coarse side						Total production in kgs
	A shift		B shift		C shift		A shift		B shift		C shift		
	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	
15.7.20	23462	73	18708	59	3990	11	9845	12	10374	13	1170	2	33307+29082+5160=
16.7.20	2274	70	21177	65	3865	11	979	12	9742	12	1184	2	32171+30919+5050=
17.7.20	24037	75	18992	58	4781	14	11397	14	10319	13	2205	4	35434+29311+6706=
18.7.20	23832	74	19483	61	4945	14	11975	15	9718	12	2295	4	35807+29201+7240=
19.7.20	22747	69	15603	48	4960	14	12069	15	8393	10	1185	2	34016+24076+6145=
20.7.20	24702	75	16846	50	5105	14	12068	15	9823	12	1105	2	36770+2669+6290=
21.7.20	23442	73	22064	73	4173	13	11023	14	10207	13	1140	2	35565+33151+5313=
22.7.20	23511	73	22884	72	8760	30.5	10996	14	10803	14	2560	3.5	34507+33687+11320=
23.7.20	12086	39.5	7870	29			4860	6.5					16745+7870=
24.7.20	21534	68	23070	74.5	10006	36	9530	13	9216	12.5	2760	5	31064+32286+12766=
25.7.20	17576	58	7594	28			3945	6	1170	2			21521+8764=
26.7.20	21542	69	20497	66	3069	10	9396	13	9313	13	1005	2	30930+29010+4074=
Average	**20062.**	**68.04**	**17899**	**56.953**	**5365.4**	**16.75**	**9006.9**	**12.45**	**9007.09**	**11.5**	**1660.9**	**2.85**	
Maximum	**24702**	**75**	**23070**	**74.5**	**10006**	**36**	**12069**	**15**	**10803**	**14**	**2760**	**5**	
Minimum	**2274**	**39.5**	**7594**	**28**	**3069**	**10**	**979**	**6**	**1170**	**2**	**1005**	**2**	
SD	**6634.61**	**10.123**	**5256.54**	**15.69**	**2227.28**	**8.91**	**3688.85**	**3.08**	**2681.42**	**8.30**	**700.79**	**1.15**	
CV %	33.07%	14.87%	29.36%	27.54%	41.51%	53.19%	40.95%	24.73%	29.77%	72.17%	42.19%	40.38%	

Source : Productivity Registered book of the mill

Table 1 and Table 3, indicates the post and pre lockdown spinning productivity status of BJCL. It is found that day wise variation i.e., CV% of productivity was much higher in post lockdown state in case of fine side compare to the pre lock down state. In post lockdown CV% of day wise production of observed days was 33.07 % whereas in pre lock down, it was 5.84 %. It is due to variation of number of machines run. This is due to uncertainty of labour,

machine operators' availability. In post lock down period lot of workmen were returned to their native state of Bihar, Odisha, and UP. Availability of machine operator is now problem in such industry. The mill is now running from external sources of contract labour, which has some uncertainty. These features are observed in three shifts in post lock down state. CV % of productivity of both the fine and coarse side are high in post lock down state compare to pre lock down states, spinning productivity in jute industry is highly affected due to impact of Covid 19 stage.

Table 2 : Observation of Spinning and winding parameters in post lock down stage(15.7.20 to 26.7.20)

Date	Fine side Spinning reports				Coarse side spinning report			
	Target Efficiency	Actual efficiency	Production /winder/day in kgs	Production/day in kgs in spinning	Target Efficiency	Actual efficiency	Production /winder/day in kgs	Production/day in kgs in spinning
15.7.20	83	73	294	323	79	78	395	792
16.7.20	82	72	286	325	79	78	414	797
17.7.20	82	72	207	325	79	78	420	772
18.7.20	82	73	290	324	79	78	384	774
19.7.20	82	73	275	331	80	79	397	802
20.7.20	82	74	293	336	79	79	401	798
21.7.20	83	73	284	317	79	78	379	774
22.7.20	83	72	280	314	79	78	366	773
23.7.20	85	75	204	291	80	77	347	748
24.7.20	83	70	277	306	79	74	328	705
25.7.20	84	73	290	293	80	77	292	639
26.7.20	83	71	277	311	79	74	352	704
Average	**82.83**	**72.58**	**271.41**	**316.33**	**79.25**	**77.33**	**372.91**	**756.5**
Maximum	**85**	**75**	**294**	**336**	**80**	**77.33333**	**420**	**802**
Minimum	**82**	**70**	**204**	**291**	**79**	**74**	**292**	**639**
SD	**0.937**	**1.311**	**31.45**	**14.668**	**0.452**	**1.669**	**37.71**	**49.63**
CV %	**1.13%**	**1.80%**	**11.58%**	**4.63%**	**0.57%**	**2.19%**	**10.11%**	**6.56%**

Source : Productivity Registered book of the mill

From table 2 and 4 , it is found that CV% of actual efficiency% , production /winder in kgs. & production /day in kgs in fine side and coarse side in pre lock down state are much better than post lock down state. High variations of such parameters are not desirable in spinning productivity. High variation in productivity were due to shortage of machine operator , lower number of machines running , poor performance etc. It is found that , per winder production in kgs / day and production in kgs/day in coarse side spinning in post lock down were corporately higher than pre lock down. It is due to heavier yarn count in post lock down state in coarse side.

Table 3 : Productivity Report of Spinning Department In Pre Lock Down Period (15.2.20 TO 26.2.20)

Date	Production in fine side						Production in coarse side						Total production in kgs
	A shift		B shift		C shift		A shift		B shift		C shift		
	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	Kgs	No of mcs	
15.2.20	24908	79	25031	80.5	23295	77	9909	14	9910	14	5340	7	34817+34941+28635=
16.2.20	23853	74	23683	74	19219	63	10326	14	6600	9	5385	7	34179+30283+24604=
17.2.20	24374	76	24924	78	21556	71	8256	11	7728	11	4785	6	32630+32652+26341=
18.2.20	25587	80	25865	81	23627	76	8020	11	5922	8	5880	8	33607+31787+29507=
19.2.20	26478	83	27190	85	23917	77	6521	9	6019	9	5702	8	32999+3209+29519=
20.2.20	27315	85	26013	82	23794	79	6170	9	6205	9	5607	8	33485+32218+29401=
21.2.20	27200	85	21529	67	17741	61	4655	7	4749	7	3725	5	31855+26278+21466=
22.2.20	28386	89.5	28999	91	25307	83.5	4620	7	5099	7.5	4344	6.5	33006+34098+29651=
23.2.20	27979	88	28013	88	23295	76	5840	9	5895	9	4870	7	33819+22908+28165=
24.2.20	28563	87	27085	84	20436	67	6100	9	6093	9	6039	9	34663+33178+26475=
25.2.20	26550	82	26703	82	23345	77	5996	9	5460	8	5875	9	32546+32163+29220=
26.2.20	27472	84	27842	86	19885	67	6101	9	6095	9	6039	9	33573+33937+25924=
Average	**26555.42**	**82.70**	**26073.08**	**81.54**	**22118.08**	**72.87**	**6876.16**	**9.833**	**6314.58**	**9.12**	5232	**8.270**	
Maximum	**28563**	**89.5**	**28999**	**91**	**25307**	**83.5**	**10326**	**14**	**9910**	**14**	6039	**9**	
Minimum	**23853**	**74**	**21529**	**67**	**17741**	**61**	**4620**	**7**	**4749**	**7**	3725	**5**	
SD	**1565.53**	**4.740**	**2065.65**	**6.408**	**2305.36**	**6.95**	**1858.93**	**2.28**	**1354.86**	**1.833**	**726.06**	**1.26**	
CV %	**5.84%**	**5.73%**	**7.92%**	**7.85%**	**10.42%**	**9.53%**	**27.03%**	**23.18%**	**21.45%**	**20.09%**	**13.87%**	**1.52%**	

Source : Productivity Registered book of the mill

Table 4 : Observation of Spinning and winding parameters in pre lock down stage (15.2.20) to 26.2.20)

Date	Fine side Spinning reports				Coarse side spinning report			
	Target Efficiency	Actual efficiency	Production /winder/day in kgs	Production/ day in kgs in spinning	Target Efficiency	Actual efficiency	Production /winder/day in kgs	Production/ day in kgs in spinning
15.2.20	83	73	275	310	79	76	332	719
16.2.20	83	75	267	316	80	78	341	744
17.2.20	83	75	274	315	80	77	354	742
18.2.20	83	74	286	317	80	78	317	734
19.2.20	82	73	286	316	80	74	323	702
20.2.20	82	73	292	314	80	77	339	692
21.2.20	83	75	295	312	80	78	320	691
22.2.20	82	72	291	313	80	76	313	670
23.2.20	85	74	297	315	80	78	302	664
24.2.20	83	74	298	320	80	80	304	675
25.2.20	83	74	298	318	80	79	301	667
26.2.20	83	75	298	317	80	79	312	675
Average	**82.91**	**73.91**	**288.08**	**315.25**	**79.91**	**77.5**	**321.5**	**697.91**
Maximum	**85**	**75**	**298**	**320**	**80**	**80**	**354**	**744**
Minimum	**82**	**72**	**267**	**310**	**79**	**74**	**301**	**664**
SD	**0.729**	**0.966**	**10.74**	**2.73**	**0.288**	**1.62**	**16.91**	**29.92**
CV %	**0.87 %**	**1.30%**	**3.72%**	**0.86%**	**0.36%**	**2.09%**	**5.25%**	**4.28%**

Source : Productivity Registered book of the mill

Figure 1 and 2 indicates the variation of production of 3 shifts in pre and post lock down period in fine side. It is found that , high fluctuation of three curve of three shifts are due to high cv% of productivity /day of the study period. It is found that in figure 2, 16th , 23rd and 25th July 20, the productivity were much less , the graph of both a and B shift falls down due to lower number of machines running ,which gives lower productivity., Due to not availability of machine operators, the productivity are lower on those days. It is the main problem of Jute industry during post lock down days. Constant standard productivity maintains is now challenging situation to the Management.

Figure 1 : Production in Fine side pre , covid of A , B and C shift , spinning department

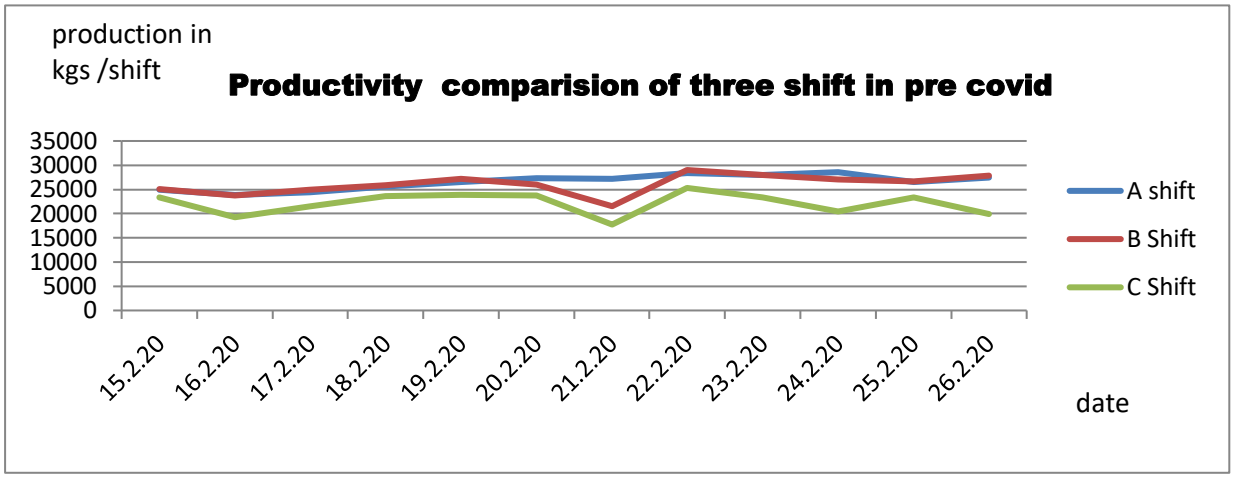


Figure 2 : Production in Fine side ,post covid of A , B and C shift , spinning department

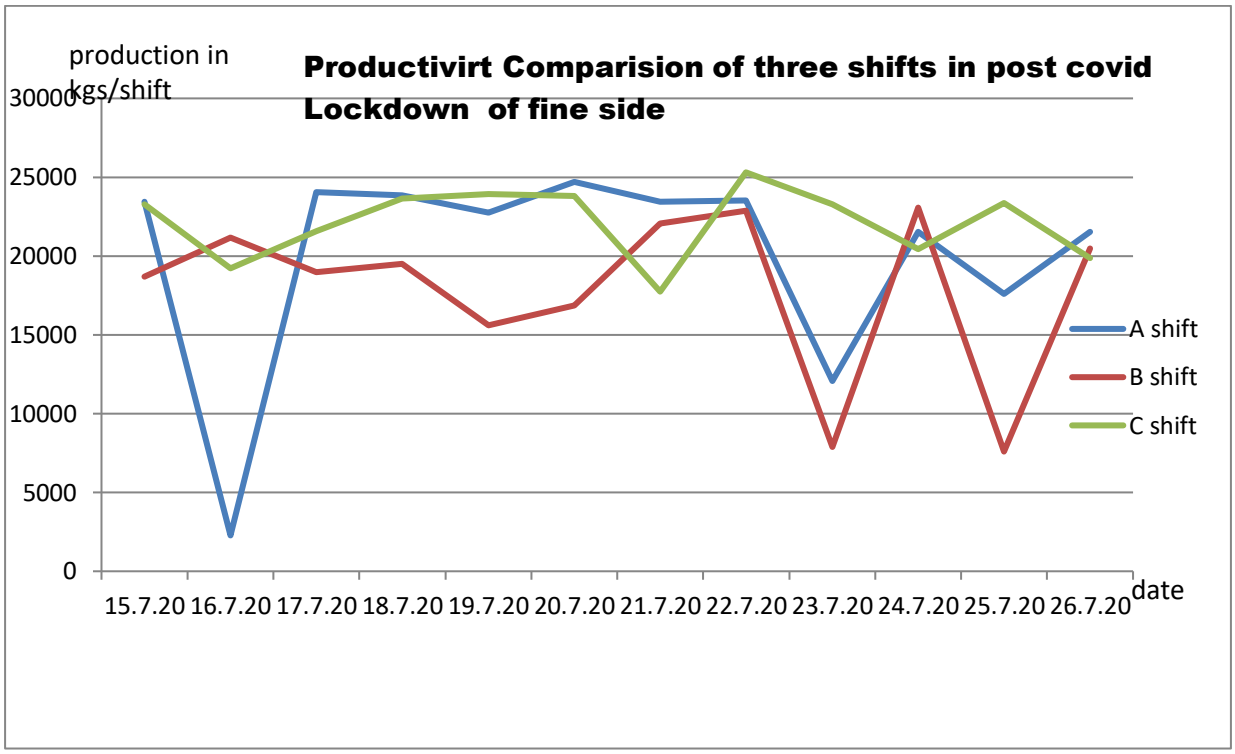


Figure 3 and 4 indicates the pre and post productivity of spinning dept. of three shifts of coarse side. From figure 4, it is found that, high variation of the curve of three shifts. C shift productivity is very low compare to A and B shift .It is due to non-availability of machine operator at C shifts. From figure 3, it is found that ,in pre lock down state three shifts production in kgs/shift are almost same From 15th to 20th the AQ and B shifts production /shift were comparatively higher than C shift. The production /shift in kgs.were gradually decreasing gradually. Figure 4 on the other hand explained that A and B shifts production in kgs/shift were higher than C shift.

Figure 3 : Production in Coarse side pre covid of A , B and C shift spinning department

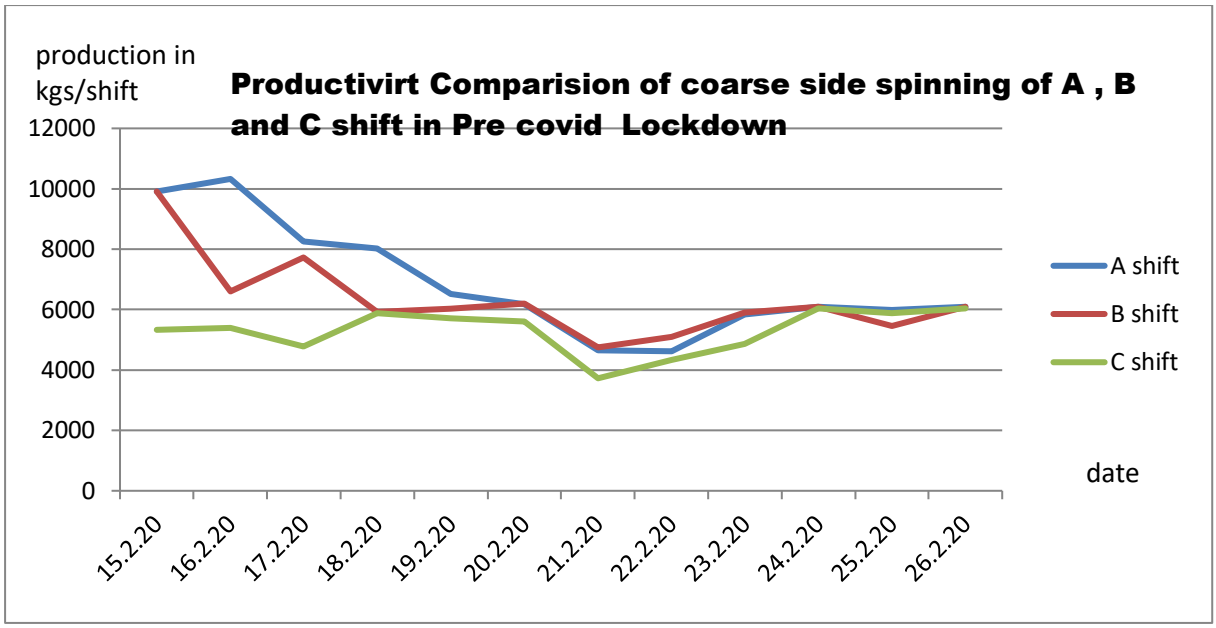
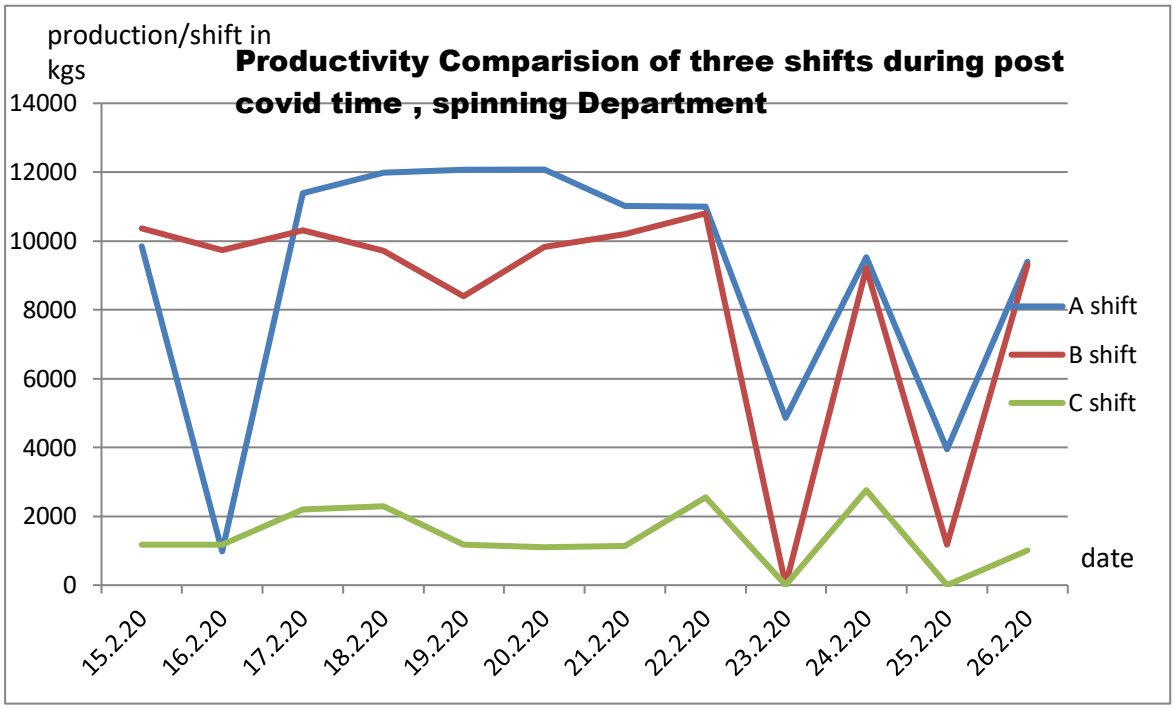


Figure 4 : Production in Coarse side post covid of A , B and C shift spinning department



From figure 5 and 6, it is found that target and actual spinning efficiency % of fine and coarse side in post lock down state are coincide and uniform, less CV% compare to pre lock down state .From figure 5, it is found that wide gap between target and actual machine efficiency % in fine side spinning department, whereas in coarse side the gap between actual and target efficiency % is corporately less compare to fine side spinning. Figure 6 represented the actual and target efficiency % of both fine side and coarse side spinning department in post lockdown state.

Figure 5 : Spinning Frame Average efficiency % /day of three shifts of fine and coarse side pre covid time

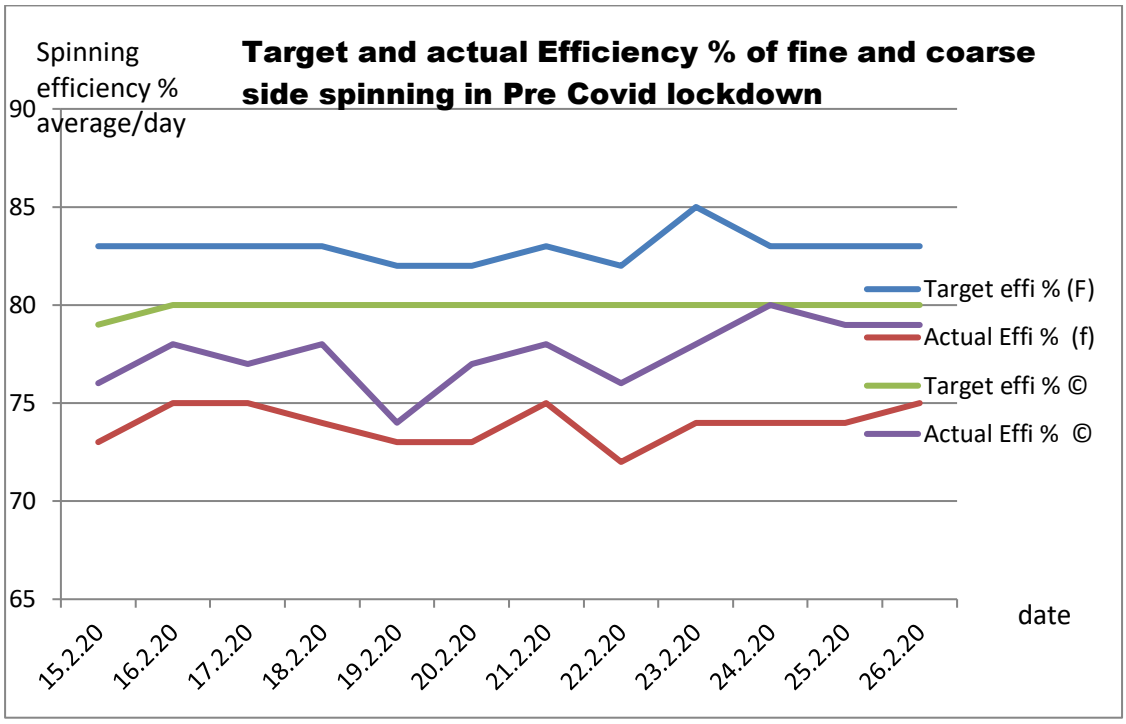


Figure 6 : Spinning Frame Average efficiency % /day of three shifts of fine and coarse side post Covid time

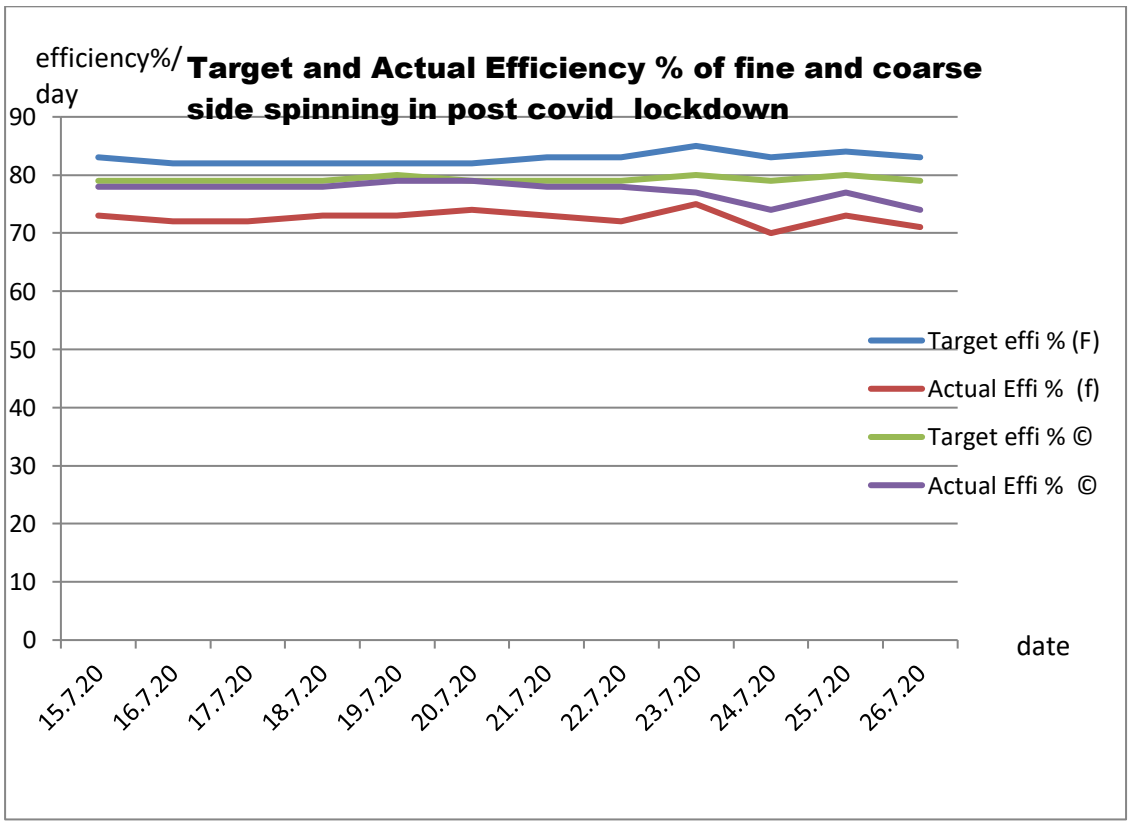


Table 5 : Comparative analysis of Spinning productivity in pre and post lock down state:

Sl No.	No of Days under studied	Subject to be observed	Pre lock down feature	Post Lock down feature	Remarks
1	12 days	Production in fine side, A shift , Average production in kgs/day	26555.42	20062	32.35% lower in productivity in A shift in post lock down state compare to pre lock down period.
2	12 day	CV% of productivity A shift	5.84%	33.07%	High variation in productivity of the study period in post lock down , compare to post lock down state in A shift.
3	12 day	Average No. of Machine run in A shift, fine side	82.7	68.04	21.5 % lower no of spinning machines run in A shift in post lock down state, compare to pre lock down .
4	12 day	CV% of Machines run in A shift, fine side	5.93%	14.87%	High variability of machines running in A shift in post lock down compare to pre lock down .
5	12 day	Production in fine side, B shift , Average production in kgs/day	26073	17899	45.6 % lower in productivity in B shift compare to pre lock down state in B shift in fine side spinning.
6	12 day	CV% of productivity B shift , fine side	7.92%	29.36%	High variability of day wise productivity in Bshift of fine side in post lock down state compare to pre lock down state.
7	12 day	Average No. of Machine run in B shift, fine side	81.54	56.953	43.17 % of lower no of spinning frame running in B shift of fine side in post lock down that pre lock down.
8	12 day	CV% of Machines run in B shift, fine side	7.85%	27.34%	High variation in day wise machine running in B shift within study period , compare to pre lock down stage.
9	12 day	Production in fine side, C shift , Average production in kgs/day,	22118.08	5365.4	312. % less in productivity in C shift in fine side in pre lock down state compare to pre lock down state.
10	12 day	CV% of productivity C shift fine side	10.42%	41.51%	Very high variation of productivity within study period of c shift productivity compare to pre lock down state of c shift in fine side..
11	12 day	Average No. of Machine run in C shift fine side	72.87	16.75	Very less no. of nahine running in C shift of fine side in post lock down state compare to pre lock down state.
12	12 day	CV% of Machines run in C shift fine side	9.53%	35.19%	High variability in running machine in C shift of fine side within study period , compare to pre lock down state.
13	12 day	Actual efficiency of Fine side spinning /day	73.91%	72.58 %	Fine side average efficiency is less compare to pre lock down period average efficiency of spinning frame.
14	12 day	Production /winder/shift in kgs of Fine side	288.08	271.41	6.1 % lower in per winder production in fine side of post lock

					down state compare to pre lock down
15	12 day	Production/day/mc in kgs in spinning of Fine side	315.25	316.33	Slightly higher in spinning machine production /frame /day in post lock down than pre lock down state.
16	12 day	Production in coarse side, A shift , Average production in kgs/day	6876.16	9006.9	Coarse side productivity has been enhanced in post lock down state compare to pre lock down in A shift, due to heavier yarn count.
17	12 day	CV% of productivity A shift coarse side	27.03%	40.95%	Day wise productivity variation of the study period in post lock down is higher compare to pre lock down.
18	12 day	Average No. of Machine run in A shift coarse side	9.83	12.45	Number of machines run in coarse side was comparatively higher compare to pre lock down state in A shift .
19	12 day	CV% of Machines run in A shift coarse side	23.15%	24.73%	Variation of machines running in A shift of the study [eriod is higher in post lock doen state of A shift compare to pre lock down state.
20	12 day	Production in coarse side, B shift , Average production in kgs/day	6314.58	9007.09	42.63 % increased in B shift spinning productivity in coarse side compare to pre lock down study period .
21	12 day	CV% of productivity B shift coarse side	21.54%	29.72%	Day wise variation of productivity in B shift is comparatively higher than pre lock down state. Tis is due to fluctuation of yarn count and non availability of machine operator in post lock down state.
22	12 day	Average No. of Machine run in B shift coarse side	9.12	11.5	Number of machines running in post lock down period in B shift in higher compare to pre lock down state, which given higher productivity.
23	12 day	CV% of Machines run in B shift coarse side	20.09%	72.97%	Day wise no. of machines running was very high in B shift of post lock down period compare to pre lock down state.
24	12 day	Production in coarse side, C shift , Average production in kgs/day	5232	1660.9	C shift production in post lock down period is much less compare to pre lock down state due to non availability of machine operators.
25	12 day	CV% of productivity C shift, coarse side	13.89%	42.19%	Day wise productivity variation in C shift of post lock down stage was much higher compare to pre lock down study period.
26	12 day	Average No. of Machine run in C shift coarse side	8.2	2.85	No. of machines running in C shift was much higher in pre lock down study period compare to post lock down state.
27	12 day	CV% of Machines run in C shift coarse side	1.52%	40.38%	Day wise productivity variation in C shift of post lock down period was much higher compare to pre lock down period.
28	12 day	Actual efficiency of coarse side spinning /day	77.5	77.33	Efficiency of coarse side spinning wes same in both the period.

29	12 day	Production /winder/day in kgs of coarse side	321.5	372.91	`Per winder production in post lock down study period was higher due to heavier count and higher productivity in spinning area.
30	12 day	Production/day /mc in kgs in spinning of coarse side	697.91	756.5	Higher production /frame in post lock down state was observed compare to pre lock down period.

SUGGESTIVE MEASURES:

Top Management has taken several measures for improvement in productivity status in post lock down period. The steps are stated below.

- Arrangement of transportation services of workmen of three shifts for outstation workmen..
- Arrangement of completely safety norms of workers at work place.
- Distribution of Masks to workers.
- Enhancement of daily wages to the contract labor from out station candidate.
- Continuous shift of working time instead of break shift during the lock down period.
- Communicating with labors of closed Jute Mills and given contact service to them at this mill.
- Maintaining the Covid 19 norms and regulations at work place safety.
- Free lodging and flooding facilities to the trainees within mill premises.
- Running of mill during general lockdown days.
- 24*7 hours open of company's own dispensary and ambulance availability.
- Thermal screening of all employees during entry at the main gate.

CONCLUSIONS:

The unit is now coming normal. The Top management has taken so many corrective measures to run the unit with full capacity. The present study helps us to observe the effect of Covid 19 on the productivity of the yarn manufacturing process. Spinning is the heart of Jute Mills. Higher productivity and quality given next process of finished goods manufacturing process under control. As a result the spinning process, i.e., yarn manufacturing processes are studied here. The Top management is trying to unit is trying to run the unit with sufficient manpower to maintain the standard productivity. Top management has given priority to ensure safety of workers at workplace.

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Impact of Soft Skills for Better Use of Library Resources and Services: a study

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Abstract: Soft skills play an essential role in the 21st-century technological era, especially to handle the techno-savvy young generation. It is defined as "Soft skills is a sociological term, which refers to the cluster of personality traits, social graces, facility with language, personal habits, friendliness and optimism, that mark people to varying degrees. Soft skills complement hard skills, which are the technical requirements of a job". (Personality Development & Soft Skills by Shalini Verma, 2013). This study is an attempt to highlight the significance of Soft Skills and its relevance among Librarians to deliver for better use of library Resources and Services. The rapid review of the literature is done on the database of PubMed, Scopus and Google Scholar, Research Gate, and academic gate etc. using the keyword of soft skills or Libraries. Collected the latest information regarding soft skills impact on libraries, then analyzed the same to identify its possible application in the domain of the library.

The study shows the individual's skills are, i.e. interpersonal, non-specialized, such as leadership, responsibility, assertiveness, and conflict resolution or mood management. Good soft skills reduce stress and conflict, improve relation-building ability, enhance intimacy, increase understanding and promote joy. It leads to better interaction with library users and results effectively use of Library Resources and Services.

Keywords: Leadership, ICT, Soft Skills, Resources etc.

INTRODUCTION:

Soft skills are defined as the cluster of people skills, social skills, communication skills, character traits, attitudes, career attribute, social intelligence and emotional intelligence quotients among others that enhance people to navigate their environment, work well with others, perform well, and achieve their goals with complementing hard skills. Soft skills are first refereed in 1972. Sitthisomjin etc.(2014) study suggested for the program enhancing soft skills for the University library staff by using Innovation development as the main component along with the support Communication skills, Thinking skills and problem-solving skills, and Life-long learning and information management. In the major way communications skills work on LSRW theory which means Listing, Speaking, Reading and Writing skills. Due to advancement in information and communication technology, library professionals job also require some of the special skills and competencies apart from the domain skills and practices of librarianship. The new type of information services and sources have come in existence, such as e-books, blogs, virtual references services, data services, remote access etc. These services are greatly required special skills and abilities.

SOFT SKILLS FOR LIBRARY PROFESSIONALS:

Library and information centres are treated as the storehouse of information and knowledge. The ability of LIS professional may include issues related to understanding information need of the user, conversation of traditional services into the digital base, self-evaluation of services by taking users feedback on a regular basis. By applying soft skills, we can create the best image in the user's eye and satisfy and attract the user community. While looking into

the job profile of library professionals, there are various soft skills required to increase the visibility, usage and effectiveness of the library services and collection in the 21st century.

Some of those are discussed below:

a) Effective Communication skills which include Listing Skills, Speaking Skills, Reading Skills and Writing Skills are an essential requirement to the library professional. They deal the diverse users and provides the various value-added services like CAS and SDI
b) Interpersonal skills: The library professionals must be able to build good interpersonal skills among the fellow staff, readers and others with whom they work closely. This skill is beneficial in terms of better usage of resources and services.
c) Presentation skills: Library staffs are required to interact with the users, vendors, publishers in their daily jobs. Presentation skills are essential while delivering their respective services. This trait is very helpful to increase the usage of resources.
d) Marketing Skills: Library subscribes to various documents to their collection. In this process, the library staffs are required to apply their marketing skills through negotiations. This skill plays a vital role in every library to minimise its cost.

Besides, Positive attitude, strong work ethics, problem-solving skills and Adaptability of day to day technologies are essential to the library staff for providing the efficient services to the users and also reduce stress and conflict, improve relation-building ability, enhance intimacy, increase understanding and promote joy.

CONCLUSIONS:

From the above discussion, it can be concluded that soft skills are playing a very vital role for better usage of library resources and services. The success or failure of the functions and services of libraries also depend on the concerned library professionals. Apart from Technical and domain knowledge, with the systematic blending of hard skills cum soft skills always accelerate the efficiency of the library professionals; as a result, it enhances users accessibility of library resources and services.

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SOCIALIZATION and ETHICS OF BUDDHISM

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Abstract: Socialization is a process of learning, communicating and behaving of an individual to social life such as parents, friends, family, school and society. Ethics in Buddhism are the teachings of the Buddha or more specifically, the basic ethics of Buddhism such as the five precepts and the relationships in society such paretns- children, husband –wife, and so on. It's the basic teaching of Buddhism that helps human beings give up what is bad, evil and to get what is good, happy for themselves and others in society. Socialization in Buddhist ethics is a process in which each individual learns and understands and practices the teachings of the Buddha that make them become a human being better in family and society. This article explains about the process of an individual how they practice Buddhist ethics that they could exchange from the unwholesome to the wholesome, from bad to good, from suffering to happy in life. It helps them cultivate and develop individuals and bring the noble things in their life and others.

Keyword: Socialization, Buddhism, Ethics, individual and society

1. Socialization

The process is beginning to take consciousness on people's behavior that is called socialization. Socialization is a process in which we learn the culture of society and behave in a conformity way of society's rules. In the process of socialization, individual receive the social experiences, naturally learn rules, regulars from the Society. Bogardus said that socialization is a process of working together, of development group responsibility, of being guided by the welfare needs of others. According to Coser, "*socialization is the interactive process by which people learn some of the values, attitudes, skills and knowledge appropriate to their roles in society*". Through the process of socialization, an individual is a member of society, he performs all functions of society.

2. The stages in socialization:

The first stage is socialization of children in the family, the second stage is socialization of children in school, and the final stage is socialization of children in society.

Socialization of child in family: family provides an environment for socialization of an individual (family in education training). He learns all things from his own family, and how to know the social behaviors to join in the life of society. The family is considered as the smallest

culture, education, how to live in traditional family, which individual receive those attitudes, his attitudes are built and developed by his family. The individual is naturally influenced by family. This is a relationship of interaction between the individual and other members in the family. The first stage of socialization is that an individual receives not only advices but also behavior of family members. Thus, this is the first period; the individual is based on the affection. This is the first important stage for an individual to go with him in all of his life.

The second stage is socialization of children in education in school. The child learns from school, gets knowledge, and based on knowledge, becomes a social human This is the process of learning that is the distinctive behavior as a member of a smaller group within the larger society. This stage takes place outside the family. It is where children learn how to act in a way that is appropriate for the situations they are in. Thus, schools require very different behavior from the home, and children must act according to new rules. New teachers have to act in a way that is different from pupils and learn the new rules from people around them. This stage of socialization is usually associated with teenagers, and involves smaller changes than those occurring in family's socialization. School's socialization is entering a new profession or relocating to a new environment or society.

The final stage is socialization of children in society. An individual takes part as a member of a team such as worker, teacher, co-college, and so on. At this time, individuals of socialization perform through formal and informal ethical standards. This stage is an overlapped process which includes both two above stages. Because an individual plays various other roles in society such as wife, husband, father, mother, child, teacher, doctor, so on. He has already learned some of the behavior required in that role and knows how to carry out part of it. The learning of the rights, obligations, expectations and outlook of a social role is preparatory to assuming it. As a person learns the proper beliefs, value and norms of status or group to which he aspires, he is learning how to act in his new role. So, socialization is a continuous process, when an infant becomes an adult, and continuing over generations. Through a continuous process of internalization of culture, society perpetuates itself. Its members transmit cultural values to the next generation and thus society continue to exist.

3. Ethics of Buddhism

"Religious socialization *is an interactive process through which social agents influence individuals'* religious *beliefs and understandings*" (Darren E. Sherkat.2003). And socialization in Buddhism is understood as a process of human being who makes perfect their attitude, personality, ethics, quality, and so on. They change from ignorance to enlightenment and guide others who will be enlightened. In other words, it is a process of changing from suffering to happiness, from unwholesome to wholesome, from attachment to no-attachment, and from self to no-self.

The human being is a central subject to create the social life which is a relation between individual and each other or group together. It is suggested in Buddhism that to become humanity, moral virtue is very important. Everyone should observe five precepts: no killing, no taking what is not given, no sexuality, no lie, and no drink what make us become ignorant. These five precepts are the basic elements to lead the good life. By way of keeping precepts, we can control the bodily action and verbal action. All human beings want to live, and scare to die. Why do we have to ignore other when we save our life? As we respect ourselves, we should respect others too. No matter why we should not harm other living beings. If possible, we should help and protect them. Such moral value leads to not only an individual good life, but also a good life of society.

The rules are considered as the means which help us find the inner freedom and confidence. When practicing these precepts, we do not worry about our moral chanters. It is sure that we do not harm others. A conscious effort to practice rules is important. For example, firstly we avoid killing living beings. This makes us more compassionate and sympathetic to the difficulties and suffering of others. Secondly, we do not take what is not given. It means that we do not attach our livelihood. Thirdly, avoiding the sexual misconduct make children, family, society harmony and happiness. Fourthly, getting rid of telling a lie is training in truthfulness and virtuous speech. We cultivate and respect for truth together. Finally, do not use an intoxicant, which is negative. This affects the mind and mentality. This is strong to love positive life. Buddha said thus "Be a lamp to yourself. Be your own confidence. Hold on the truth within yourself as to the only truth". Practicing five precepts is the path to perfect ourselves personality. This is a natural factor in the cultivation of mindfulness and wisdom, which are the essence of insight meditation.

It is stated in Buddhist literature (Bhikkhu Bodhi, 2012), we should know social duties to have good relationships in society. Family is an important part of society because a good family leads to a safe society. In a line of family, there are five duties which children should know to respect parents: He or she should know to support parents. Children look after parents who aged, when they need to be taken bath, given food, and so on. Children perform their duties for parents who need some works in an office or government. Children keep up the tradition of family and don't waste parents' property, gold and silver. Children are worthy of their heritage; the children are truthful to receive parents' heritage. After parents' death, children should distribute gifts on their behalf. These are the duties which the children provide their parents. Parallel, the parents have five roles to educate their children, such as teach children how to avoid from evils; support and encourage children in doing good things; train their children to get skills; find their children a suitable wife; hand over the inheritance to the children. Beside the roles between parents and children, the roles between husband and wife also are important in family as follows:

There are five ways which the husband respects his wife:

- Respecting her
- Being un-belittle her
- Being faithful to her
- Giving authority to her
- Supporting adornments when she needs

And a wife should respect her husband with five ways follow:

- Organizing work with family
- Being kind to the servants
- Being faithful
- Protecting his business
- Having skill and hard-working

They will get happiness and harmony in the family if they perform the duties well. They avoid fear and conflict. Besides, there are the rules of relationship between parents and children, teacher and student; master and disciple; boss and worker; friend and friend. Qualities of every group are important, because all attitudes of individual create the good life in society. The Buddha said clearly that there are four kinds of friends: The helpful friend: who helps his

friend anytime, anywhere with unconditioned. Attitudes of helpful friend: He looks after his friend when his friend is off protected; he looks after his friend's belongings when his friend is wandering; he is thoughtful when his friend's spirit is fallen; he gives his friend twice ask for work if his friend need. The friend has already shared his friend happiness and sadness. There are four elements for this friend: he shares his friend his secrets; keep his friend's secrets; he did not hide when his friend has problems; he would sacrifice his life for his friend. The advisory friend can share all what is good for his friend, this friend has four elements such as he denies his friend make bad; he supports his friend make better; he informs what his friend does not know; and he points out the path of heaven. The sympathetic friend has four ways: he is sorrow when his friend is unhappy; he is happy when his friend gets good fortune; he prevents others who badly tells to his friend; he mentions others who speak what is good for his friend.

Practicing the precepts and the roles between relationships, which prevent the bad actions of body and speech. In relationship of family, school; and society; every individual should cultivate and develop the attitudes of mind; they make every person better in daily life. There are four attitudes of mind: (Brahmavihara): Loving-kindness (Metta), Compassion (Kuruna); Sympathetic (Mudita), and Equanimity (Upekkha). According to Buddhism, the mind is an important aspect to control our actions. So the four qualities are known as the four sublime states or the four noble qualities. Firstly, Metta (loving-kindness): It is love for all beings. Without any conditions, whether they are rich or poor, good or bad, pleasant or unpleasant, ill & diseased or healthy; whether we know them or not, whether they are humans or animals or other beings. It helps us reduce our hate and anger. Secondly, Kuruna: It is compassion for all people and beings who are less gifted than us and are suffering. It helps us reduce our pride and greed. Thirdly, Mudita: It is sympathetic joy or feeling joy in prosperity and happiness of others. It helps us reduce our jealousy. Finally, Upekkha: It is Equanimity, which treats all people and all beings equal and accept others as they are. It helps us reduce our indifference. The four noble qualities are the inner elements of all living beings, which help in cultivating the spirit of individual and relationship in society. Nyanaponika Thera (1994), he detailed that the four attitudes are said to be *excellent* or *sublime* because they are the right or ideal way of conduct towards living beings. They provide, in fact, the answer to all situations arising from social contact. They are the great removers of tension, the great peacemakers in social conflict, and the great healers of wounds suffered in the struggle of existence. They level social barriers, build harmonious communities, awaken slumbering magnanimity long

forgotten, revive joy and hope long abandoned, and promote human brotherhood against the forces of egotism. In the Anguttara Nikaya, the Buddha said that the practice of the four noble states brings the good life: "*May all being, all living things, all creatures, every one, meet with good fortune; may nothing bad come to anyone*."

4. Conclusion

Socialization of Buddhist ethics is related to the spiritual qualities that they are likely to produce and promote as follows as the precepts increases our awareness of how we may skillfully conduct ourselves in body and speech and helps us to see more clearly whether we are improving in this process of self-discipline. For example, compassion is a spiritual quality that we all possess to some degree. However, without a conscious and persistent effort to develop it, this important quality may remain rudimentary and weak. By consciously practicing the first precept, we bring this compassion to a higher level of development and come a step closer to the realization of the Dharma. In the process, our conduct becomes more refined and our mind becomes more sensitive to the problems and suffering of others. By practicing the second precept we not only purify our livelihood, but train in generosity and non-attachment. The third precept has a direct connection with the training in sense restraint, which is an essential feature on higher spiritual development. In fact, enlightenment is not possible without mastery over the senses. The fourth precept deals with training in truthfulness and virtuous speech. The objective of this precept is not only the cultivation of respect for truth, but a way of life that is sincere and free from falsehood in every respect. Even the fifth precept, which enjoins against the use of intoxicants, is not merely negative, for the resultant effects that take place in the mind in terms of mental strength and moral integrity are very positive. The observance of this precept is also a natural precursor to the cultivation of mindfulness and wisdom, which are the essence of insight meditation. Each and every precept increases our awareness of how we may skillfully conduct ourselves in body and speech and helps us to see more clearly whether we are improving in this process of self-discipline. And responsibility are important features of the practice of Buddhist morality. Because these precepts are meant to be a course of training, it can hardly be expected that each and every practitioner will be able to follow them without committing the slightest error, any more than it can be expected of a music student not to make a single mistake in the course of his lessons. For people with certain temperaments or occupations, some precepts may appear more difficult to follow than the rest, but that should not be an obstacle to making an attempt to keep the precepts. If one is discouraged from practicing, one need simply considers that these precepts are a course of

training; and training, by definition, implies imperfection and a gradual process of development. However, for those who are new to Buddhism, it may be a good idea to begin with greater emphasis on those precepts that are easier to follow, bearing the others in mind for later development. For instance, the second and the third precepts obviously need to be practiced by virtue of necessity, for they are supported by laws and are in perfect harmony with customs and conventions in all civilized societies.

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Managerial Attributes Co-Relating Faculty and Students

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Abstract: Students are the customers for the service provided by the business schools. Their expectations from the members of faculty who impart knowledge on managerial skills to the students are ascertained. This has important implications for improving the quality of education in the business schools and also for providing better services to other stakeholders like industry, parents and society. This study conducts a survey among the students of business schools by administering a questionnaire that contains questions relating to six important attributes of management faculty. The study finds out that the six attributes are grouped into two that are renamed as Attributes for effective knowledge absorption and Attributes for holistic growth.

Keywords: Faculty Attribute, Management Education, Teaching Learning Process, Business School, Mentoring, Delivery Skills, Subject Knowledge, Motivation, Curricular and Co-Curricular Activities, Service Organizations.

Back Ground

The success of any service organization depends on its ability to consistently meet the expectations of its customers. In an educational institution, the students are both the inputs to the process and the output of the process. They are also the consumers of the services provided by the institution. It is important to understand their expectations from the members of faculty. Berry and Parasuraman (1992) argue that the ability to meet the customers' service expectation consistently or exceedingly is crucial to the strategic success of service organizations. In the business schools, a lot of importance is attached to the industry's expectations of the management graduates. According to Laha (2002) the management graduates produced by the business schools are recruited by the industry. Hence, industry needs to assess the quality of education imparted by these business schools while deciding on recruitment from these schools.

In order to meet the industry's expectation the curriculum is updated on a continuous basis. However, the students' ability to successfully absorb the inputs provided by the business school

depends on if their perspective on, "what are their expectation of a management faculty?" is met. That students are the consumers of the services provided by business schools is put forth by Myron (1993). He argues that there are a number of consumers for the product provided by the business school. He argues that the most important among them are the students. This is because the students live with this product for the rest of their life. The second sets of consumers for this product are the parents who pay for these services provided to their wards. The third in the list is the future employees who avail benefits of these services provided to the students by hiring them as employees and paying for their services. The last in the list is the society at large. The society also enjoys the fruits of the services provided by the business school as the student is a member of the society. Hence, it becomes important to understand their concerns.

This study assesses the attributes of the management faculty that are considered the most important by the students of management. From a list of six attributes namely effectiveness of teaching methodology, subject knowledge, motivation, delivery skills, mentoring and involvement in curricular and co-curricular activities, students are asked to rank these attributes.

Management education in India started way back in 1950s. Indian Institute of Social Welfare and Business Management was the first institution to be floated for providing management education. Today, over more than 1600 business schools provide management education at the under graduate and post-graduate level in the country. This has intensified the competition among the business schools in trying to attract good students. Since the objective of any good business school is to produce students who are academically sound and employable by the industry, the choice of the right kind of students with learning ability is extremely important. In order to make the students employable by the industry, the industry's expectations of a management graduate are ascertained and are incorporated into the curriculum. To produce academically sound students the business schools focus on the teaching learning process. However, the success of the business schools in meeting their twin objectives is a function of not only the quality of the students enrolled for the programme but also their ability to absorb the class inputs effectively.

Management education uses a variety of pedagogical approaches in addition to just lecturing like case studies, group discussion, role plays, brainstorming, project works, and management games. The effective use of these pedagogical approaches in a class room environment is a function of the ability and efficiency of the members of faculty of the business school. In addition to being a subject expert, the faculty member of a business school need to have a lot of other attributes like

ability to motivate the students, carry out effective mentoring for the students, involve the students in curricular and co-curricular activities, efficient use of teaching learning process, delivery skills, etc. Each of these attributes or the combination of these attributes impact the class room learning of the student. In order to understand, the importance of these attributes for the student's learning process, the study ascertains the student's perspective to assess which of these are considered the most important attributes for their learning process. The expectations of the students about the attributes that they consider important for management faculty becomes important to understand to facilitate this process of effective absorption. Gordon and Partigon (1993) write, "The success with which an institution provides educational environments which enable students effectively achieve worthwhile learning goals including appropriate academic standards."

The findings of the study are useful for the business schools to recruit the right kind of teachers and retain them. The attributes that are found to be important in this study may carry due weightage in the assessment system. Data on the students' perspectives on essential faculty attributes will help both in assessing the present quality of service offered in the business schools and also help in planning its enhancement. Hill, Lomas and MacGregor (2003) show that the data and information sought from the customers will help both the service provider and stakeholder to assess the level of quality. Cheng (1995) argues, "Education quality is the character of the set of elements in the inputs, process and output of the education system that provides services that completely satisfy both internal and external strategic constituencies by meeting their explicit and implicit expectations". There is also an increasing expectation by students that they should have choices in terms of subjects, modes of delivery, methods of assessment and time spent on campus. The respondents have suggested that the experienced faculty members have done their jobs to the complete satisfaction of the students.

The Study

The study focuses on the analysis of the students perspectives on their expectations of management faculty. The study started with a long list of probable attributes that a management faculty should possess to be effective. This list was put up for discussion by a focus group. Based on the focus group discussion results, the attributes are reduced to six. The list of the six attributes chosen for the study and the definition of each of these attributes is given below.

Subject knowledge: Subject knowledge of the faculty refers to the training and experience that the faculty possesses in management education and its relevant areas.The subject knowledge

manifests (i) in the ability to understand the broad range of topics relating to management education, (ii) in consistently being able to demonstrate a command over subject specific skills including the application of knowledge, (iii) in the ability to add one's own perspectives to the current happenings in the related areas and (iv) in the ability to relate theoretical knowledge with practice.

Effectiveness of teaching methodology: Methods of teaching include formal lecture, tutorial sessions, group discussions, role plays, case analysis, projects, etc. The effectiveness of the teaching methodology depends on its appropriateness for the subject/topic. The faculty has the responsibility of choosing the most appropriate methodology for teaching each topic.

Delivery skill: Delivery skills related to the ability of the faculty to communicate what he/she wants. It includes the effective use of the five facets of the human body namely eyes, voice, expression, appearance and body language to reach the students with the content intended for teaching.

Motivation: Motivation is the desire to achieve a goal. Motivation strengthens the ambition, increases initiative. It provides the direction, courage, energy and perseverance to achieve the goal set. Motivated students can set themselves on the path to success in a focused manner. The faculty's ability to motivate the students to learn is a crucial component of successful imparting of knowledge.

Mentoring: In general, teachers used to maintain certain distance from the students mentally and emotionally. Recent trends suggest that the distance has begun to reduce. The stakeholders are suggesting that teacher-student relationship is very essential in higher education to promote and guide the latter in a positive way. This is achieved through the mentoring system present in many business schools today. In a healthy mentoring relationship, the student is encouraged and expected to be candid in responding to the teacher's ideas, methods and words. Mentoring also includes acquainting the student with the specialized field and helps the student acquire ease and comfort in their mastery. The process may include travel, social activities and glimpses into each other's personal lives. Despite this closeness and sharing, the teacher does remain a hand-holding mentor and maintains certain evaluative responsibilities while the student continues to be on the mentor's guidance and approval.

Curricular and co-curricular activities: Apart from teaching and conducting tests, teacher should organize curricular and co-curricular activities such as debates, seminars, technical exposure,

extempore speeches, field visits and research to improve the student's skills and knowledge.

Research Design

A structured questionnaire is administered on the student respondents. The questionnaire contains questions relating to six attributes namely effectiveness of teaching learning process, subject knowledge, motivation, delivery skills, mentoring and involvement in curricular and co-curricular activities. Students are asked to rank each of these attributes in terms of its importance for the learning process.

The selected attributes are arranged with five points rating scale such as "Excellent", "Good", "Average", "Poor", and "Very Poor". The responses are assigned scores as 5, 4, 3, 2, and 1 respectively.

100 students from five different business schools are the sample for the study. These business schools are chosen based on simple random sampling. The responses to the questionnaire are analyzed using factor analysis. Factor analysis is chosen in order to prioritize the attributes in terms of their importance.

Results and Discussion

The statistical package used for the study is SPSS. The statistical tool used for the analysis is factor analysis. Factor analysis attempts to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. Factor analysis is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables.

Principal Component Analysis (PCA) method is used in this study. There are also many different types of rotations that can be done after the initial extraction of factors, including orthogonal rotations, such as varimax and equimax, which impose the restriction that the factors cannot be correlated, and oblique rotations, such as promax, which allow the factors to be correlated with one another. This technique is used to determine the number of factors that are to be extracted.

Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors. The higher the score, the more reliable the generated scale is. Nunnaly (1978) has indicated 0.6 to be an acceptable reliability coefficient. As it is, the procedure output has an overall alpha of 0.598 (rounded from .598 from the top of table) which is good considering that .60 is the cutoff value for being acceptable.

Table – 1: Communalities

Attributes	Extraction
Subject knowledge	.602
Delivery Skill	.616
Teaching Learning process	.464
Motivation	.533
Mentoring	.607
Curricular and Co-curricular activities	.464

The communalities in the column labeled "Extraction" reflect the common variance in the data structure. The amount of variance in each variable that can be explained by the retained factors is represented by the communalities after extraction.

Six factors (components) were extracted, the same as the number of variables factored. In the final part of the table labeled Rotation Sum of Squared Loadings the Eigen values of the factors after rotation are displayed. Rotation has the effect of optimizing the factor structure and one consequence for the data is that the relative importance of the six factors is equalized. 55% of total variance is obtained after rotation of all the factors.

A way to determine the number of factors to extract in the final solution is Cattell's scree plot. This is a plot of the Eigen values associated with each of the factors extracted, against each factor. At the point that the plot begins to level off, the additional factors explain less variance than a single variable.

Table – 2: Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.057	34.286	34.286	2.057	34.286	34.286	1.907	31.791	31.791
2	1.229	20.479	54.765	1.229	20.479	54.765	1.378	22.974	54.765
3	.851	14.182	68.947						
4	.820	13.670	82.617						
5	.656	10.936	93.553						
6	.387	6.447	100.000						

In the above scree plot the curve begins to tail off after two factors. Therefore we probably justify retaining two factors for the study.

The two main factors identified are

1. Effectiveness for classroom absorption
2. Effectiveness for holistic growth

Table - 3: Factor Loading

Factors Identified	Attributes	Extraction
Attributes for effective knowledge absorption	1. Delivery skills	0.775
	2. Motivation	0.726
	3. Curricular and Co-Curricular Activities	0.649
	4. Subject Knowledge	0.597
Attributes for holistic growth	5. Mentoring	0.779
	6. Teaching Learning Process	0.680

Students of management education are drawn from different disciplines, namely engineering, arts, humanities, medicine, etc. They require an orientation towards management education, in addition to specific managerial skills. The transition from the discipline at the undergraduate level to the management education requires hand holding exercise on the part of the faculty.

It can be seen from the factor loadings, that the attributes of faculty are grouped into two sets. The first set of attributes is delivery skills, motivation, curricular and co-curricular activities and subject knowledge. These are essential attributes for the management faculty to facilitate effective knowledge absorption in the class room. Hence, these factors are named as "Attributes for effective knowledge absorption".

The second set of attributes includes mentoring and teaching learning process. These are the attributes of faculty that help contribute to the holistic growth of the students. These attributes are renamed as, "Attributes for holistic growth."

It can be seen from the factor loadings that Mentoring has emerged the single most important attribute in the analysis. In the mentoring process the members of faculty assume various roles like that of a friend, advisor, role model and an agent for the overall development of self esteem. Mentoring assumes special importance in management education since students who enroll in business schools come from various backgrounds. The process of mentoring handles issues like fear, complex, ego, anxiety and gets the students ready for their role in companies.

Conclusion

The study has found that the six attributes are divided into two groups by the factor analysis. The two groups are renamed as Attributes for effective knowledge absorption and Attributes for holistic growth. The attribute that has emerged as the single most important factor is mentoring. This

shows that since the students of management education are drawn from different disciplines in the undergraduate level they need to be hand held through the management education weeding also the confusion, fear, anxiety and complex.

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Geogebra as a technology tool of teaching Mathematics in Secondary school education

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Abstract:

In today's world of education, there are many technology tools available for teaching learning process. GeoGebra is a Mathematics software which is a great tool for teaching Mathematics at any level of education. It is a free software. In the present paper, I shall present different ways to use GeoGebra as a teaching tool in secondary Mathematics education.

Keywords:

GeoGebra, technology tool , Secondary school education

1. Introduction

In the Indian education system, Mathematics is considered to be a crucial subject since it is enables us to develop logical and critical thinking. There are actually thousands of different jobs that require some knowledge of mathematics. But, most of the students have Mathematics anxiety. One of the major reasons for Mathematics anxiety could be linked to the traditional method of teaching. Further, in India every child has different needs that cannot been catered through these traditional teaching methods.

"Instead of making students love the Math they hate, Make the Math they would love"

Teaching Mathematics will be effective only if it is sensible, relevant and interesting. Further, it should cater to the need of every student and should connect to real world. In an attempt to achieve these objectives, technology plays a vital role in the teaching and learning process. Reports have indicated that technology is a useful tool in supporting and transforming teaching and learning. In mathematics classroom, technology can help students and teachers to perform calculation, analyse data, explore mathematical concepts thus increasing the understanding of mathematics. One of the technology that could be used thereby in Mathematics teaching is Math software, GeoGebra.

What is GeoGebra ?

The logo of GeoGebra looks as follows.

GeoGebra

GeoGebra is an interactive geometry, algebra, statistics , spreadsheets, graphing and calculus application, intended for learning and teaching mathematics and science from primary school to university level in one easy-to-use package. GeoGebra is available on multiple platforms with its desktop applications for Windows, macOS and Linux, with its tablet apps for Android, iPad and Windows, and with its web application based on HTML5 technology.

Following are few images of Geogebra screen.

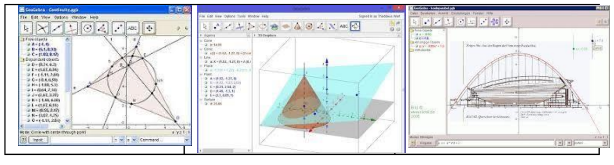


Figure 1: Images of GeoGebra screen

It's creator, Markus Hohenwarter, started the project in 2001 (as part of his master's thesis) at the University of Salzburg, continuing it at Florida Atlantic University (2006–2008), Florida State University (2008–2009), and now at the University of Linz together with the help of open-source developers and translators all over the world. After a successful Kickstarter campaign, GeoGebra expanded their offerings to include an iPad, an Android and a Windows Store app version.

Technology tools refers to software, primarily, that can be used to develop or support online course content.

Secondary school education is the education beyond the elementary grades; provided by a high school or college preparatory school

2. Inclusion of GeoGebra as objectives of the Mathematics curriculum in Indian School

The objectives of the Mathematics and ICT curriculum of grade 9, 10 of SSC board are,

i. Use the available modern technology to understand the concepts in Mathematics.
ii. Use of GeoGebra in understanding Mathematics and Mathematics modelling respectively.

3. Uses of GeoGebra at the Secondary School level

At the Secondary School level , GeoGebra could be used for the following purposes,

A. Sketching purpose

It is very difficult for a Math teacher to draw accurate Mathematical shapes just using chalk and board in the classroom. GeoGebra could be used to draw various 2-D and 3-D shapes.

B. 2-Dimension Shapes :

GeoGebra could be used to sketch different 2-D mathematical shapes such as point, segment , line, ray, closed figures such as regular or irregular polygon, circle etc. Figure 2 denotes different shapes which could be easily drawn using top tool bar in GeoGebra.

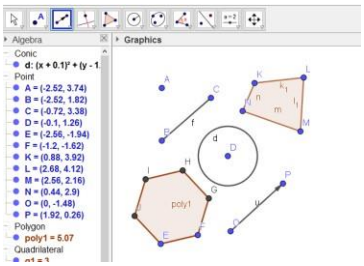


Figure 2 : Sketch of 2-D Geometrical shapes

These shapes could help teacher to introduce the shapes and all it's different parts such as sides, vertex, interior angle, radius, chord ,diameter, edge ,sector etc.

C. 3-D Dimension Shapes:

GeoGebra could be used to sketch different3-D Mathematical shapes such as sphere, cone, prism and pyramids with different bases etc.
3-D diagrams could be used to teach Mensuration and Trigonometry. It could help students to understand 3-D diagrams very clear and hence enhance their understanding and imagination of 3-D objects.

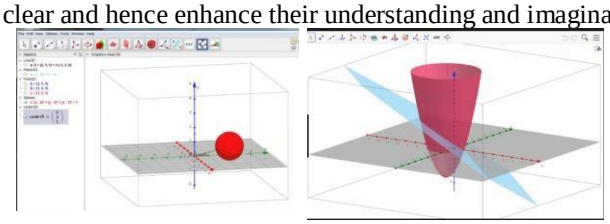


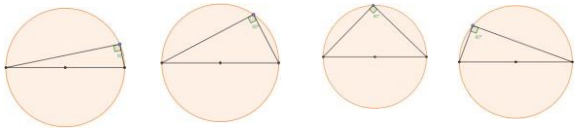
Figure 3 : Sketch of 3-D Geometrical shapes

Teacher could also draw any other diagrams using the combination of these shapes and able to make questions on the basis of these diagrams.

D. Measuring purpose:

GeoGebra could help to measure angles, area of any closed figure, slope of any line and distance of any segment and so on.
This feature is very helpful for the teacher to explain the theorems or properties of the given shape by using inductive deductive

method. For example, teacher could use this tool to explain circle theorems, like," Angle inscribed in a semicircle is right angle" Teacher could draw an angle inscribed in a semicircle. The inscribed angle in a semicircle could be measured by using measuring tool of an angle. Using move tool, the vertex of the inscribed angle could be moved along a circumference of a semicircle in which that angle is inscribed. Student could observe the measurement as 90^0 and can conclude that,"Angle inscribed in a semicircle is right angle" . Figure 4 shows the images of measurement of angle inscribed in a semicircle.



(a) (b) (c) (d)

Figure 4 : Angle inscribed in a semicircle is right angle

This could also be given as a project to students and ask them to conclude/find the result.
This way all the circle theorems or any properties of geometrical shapes could be explained to students with clear understanding.
Few more examples of theorems which could be easily explain to students on the following topics 1. sum of interior angles of polygons 2. properties of diagonals, sides or angles of different quadrilaterals 3. Pythagoras theorem 4. properties of angles made by transversal of parallel lines etc.
This will save lot time and energy of the teacher. Also, it will work as a great motivational tool for student and enhance their thinking and critical skills.

E. Graphing purpose:

GeoGebra could be used as a wonderful tool for graphing purpose such as drawing bar graph, histogram, graphing any function using input option.

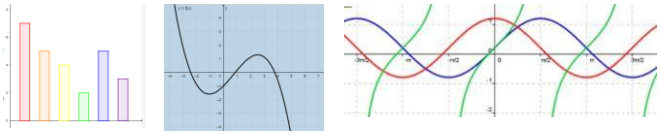


Figure 5 : Sketch of graphs

This feature will help to teach different shapes and properties of graphs or solving equations graphically.

F. Transformation purpose

Geogebra is the best tool for teaching transformation. Objects could be reflected about any line or point, rotated at any angle either clockwise or anti clockwise, enlarged by any factor or translated by any factor . This visual representation helps students to understand concepts clearly and easily. It could also be a great tool for teacher to teach concepts easily and interestingly.

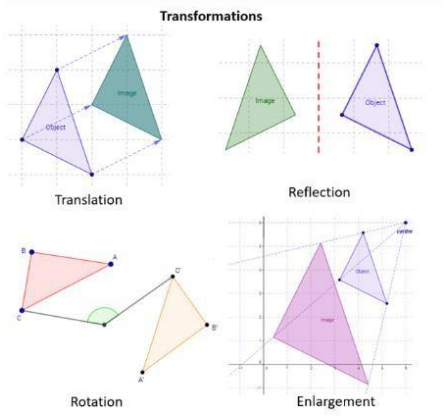


Figure 6 : Transformation of graphs

These graphs could be moved anywhere and the respective changes in the equation could be observed. This will help to understand different transformations geometrically and the respective changes in the function

4. Other Features of GeoGebra

Apart from the above purposes, GeoGebra could also be used as a great tool by using following features,

i. Add text of different sizes, colours and styles.

ii. Change the text, colur or style of the drawn objects.

iii. Changing the scale or ratio of axes.

iv. Changing the grid style in the background. Also, select or deselect grid and axes.

v. Draw; perpendicular bisector of a given segment, bisector of an angle ,parallel lines or tangents .

vi. Using sliders which will help to change the different values of the constant and see the effect of it on the shape of the graph (basically modelling the graph)

vii. Inserting any image in the graph and model (find the equation of the curve of the image or overwrite on the image.

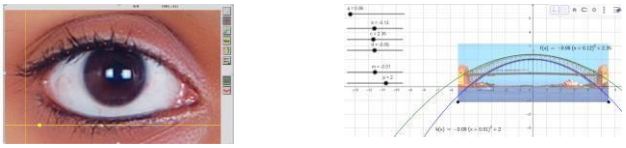


Figure 7 : Modelling of the images

viii. Navigation tool is also one of the important tool. Teacher could keep the GeoGebra document ready and could just navigate it in the classroom as per the required speed of the class by using navigation tool.

5. GeoGebra applet are best teaching tools .

GeoGebra applets are available on https://www.geogebra.org/ which has many free online math tools for graphing, geometry, 3D, and more! These applets are available mostly for all the topics. These are posted by experts and teachers.
For example, if Teacher want to teach net of cube she/he will get many applets and one of the example is as follows.

Just moving the dot which is in the bottom right corner (open the net –red colour slider) it help to open the net of cube and this 3-D visual representation as we move the slider to the right side .This helps teacher to teach this concepts very easily.

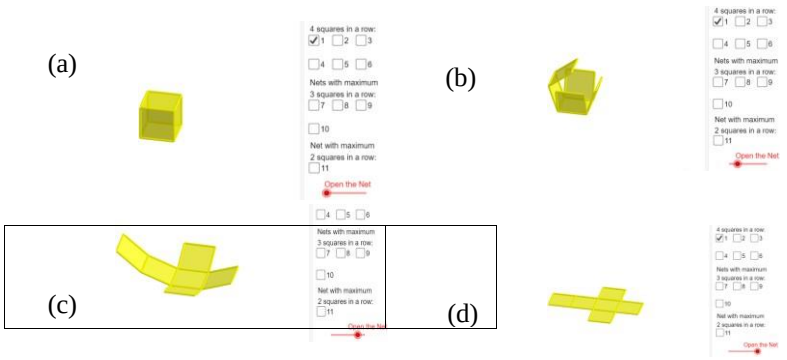


Figure 8 : Applet, net of a cube

These appletes are available for other subjects too such as Physics,Chemistry,Economics etc.
These appletes helps to save lot of energy and time of the teacher.Without actual Physical model teacher could demonstrates different mathematical models in the classroom.It will makes Mathematics Teaching Learning Process fun and interesting.
Mathematics anxiety causes for children to fear math which could be taken care by using GeoGebra in the teaching. It will create positive experiences in math class and make Math interesting and meaningful for students. It will emphasize the importance of original, quality thinking rather than rote manipulation of formulae.

6. Conclusion :

GeoGebra is a boon for Mathematics. It's depend on the teacher how well and creatively to use it in the classroom as a Mathematics tool. It will definitely help students to understand different concepts of Mathematics and create interest for Math. It will help teachers to remove student's Math anxiety. Ultimately, use of GeoGebra will help to increase the confidence level of the learners and increase their achievement. This tool will also help teachers to accommodate different learning styles. GeoGebra is a very useful tool right from Primary education to University level. It is also helpful in teaching all the topics such as Algebra, Geometry, Calculus, Probability, Statistics, Vectors and many more. It could also

be used to explain simple to complex concept. Teacher could learn different features of GeoGebra through different videos which are available on youtube.com. Finally, GeoGebra could definitely make Mathematics interesting for all the students if teacher use it appropriately and effectively.

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On distance based topological indices of structural isomers of Cyclohexane, Octane, Heptane and Hexane isomers

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Abstract:

In this article, the distance based topological indices namely Wiener index and Mostar index are calculated with the structural isomers of Cyclohexane ring, Octane, Heptane and Hexane isomers. After that the calculated value for the Wiener index and Mostar index are correlated with the known structural isomers of Cyclohexane, Octane, Heptane and Hexane isomers. Now in this article we conclude that, in what way the topological indices are predicted the boiling point of the structural isomers of C_6H_{14}, C_7H_{16}, C_8H_{18} and C_9H_{18}

Keywords: Cyclohexane ring, Octane isomer, Heptane isomer, Hexane isomer, QSPR, QSAR

Introduction:

Graph theory is a branch of Discrete Mathematics. Naturally a graph consists of the set of vertices and edges. Also, molecular graphs are a special case of chemical graphs, which represents the constitution of molecules. These constitutional molecular graphs are also called constitutional graphs. When the constitutional graph of a molecule is represented in a 2-dimensional basis it is called Structural graph.

Topological indices are mostly computed with the structural graphs or structural isomers. We have the known distance based topological indices namely Wiener and Mostar indices are selected and computed in this article. Here the calculated value for Wiener index and Mostar index are correlated with the boiling point of the Structural isomers of Cyclohexane, Octane, Heptane and Hexane isomers. The limit of the correlated value is $-1 \leq r \leq 1$. We have the correlated value is either 0.8 or 0.9, which is highly predicted value. Suppose it is less than 0.7, which is predicted only. So first calculate the Wiener index and Mostar index of the following structural isomers and then we have to clarify that in what level these topological indices are predicted the boiling point of the structural isomers of Cyclohexane ring, Octane, Heptane and Hexane isomers.

Basic Definitions:

In 1947, the author Harry Wiener was first introduced this index. So that reason the index is named as Wiener index. The Definition of Wiener index W(G) is, the sum of distances between all pairs of vertices in G

$$W(G) = \frac{1}{2} \sum_{(u,v) \subseteq v(G)} d_G(u,v)$$

Here d(u,v) is the distance between any two vertices of G. Also the Mostar index is considered as

$$Mo(G) = \sum_{(u,v) \in E(G)} |n_u(e) - n_v(e)|$$

Where $n_u(e)$ denotesthe number of vertices of G closer to u than v, $n_v(e)$ denotesthe number of vertices of G closer to v than u.

Main results and comparative analysis

Here the wiener and Mostar indices are calculated with the structural isomers of C_6H_{14}, GH_{16}, C_8H_{18} and C_9H_{18} and also which is listed in table 1,2,3 and 4.

Table 1

Table 1 shows the calculated value for Wiener index, Mostar index and the boiling point of Hexane isomer.

ISOMERS	BP	W	M
n- henane	155.7	35	12
3-mp	145.9	31	16
2-mp	140.5	32	14
2,3 dmp	136.4	29	16
2,2 dmp	121.5	28	18

Table 2

Table 2 shows the calculated value for wiener index, Mostar index and the boiling point of Heptane isomers.

ISOMERS	BP	W	M
Heptane	98	56	18
2-mh	90	52	20
3-mh	92	50	22
2,2 dmp	79	46	24
3,3 dmp	86	46	18
2,3 dmp	90	48	22
2,4 dmp	81	44	26
3 e p	94	48	24
2,2,3 dmp	81	42	26

Table 3

Table 3shows the topological indices of wiener index and mostar index also the boiling point of octane isomers.

ISOMERS	BP	W	M
Noctane	125.7	84	24
2M	117.6	79	26
3M	118.9	76	30
4M	117.7	75	30
3E	118.5	72	32
22MM	106.8	71	30
23 MM	115.6	70	32
24 MM	109.4	71	30
25 MM	109.1	74	28
33 MM	112.0	67	34

34 MM	117.7	68	32
2M3E	115.6	67	34
3M3E	118.3	64	36
223MMM	109.8	63	34
224MMM	99.54	66	32
233MMM	114.8	62	36
234MMM	113.5	65	34
2233MM	106.5	58	30

Table 5
Table 5 shows the topological indices of wiener index and Mostar index the boiling point of cyclohexane ring

ISOMERS	**BP**	**W**	**M**
1,3,5 Tch	139.5	84	27
1,2,3 Tch	143.5	82	31
1,2,4 Tch	143.5	84	27
1,2,2 Tch	145.2	71	35
1,3,3 Tch	138.5	82	31
1,1,4 Tch	135	84	27
1e1 Mch	152.2	84	37
1e2Mch	150.8	86	33
1e3 Mch	150.8	88	29
1e4 Mch	150.8	90	25
Isopropy1 ch	151.9	88	25
Propy1 ch	155.8	94	33

Table 6
Table six shows the correlated value for the two topological indices and the boiling point of structural isomers of cyclohexane ring, octane, heptane and Hexane isomers

TOPOLOGICAL INDICES	**C_6H_{14}**	**C_7H_{16}**	**C_8H_{18}**	**C_9H_{18}**
	BP	BP	BP	BP
WI	0.911	0.8461	0.538	0.467
MI	-0.8758	-0.9059	-0.20	0.5132

Conclusion:

In this article we have used the Physico-chemical properties of structural isomers of C_6H_{14}, C_7H_{16}, C_8H_{18} and C_9H_{18}. Also, we have found the correlation between the structural isomer's and the mentioned topological indices. In table 5, we conclude that the carbon value increases, automatically the correlated value for wiener index decreases. So, we decide the indices which have taken are suitable for predicting the Physio-chemical properties of the boiling point of structural isomers of cyclohexane ring, octane, Heptane and hexane isomers.

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Comparative analysis of degree based topological indices and their corresponding neighbourhood degree-sum topological indices.

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Abstract Neighbourhood degree-sum topological index is sum of degree of neighbourhood vertices of the vertex u and is denoted as S_u where degree based topological index is the number of edges meet at u and is denoted as d_u. In this paper, we have done the comparative analysis between ten notable degree-based indices with their corresponding neighbourhood degree-sum topological indices. We report here, the correlation of mentioned types of topological indices with five physico-chemical properties of octane isomers. Furthermore, we have discussed about a deeper-lying relation between Augmented Zagreb Index with Atom-bond Connectivity Index based on the correlation with one of the physico-chemical properties (boiling point) of octane isomers.

Keywords: Neighbourhood degree-sum topological indices, degree of vertex, Physico-Chemical properties.

Introduction

Graph theory is the main branch of discrete mathematics which involves in many applications to modelling real life problems. Chemical graph theory has an important role in QSPR analysis through topological indices. Topological indices are the numbers associated with molecular graphs where atoms denote vertices and their respective chemical bonds denote edges. Degree based topological index is the main branch of topological indices. It includes neighborhood degree-sum topological indices whose applications have been widespread in recent years. Eighteen octane structural isomers have been used in the study of QSPR/QSAR due to their structural discrimination and the availability of experimental values (Physico-Chemical properties). In 1975, Milan Randic set forth the first degree based topological index in his seminal paper "On Characterization of molecular branching". Zagreb indices is the one of the oldest degree-based topological indices in analysing the structure-dependence of total π-electron energy. Neighborhood degree is the summation of degree of nearest(neighborhood) vertices and is denoted as S_u whereas the degree of vertex is the number of edges meet at a vertex u and is denoted as d_u.

In chemical applicability, many degree-based as well as neighborhood degree-sum based topological indices are employed. It began in 1947 when Wiener index was used to determine the physical properties of alkanes. One of the main applications of topological indices is to predict[19] the Physico-chemical properties of chemical compounds. Here we compare the predicting ability of the existing degree-based topological indices and their corresponding neighborhood degree-sum based topological indices like QSPR models to predict the properties[18] (boiling point- ***BP***, entropy-***S***, acentric factor, enthalpy of vaporization-***HVAP***, standard enthalpy of vaporization-***DHVAP***) of octane isomers.

Preliminaries

Let G be a simple connected graph with vertex set $V(G)$ and edge set $E(G)$. Throughout this paper, we have taken molecular graph G where the vertex set contains the atoms as vertices and edge set contains connectors(bonds) as edges.

Degree $d_u(G)$ is considered as $d_u(G) = \{u \epsilon V(G) / uv \epsilon E(G)\}$

Neighborhood degree-sum S_u is considered as

$S_u(G) = \sum_{u \epsilon N(G)} d_u$ where $N(G)$ is the set of neighborhood vertices of u.

Table 1 shows the basic definitions of degree-based & their corresponding neighbourhood degree-based topological indices.

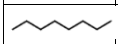
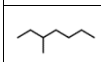
No	Degree-based topological indices	Neighborhood degree-sum topological indices
1	[7] Augmented Zagreb Index $Az(G) = \sum_{u,v \in E} \left(\frac{d_u d_v}{d_u+d_v-2}\right)^3$	[13] Sanskruti Index $S(G) = \sum_{u,v \in E} \left(\frac{S_u S_v}{S_u+S_v-2}\right)^3$
2	[2] Atom Bond Connectivity Index $ABC(G) = \sum_{u,v \in E} \sqrt{\frac{d_u+d_v-2}{d_u d_v}}$	Fourth version of Atom Bond Connectivity Index $ABC_4(G) = \sum_{u,v \in E} \sqrt{\frac{S_u+S_v-2}{S_u S_v}}$
3	[16] Geometric Arithmetic Index $GA(G) = \sum_{u,v \in E} \frac{2\sqrt{d_u d_v}}{d_u+d_v}$	Fifth version of Geometric Arithmetic Index $GA_5(G) = \sum_{u,v \in E} \frac{2\sqrt{S_u S_v}}{S_u+S_v}$
4	Harmonic Index $H(G) = \sum_{u,v \in E} \frac{2}{d_u+d_v}$	[17] Neighborhood version of Harmonic Index $NH(G) = \sum_{u,v \in E} \frac{2}{S_u+S_v}$
5	[12] Forgotten Index $F(G) = \sum_{u,v \in E} (d_u)^2 + (d_v)^2$ Or $F(G) = \sum_{u \in V} (d_u)^3$	[17] Neighborhood version of Forgotten Index $NF^*(G) = \sum_{u,v \in E} (S_u)^2 + (S_v)^2$ and $NF(G) = \sum_{u \in V} (S_u)^3$
6	[5] First Zagreb Index $M_1(G) = \sum_{u,v \in E} d_u + d_v$ Or $M_1(G) = \sum_{u \in V} (d_u)^3$	[17] Neighborhood version of First Zagreb Index $NM_1^*(G) = \sum_{u,v \in E} S_u + S_v$ and $NM_1(G) = \sum_{u \in V} (S_u)^2$
7	[5] Second Zagreb Index $M_2(G) = \sum_{u,v \in E} d_u d_v$	[17] Neighborhood version of Second Zagreb Index $NM_2(G) = \sum_{u,v \in E} S_u S_v$
8	[3] *Randic Index* $R(G) = \sum_{u,v \in E} \frac{1}{\sqrt{d_u d_v}}$	Neighborhood version of Randic Index $NR(G) = \sum_{u,v \in E} \frac{1}{\sqrt{S_u S_v}}$
9	[3] Sum Connectivity Index $S(G) = \sum_{u,v \in E} \frac{1}{\sqrt{d_u+d_v}}$	Neighborhood version of Sum Connectivity Index $NS(G) = \sum_{u,v \in E} \frac{1}{\sqrt{S_u+S_v}}$
10	[10] Hyper Zagreb Index $HM(G) = \sum_{u,v \in E} (d_u + d_v)^2$	[17] Neighborhood version of Hyper Zagreb Index $NHM(G) = \sum_{u,v \in E} (S_u + S_v)^2$

Table 2 and 3 show the results of the ten degree-based topological indices and their corresponding neighborhood degree-sum degree based topological indices. Forgotten Index and First Zagreb Index are calculated by vertex as well as edge partition methods. Their corresponding neighborhood degree-sum topological indices($NF^*(G) \neq NF(G)$ & $NM_1^*(G) \neq NM1(G)$) give unequal values. Table 4 shows the results of correlation between the basic Physico-chemical properties(*BP,S,* Acentric factor, *HVAP & DHVAP*) of n-octane isomers with mentioned degree-based as well as neighborhood degree-based topological indices.

Table 2. Shows the results of degree based topological indices with n-octane isomers.

Octane isomers	*Az*(*G*)	*ABC*(*G*)	*GA*(*G*)	*H*(G)	*F*(*G*)	$M_1(G)$	$M_2(G)$	*R*(*G*)	*SUM*(*G*)	*HM*(*G*)
	56	4.94977	6.88562	3.83333	50	26	24	3.91422	3.6547	98
	46.75	5.16855	5.67486	3.56667	62	28	26	3.77006	3.52456	114
	51.375	5.05916	6.71124	3.63334	62	28	27	3.80807	3.54912	116
	51.375	5.05916	6.71124	3.63334	62	28	27	3.80807	3.54912	116
	56	4.94977	6.76782	3.7	62	28	28	3.84608	3.57368	118
	39.1111	5.42653	6.28562	3.2	92	32	30	3.56067	3.32723	152
	45.51563	5.2375	6.52069	3.4	74	30	30	3.68074	3.43281	134
	42.125	5.27794	6.43028	3.36667	74	30	29	3.66391	3.41898	132
	37.5	5.38733	6.42369	3.3	74	30	28	3.6259	3.39442	130
	44.74074	5.26761	6.37124	3.30006	92	32	32	3.62134	3.36562	156
	50.14063	5.12811	6.57726	3.20482	74	30	31	3.71875	3.45732	136
	50.14063	5.12811	6.57726	3.20482	74	30	31	3.71875	3.45732	136
	50.37037	5.10869	6.45686	2.73333	92	32	34	3.68201	3.40401	160
	40.31011	5.47431	6.17838	3.05238	104	34	35	3.48139	3.24415	174
	29.86111	5.64531	6.05466	2.93333	104	34	32	3.41651	3.19709	168
	41.31471	5.42478	6.70741	3.08571	104	34	36	3.50405	3.25798	176
	39.65626	5.41584	6.33012	3.16667	86	32	33	3.55342	3.3165	152
	33.18518	5.80855	5.8	2.65	134	38	40	3.25	3.03682	214

Table 3. shows the results of neighborhood degree based topological indices with n-octane isomers.

Octane isomers	*S*	ABC_4	GA_5	*NH*	*N* F*	*NF*	*N* M_1*	*N M_1*	*N M_2*	*NR*	*NSUM*	*N HM*
	100.537	4.54233	6.93908	2.12143	172	326	48	90	84	2.14386	2.71099	340
	115.0822	4.4392	6.93664	1.95158	202	406	52	104	98	1.97151	2.60130	398
	122.61378	4.44109	6.86822	1.91348	224	448	54	108	106	1.9559	2.56987	436
	123.91016	4.44298	6.86435	1.95000	228	472	54	110	107	1.9911	2.58753	442
	124.14258	4.45621	6.78913	1.89849	252	520	56	114	115	1.96436	2.55123	482
	155.83184	4.25251	6.92663	1.73420	274	632	60	138	132	1.75445	2.44290	538
	145.952	4.32354	6.81908	1.73586	282	582	60	126	129	1.78369	2.44421	540
	138.63364	4.34725	6.86001	1.75880	258	558	58	124	121	1.79941	2.46879	500
	132.46078	4.33091	6.94658	1.78730	232	486	56	118	113	1.80194	2.49494	458
	170.69576	4.2673	6.78158	1.65642	220	728	64	146	148	1.71766	2.38115	620
	150.66144	4.34319	6.73084	1.67778	306	630	62	130	136	1.75341	2.40431	578
	163.11248	4.31513	6.56525	1.63417	330	727	64	141	146	1.71322	2.37217	622
	182.73748	4.29184	6.40313	1.53896	374	806	68	152	163	1.64476	2.30143	700
	192.86378	4.13509	6.75786	1.46900	384	850	70	162	171	1.52741	2.25203	726
	170.60628	4.1673	6.83317	1.58659	312	778	64	156	147	1.6062	2.34610	606
	200.76881	4.1345	6.62052	1.41431	408	874	72	164	179	1.48892	2.21368	766
	166.33789	4.21608	6.60986	1.53333	342	728	66	144	151	1.58908	2.30779	644
	248.75879	3.89657	6.77254	1.23377	488	1070	80	194	217	1.27674	2.07632	922

Comparative Analysis

(a) Between degree-based & neighborhood degree-based topological indices in correlation with Physico-chemical properties of n-octane isomers.

(b) Between Augmented Zagreb Index with Atom-bond Connectivity Index based on the correlation with boiling point of octane isomers.

(a) Based on the results shown in table 2 & 3, the ten degree-based topological indices and their corresponding twelve neighborhood degree-based topological indices are correlated with the basic Physico-chemical properties [19, 20]of n-octane isomers(Table 4).

Table 4. shows the results of correlation coefficients between the physicochemical properties of n-octane isomers with degree based as well as neighborhood degree-sum based topological indices.

Topological Index	*BP*	*S*	Acentric Factor	*HVAP*	*DHVAP*
$Az(G)$	0.9223	0.6863	0.6676	0.9378	0.8997
$S(G)$	-0.5352	-0.9556	-0.9844	-0.7504	-0.831
$ABC(G)$	-0.8631	-0.8207	-0.7929	-0.9298	-0.9253
$ABC_4(G)$	0.6998	0.953	0.9594	0.8611	0.913
$GA(G)$	0.5964	0.5219	0.4425	0.6440	0.5911
$GA_5(G)$	-0.1126	0.4389	0.5518	0.1529	0.2317
$H(G)$	0.6154	0.9124	0.9253	0.8121	0.8577
$NH(G)$	0.5696	0.9334	0.9857	0.7844	0.8520
$F(G)$	-0.7047	-0.9528	-0.965	-0.8716	-0.924
$NF^*(G)$	-0.398	-0.8888	-0.9227	-0.6287	-0.7135
$NF(G)$	-0.5493	-0.9300	-0.9912	-0.7636	-0.8412
$M_1(G)$	-0.7203	-0.9543	-0.9731	-0.886	-0.9361
$NM_1^*(G)$	-0.4951	-0.9361	-0.9850	-0.7222	-0.8063
$NM_1(G)$	-0.6235	-0.9475	-0.9947	-0.8181	-0.8875
$M_2(G)$	-0.5007	-0.9410	-0.9864	-0.7281	-0.8118
$NM_2(G)$	-0.4955	-0.9427	-0.9844	-0.7191	-0.8063
$R(G)$	0.8208	0.9061	0.9042	0.9361	0.9582
$NR(G)$	0.6326	0.9456	0.9839	0.8300	0.8881
$SUM\ (G)$	0.8023	0.9231	0.9299	0.9318	0.9612
$NSUM(G)$	0.5517	0.9364	0.9879	0.7699	0.8881
$HM(G)$	-0.6567	-0.9613	-0.9829	-0.8425	-0.9043
$NHM(G)$	-0.4591	-0.9319	-0.9787	-0.6917	-0.7818

From the following paragraphs, predictive ability[22,23] of the above mentioned ten topological indices and their corresponding twelve neighborhood degree-sum topological indices are tested with basic physico-chemical properties of eighteen structural octane isomers are discussed.

Boiling Point(*BP*) Augmented Zagreb Index and Atom Bond Connectivity Index show higher correlation(0.9223 & 0.8631) than other degree based topological indices. Besides their corresponding neighborhood degree-based topological indices show moderated correlation with boiling point of n-octane isomers. The important analysis regarding the correlation, degree based topological indices are higher than their corresponding neighbourhood degree-based topological indices.

Entropy(*S*) Sanskruti Index (neighborhood degree based topological index of Augmented Zagreb Index) shows higher value(|0.9553|) than Augmented Zagreb Index. In the same way, ABC_4 Index, *NH* index, NM_2 index, *NR* index & *NSUM* index express higher correlation with entropy of n-octane isomers than their corresponding degree-based topological indices.

Acentric Factor This property of n-octane isomers is highly correlated with neighborhood degree-sum of the above-mentioned topological indices than their corresponding degree-based indices except neighborhood version of Hyper Zagreb Index & Second Zagreb Index (considerably insignificant deviation).

HVAP* & *DHVAP The correlation coefficients linking the *HVAP* & *DHVAP* of n-octane isomers and mentioned degree based topological indices exhibit higher value than their corresponding neighborhood version of degree-based indices. It indicates that, degree-based topological indices should be preferred in designing quantitative structure-property relations with the above physico-chemical properties of n-octane isomers.

(b) Generalised formulation of Augmented Zagreb Atom Bond Connectivity Index

$$(\mathrm{AzABC})_\alpha(G) = \sum_{u,v \in E} \left(\frac{d_u\, d_v}{d_u + d_v - 2}\right)^\alpha \quad \text{where } \alpha \epsilon \mathrm{R}$$

When α = 3, $Az(G) = \sum_{u,v \in E} \left(\frac{d_u\, d_v}{d_u + d_v - 2}\right)^3$ and α = -1/2, $ABC(G) = \sum_{u,v \epsilon E} \sqrt{\frac{d_u + d_v - 2}{d_u\, d_v}}$

The interesting factor of these two indices is that they show higher correlation value than other degree-based indices with boiling point of n-octane isomers. This feature leads us to investigate with numerous values of α to get comparatively good correlation for further studies.

Table 5. shows correlation coefficients of boiling point of n-octane isomers with the indices.

α	$\lvert(\mathrm{AzABC})_\alpha(G)\rvert$
1	0.887
2	0.9042
3	0.9223 *Az*(*G*)
-1/3	0.8656
-1/2	0.8631 *ABC*(*G*)
-1	0.8564
-2	0.8434

From the results of Table 5 reveal that, when α is positive, the correlation of boiling point of n-octane isomers high with increasing α values and at the same time α is negative, the correlation decreased with decreasing α values.

Conclusion

From the above results, we conclude that degree-based topological indices are more suitable than neighborhood degree-sum topological indices in the predictive study of boiling points of structural isomers. Among the indices Augmented Zagreb Index and Atom Bond Connectivity Index are suitable for structure property relations linked with boiling points of n-octane isomers. HVAP and DHVAP of isomers are highly correlated with neighborhood degree-sum topological indices. This paper will pave the path for many intricate predictive analyses of structural isomers for their chemical applications.

Table 6. Shows the of experimental values[18] of boiling point, entropy, acentric factor, enthalpy of vaporization & standard enthalpy of vaporization of eighteen structural octane isomers.

S. No	Octane isomers	BP	S	Acentric Factor	HVAP	DHVAP
1	n-octane	125.665	111.67	0.397898	73.19	9.915
2	2-methyl heptane	117.647	109.84	0.377916	70.30	9.484
3	3-methyl heptane	118.925	111.26	0.371002	71.3	9.521
4	4-methyl heptane	117.709	109.32	0.371504	70.91	9.483
5	3-ethyl hexane	118.534	109.43	0.362472	71.70	9.476
6	2,2-dimethyl hexane	106.840	103.42	0.339426	67.70	8.915
7	2,3-dimethyl hexane	115.607	108.02	0.348247	70.20	9.272
8	2,4-dimethyl hexane	109.429	106.98	0.344223	68.50	9.029
9	2,5-dimethyl hexane	109.103	105.72	0.356830	68.60	9.051
10	3,3-dimethyl hexane	111.969	104.74	0.322596	68.50	8.973
11	3,4-dimethyl hexane	117.725	106.59	0.340345	70.20	9.316
12	2-methyl-3-ethyl pentane	115.450	106.06	0.332433	69.70	9.209
13	3-methyl-3-ethyl pentane	118.259	101.48	0.306899	69.30	9.081
14	2,2,3-trimethyl pentane	109.841	101.31	0.300816	67.30	8.826
15	2,2,4-trimethyl pentane	99.238	104.09	0.305370	64.87	8.402
16	2,3,3-trimethyl pentane	114.760	102.06	0.293177	68.10	8.897
17	2,3,4-trimethyl pentane	113.467	102.39	0.317422	68.37	9.014
18	2,2,3,3-tetramethyl butane	106.470	93.06	0.255294	66.20	8.410

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Iterating a Common Solution of a System of Generalized Mixed Variational-Like Inclusion Problems and the Set of Fixed Point Problems

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Abstract: In this manuscript, using H-η-accretive mappings we study the existence of common solution of a system of generalized mixed variational-like inclusion problems and the set of fixed point problems in q-uniformly smooth Banach Spaces. The method used in this paper can be considered as an extension of methods for studying the existence of common solution for various classes of variational inclusions considered and studied by many authors in q-uniformly smooth Banach spaces.

Keywords: system of generalized mixed variational-like inclusion problems, Fixed point problems, H-η-accretive mappings, resolvent operator technique, q-uniformly smooth Banach Spaces, iterative algorithm, convergence analysis.

MSC-numbers: 47H09, 47J20, 49J40.

1. Introduction

A widely studied problem known as variational inclusion problem have many applications in the fields of optimization and control, economics and transportation equilibrium, engineering sciences, etc. Several researchers used different approaches to develope iterative algorithms for solving various classes of variational inequality and variational inclusion problems. For details, we refer,[5-10,13,17,23] and the references therein.

Equally important for the variational inequalities and variational inclusion problems, we also have the problem of finding the fixed points of the nonlinear mappings, which is a subject of current interest. In this direction, several authors have introduced some iterative schemes for finding a common element of a set of the solutions of the variational problems and a set of the fixed points of nonlinear mappings, see [4,15,22] and the references therein.

Motivated and inspired by the above works and by the ongoing research in this direction, in this paper, we introduce and study a system of generalized mixed variational-like inclusion problems and the set of fixed point problems in q-uniformly smooth Banach Spaces. Using resolvent operator technique, we develope an iterative algorithm for solving the system. Further, we consider the convergence criteria of an iterative algorithm to find the common solution of a system of generalized mixed variational-like inclusion problems and fixed point problems of nonlinear Lipschitz mappings in q-uniformly smooth Banach Spaces and prove that the sequences generated by the iterative

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algorithm converge strongly to a common element of the two systems.

2. Resolvent Operator and Formulation of Problem

We need the following definitions and results from the literature.

Let X be a real Banach space equipped with norm $\|.\|$ and $X^\star$ be the topological dual space of X. Let $< ., . >$ be the dual pair between X and $X^\star$ and 2^X be the power set of X.

Definition 2.1[23]. For $q > 1$, a mapping $J_q : X \to 2^{X^\star}$ is said to be generalized duality mapping, if it is defined by

$$J_q(x) = \{f \in X^\star : \langle x, f\rangle = \|x\|^q, \|x\|^{q-1} = \|f\|\}, \quad \forall x \in X.$$

In particular, J_2 is the usual normalized duality mapping on X. It is well known (see, e.g., [23]) that

$$J_q(x) = \|x\|^{q-2} J_2(x), \quad \forall x(\neq 0) \in X.$$

Note that if $X \equiv H$, a real Hilbert space, then J_2 becomes the identity mapping on X.

Definition 2.2[23]. A Banach space X is said to be smooth if, for every $x \in X$ with $\|x\| = 1$, there exists a unique $f \in X^\star$ such that $\|f\| = f(x) = 1$.
The modulus of smoothness of X is the function $\rho_X : [0, \infty) \to [0, \infty)$, defined by

$$\rho_X(\sigma) = \sup\left\{ \frac{\|x + y\| + \|x - y\|}{2} - 1 : x, y \in X, \|x\| = 1, \|y\| = \sigma \right\}.$$

Definition 2.3[23]. A Banach space X is said to be

(i) uniformly smooth if $\lim_{\sigma \to 0} \frac{\rho_X(\sigma)}{\sigma} = 0$,

(ii) q-uniformly smooth, for $q > 1$, if there exists a constant $c > 0$ such that $\rho_X(\sigma) \leq c\sigma^q$, $\sigma \in [0, \infty)$.

It is well known (see,e.g.,[24]) that

$$L_q(or\ l_q) \text{ is } \begin{cases} q-\text{uniformlysmooth}, & \text{if } 1 < q \leq 2, \\ 2-\text{uniformlysmooth}, & \text{if } q \geq 2. \end{cases}$$

Note that if X is uniformly smooth, J_q becomes single-valued. In the study of characteristic inequalities in q-uniformly smooth Banach spaces, Xu [23] established the following lemma.

Lemma 2.4[23]. Let $q > 1$ be a real number and let X be a smooth Banach space. Then the following statements are equivalent:

(i) X is q-uniformly smooth.

(ii) There is a constant $c_q > 0$ such that for every $x, y \in X$, the following inequality holds

$$\|x + y\|^q \leq \|x\|^q + q\langle y, J_q(x)\rangle + c_q\|y\|^q.$$

Definition 2.5. Let X be a q-uniformly smooth Banach space. Let $H : X \to X$, $\eta : X \times X \to X$ be single-valued mappings and $M : X \times X \to 2^X$ be multi-valued mapping. Then

(i) H is said to be η-accretive, if

$$\Big\langle Hx - Hy, J_q\Big(\eta(x, y)\Big)\Big\rangle \geq 0, \quad \forall x, y \in X.$$

(ii) H is said to be strictly η-accretive, if H is η-accretive and equality holds if and only if $x = y$.

(iii) H is said to be k-strongly η-accretive if there exists a constant $k > 0$ such that

$$\Big\langle Hx - Hy, J_q(\eta(x, y))\Big\rangle \geq k\|x - y\|^q, \quad \forall x, y \in X.$$

(iv) η is said to be τ-Lipschitz continuous, if there exists a constant $\tau > 0$ such that

$$\|\eta(x, y)\| \leq \tau\|x - y\|, \quad \forall x, y \in X,$$

(v) M is said to be η-accretive in the first argument if

$$\Big\langle u - v, J_q(\eta(x, y))\Big\rangle \geq 0, \quad \forall x, y \in X, \quad \forall u \in M(x, t), v \in M(y, t), \text{ for each fixed } t \in X,$$

(vi) M is said to be strictly η-accretive, if M is η-accretive in the first argument and equality holds if and only if $x = y$.

Definition 2.6. Let X be a q-uniformly smooth Banach space. Let $T : X \to X$, $N, \eta : X \times X \to X$ be single-valued mappings and $S_1, S_2 : X \to X$ be nonlinear mappings. Then

(i) T is said to be μ-η-cocoercive if there exists a constant $\mu > 0$ such that

$$\Big\langle Tx - Ty, J_q(\eta(x, y))\Big\rangle \geq \mu\|Tx - Ty\|^q, \quad \forall x, y \in X.$$

(ii) N is said to be (r, δ)-mixed Lipschitz continuous if there exist constants $r > 0, \delta > 0$ such that

$$\|N(x, z) - N(y, t)\| \leq r\|x - y\| + \delta\|z - t\|, \quad \forall x, y, z, t \in X.$$

(iii) S_1, S_2 is said to be m_1, m_2-Lipschitz continous, respectively, if there exists a constant $m_1, m_2 > 0$ such that

$$\|S_1(x_1) - S_1(x_2)\| \leq m_1\|x_1 - x_2\|, \quad \forall x_1, x_2 \in X.$$

$$\|S_2(y_1) - S_2(y_2)\| \leq m_2\|y_1 - y_2\|, \quad \forall y_1, y_2 \in X.$$

We denote by $K(S_1, S_2)$ the set of fixed points of S_1, S_2 such that $K(S_1, S_2) = \{(x, y) \in X \times X : S_1(x) = x, S_2(y) = y.\}$

Throughout the rest of the paper unless otherwise stated, we assume X to be q-uniformly smooth Banach space.

Definition 2.7. Let $H : X \to X, \eta : X \times X \to X$ be single-valued mappings, $M : X \times X \to 2^X$ be a multi-valued mapping, then M is said to be H-η-accretive mapping if for each fixed $t \in X, M(., t)$ is η-accretive in the first argument and $(H + \lambda M(., t))X = X$, $\forall \lambda > 0$.

Lemma 2.8[12]. Let $\{\zeta^n\}, \{\nu^n\}$ and $\{c^n\}$ be nonnegative sequences satisfying

$$\zeta^{n+1} \leq (1 - \omega^n)\zeta^n + \omega^n\nu^n + c^n, \quad \forall n \geq 0,$$

where $\{\omega^n\}_{n=0}^{\infty} \subset [0, 1]$, $\sum_{n=0}^{\infty} \omega^n = +\infty$, $\lim_{n\to\infty} \nu^n = 0$ and $\sum_{n=0}^{\infty} c^n < \infty$. Then $\lim_{n\to\infty} \zeta^n = 0$.

Definition 2.9. The Hausdorff metric $\mathcal{D}(\cdot, \cdot)$ on $CB(X)$, is defined by

$$\mathcal{D}(B, P) = \max\left\{\sup_{u\in B} \inf_{v\in P} d(u, v), \ \sup_{v\in P} \inf_{u\in B} d(u, v)\right\}, \ B, P \in CB(X),$$

where $d(\cdot, \cdot)$ is the induced metric on X and $CB(X)$ denotes the family of all nonempty closed and bounded subsets of X.

Definition 2.10[3]. A set-valued mapping $P : X \to CB(X)$ is said to be γ-$\mathcal{D}$-Lipschitz continuous, if there exists a constant $\gamma > 0$ such that

$$\mathcal{D}(P(x), P(y)) \leq \gamma\|x - y\|, \quad \forall x, y \in X.$$

Theorem 2.11(Nadler [14]). Let $P : X \to CB(X)$ be a set-valued mapping on X and (X, d) be a complete metric space. Then:

(i) For any given $\mu > 0$ and for any given $x, y \in X$ and $u \in P(x)$, there exists $v \in P(y)$ such that

$$d(u, v) \ \leq \ (1 + \mu)\mathcal{D}(P(x), P(y)),$$

(ii) If $P : X \to C(X)$, then (i) holds for $\mu = 0$, (where $C(X)$ denotes the family of all nonempty compact subsets of X).

Theorem 2.12. Let $H : X \to X$, $\eta : X \times X \to X$ be single-valued mappings. Let $H : X \to X$ be k-strongly η-accretive, $M : X \times X \to 2^X$ be $H - \eta-$accretive mapping. If the following inequality : $\left\langle u - v, J_q(\eta(x, y))\right\rangle \geq 0$, holds $\forall (y, v) \in$ Graph $(M(., t))$, then $(x, u) \in$ Graph$(M(., t))$, where Graph $(M(., t)) := \{(x, u) \in X \times X : u \in M(x, t)\}$.

Proof. Suppose, on the contrary that there exists some $(x_0, u_0) \notin$ Graph $(M(.,t))$ such that

$$\Big\langle u_0 - v, J_q(\eta(x_0, y))\Big\rangle \geq 0, \quad \forall (y, v) \in \text{ Graph } (M(.,t)). \tag{2.1}$$

Since M is $H-\eta$-accretive operator,

$$\Longrightarrow (H + \lambda M(.,t))(X) = X \quad \forall \lambda > 0 \text{ and for each fixed } t \in X.$$

Therefore, there exists $(x_1, u_1) \in$ Graph $(M(.,t))$ such that

$$H(x_1) + \lambda u_1 = H(x_0) + \lambda u_0 \in X. \tag{2.2}$$

Combining (2.1) and (2.2), we have

$$\begin{aligned} 0 \leq \lambda \Big\langle u_0 - u_1, J_q(\eta(x_0, x_1))\Big\rangle & \\ = \quad -\Big\langle H(x_0) - H(x_1), J_q(\eta(x_0, x_1)\Big\rangle & \\ \leq \quad -k\|x_0 - x_1\|^q \leq 0. & \end{aligned}$$

Since $k > 0$, therefore $x_1 = x_0$, .
Hence, it follows from (2.2) that $u_1 = u_0$, a contradiction. This completes the proof.

Theorem 2.13. Let $H : X \to X$, $\eta : X \times X \to X$ be single-valued mappings. Let $H : X \to X$ be k-strongly η-accretive, $M : X \times X \to 2^X$ be $H - \eta-$accretive mappings. Then the mapping $(H + \lambda M(.,t))^{-1}$ is single-valued, $\forall\ \lambda > 0$.

Proof. For any $z \in X$, let $x, y \in (H + \lambda M(.,t))^{-1}(z)$. It follows that

$$\frac{1}{\lambda}(z - H(x)) \in M(x,t),$$

and

$$\frac{1}{\lambda}(z - H(y)) \in M(y,t).$$

Since $M(.,t)$ is η-accretive in the first argument and H is k-strongly η-accretive, we have

$$\begin{aligned} 0 \leq \Big\langle \frac{1}{\lambda}(z - H(x)) - \frac{1}{\lambda}(z - H(y)), J_q(\eta(x,y))\Big\rangle & \\ = \quad -\frac{1}{\lambda}\Big\langle H(x) - H(y), J_q(\eta(x,y))\Big\rangle & \\ \leq \quad -\frac{1}{\lambda}k\|x - y\|^q, & \end{aligned}$$

which implies that

$$\frac{1}{\lambda}k\|x - y\|^q \leq 0.$$

Since $k > 0$, therefore $x = y$ and so $(H + \lambda M(.,t))^{-1}$ is single-valued. This completes the proof.

Definition 2.14. Let $H : X \to X$, $\eta : X \times X \to X$ be single-valued mappings. Let $H : X \to X$ be k-strongly η-accretive, $M : X \times X \to 2^X$ be $H - \eta-$accretive mappings. Then for each fixed $t \in X$, the resolvent operator $R^{H,\eta}_{M(.,t),\lambda} : X \to X$ is defined by

$$R^{H,\eta}_{M(.,t),\lambda}(x) = (H + \lambda M(.,t))^{-1}(x), \quad \forall x \in X.$$

Now, we prove the following result which guarentees the Lipschitz continuity of the resolvent operator $R^{H,\eta}_{M(.,t),\lambda}$.

Theorem 2.15. Let $H : X \to X$ be k-strongly η-accretive and $\eta : X \times X \to X$ be τ-Lipschitz continuous. Let $M : X \times X \to 2^X$ be $H - \eta-$accretive mappings. Then for each fixed $t \in X$, the resolvent operator $R^{H,\eta}_{M(.,t),\lambda} : X \to X$ is Lipschitz continuous with constant L, that is,

$$\|R^{H,\eta}_{M(.,t),\lambda}(x) - R^{H,\eta}_{M(.,t),\lambda}(y)\| \leq L\|x - y\|, \quad \forall x, y \in X, \text{ where } L := \frac{\tau^{q-1}}{k}.$$

Proof. Let $x, y \in X$. Then from Definition 2.14, it follows that

$$R^{H,\eta}_{M(.,t),\lambda}(x) = (H + \lambda M(.,t))^{-1}(x),$$

and

$$R^{H,\eta}_{M(.,t),\lambda}(y) = (H + \lambda M(.,t))^{-1}(y),$$

and so

$$\frac{1}{\lambda}\left(x - H(R^{H,\eta}_{M(.,t),\lambda}(x)\right) \in M\left(R^{H,\eta}_{M(.,t),\lambda}(x), t\right),$$

and

$$\frac{1}{\lambda}\left(y - H(R^{H,\eta}_{M(.,t),\lambda}(y)\right) \in M\left(R^{H,\eta}_{M(.,t),\lambda}(y), t\right).$$

For the sake of brevity, let $A(x) = R^{H,\eta}_{M(.,t),\lambda}(x)$, $A(y) = R^{H,\eta}_{M(.,t),\lambda}(y)$.
Since $M(.,t)$ is η-accretive operator in the first argument, we have

$$0 \leq \left\langle \frac{1}{\lambda}(x - H(A(x))) - \frac{1}{\lambda}(y - H(A(y))), J_q\Big(\eta\Big(A(x), A(y)\Big)\Big)\right\rangle$$

or,

$$\left\langle x - y, J_q\Big(\eta\Big(A(x), A(y)\Big)\Big)\right\rangle \geq \left\langle H(A(x)) - H(A(y)), J_q\Big(\eta\Big(A(x), A(y)\Big)\Big)\right\rangle.$$

Since H is k-strongly η-accretive, we have

$$\|x - y\| \left\|\eta\Big(A(x), A(y)\Big)\right\|^{q-1}$$

$$
\begin{aligned}
&\geq \Big\langle x-y, J_q\Big(\eta\Big(A(x),A(y)\Big)\Big)\Big\rangle \\
&\geq \Big\langle H(A(x))-H(A(y)), J_q\Big(\eta\Big(A(x),A(y)\Big)\Big)\Big\rangle \\
&\geq k\,\|A(x)-A(y)\|^q,
\end{aligned}
$$

therefore,

$$\|x-y\|\ \tau^{q-1}\ \|A(x)-A(y)\|^{q-1} \geq k\,\|A(x)-A(y)\|^q.$$

This implies

$$\|A(x)-A(y)\| \leq \frac{\tau^{q-1}}{k}\|x-y\|,$$

or,

$$\|R^{H,\eta}_{M(.,t),\lambda}(x)-R^{H,\eta}_{M(.,t),\lambda}(y)\| \leq \frac{\tau^{q-1}}{k}\|x-y\|.$$

This completes the proof.

Definition 2.16. Let $H: X\to X, \eta: X\times X\to X$ be single-valued mappings, let $\{M^n\}, M^n: X\to 2^X$ be a sequence of $H-\eta-$accretive mappings. A sequence $\{M^n\}_{n\geq 0}$ is said to be graph convergent to M, denoted by $M^n \xrightarrow{G} M$, if for each $(x,u)\in graph(M)$, there is a sequence $\{(x^n,u^n)\}_{n\geq 0}\subseteq graph(M^n)$ such that $x^n\to x, u^n\to u$ as $n\to\infty$.

Lemma 2.17. Let $H: X\to X$ be k-strongly η-accretive and s-Lipschitz continuous, $\eta: X\times X\to X$ be τ-Lipschitz continuous and $\{M^n\}, M^n: X\times X\to 2^X$ be a sequence of $H-\eta-$accretive mappings for $n=0,1,2,....$ If $M^n(.,t^n)\xrightarrow{G} M(.,t)$ then $\lim\limits_{n\to\infty} R^{H,\eta}_{M^n(.,t^n),\lambda}(u) = R^{H,\eta}_{M(.,t),\lambda}(u),\ \ \forall u\in X$.

Proof. Since $(H+\lambda M(.,t))(X)=X,\ \ \forall z\in X$.

Hence there exists $(x,u)\in graph(M(.,t))$ such that $z=H(x)+\lambda u$.

Since $M^n(.,t^n)\longrightarrow M(.,t)$, therefore there exists $\{x^n,u^n\}\subset graph(M^n(.,t^n))$ such that $x^n\to x, u^n\to u$ as $n\to\infty$.

Let $z^n=H(x^n)+\lambda u^n$ and noting that

$$R^{H,\eta}_{M(.,t),\lambda}(H(x)+\lambda u)=x, \quad \text{and}\ \ R^{H,\eta}_{M^n(.,t^n),\lambda}(H(x^n)+\lambda u^n)=x^n.$$

Using Lipschitz continuity of $R^{H,\eta}_{M(.,t),\lambda}$, we have

$$
\begin{aligned}
&\Big\|R^{H,\eta}_{M^n(.,t^n),\lambda}(z)-R^{H,\eta}_{M(.,t),\lambda}(z)\Big\| \\
&\quad\leq \Big\|R^{H,\eta}_{M^n(.,t^n),\lambda}(z^n)-R^{H,\eta}_{M(.,t),\lambda}(z)\Big\| + \Big\|R^{H,\eta}_{M^n(.,t^n),\lambda}(z^n)-R^{H,\eta}_{M^n(.,t^n),\lambda}(z)\Big\| \\
&\quad\leq \|x^n-x\| + \frac{\tau^{q-1}}{k}\|z^n-z\| \\
&\quad= \|x^n-x\| + \frac{\tau^{q-1}}{k}\|(H(x^n)+\lambda u^n)-(H(x)+\lambda u)\|
\end{aligned}
$$

$$\leq \quad \|x^n - x\| + \frac{\tau^{q-1}}{k}\{\|H(x^n) - H(x)\| + \lambda\|u^n - u\|\}$$

$$\leq \quad \|x^n - x\| + \frac{\tau^{q-1}}{k}\{s\|x^n - x\| + \lambda\|u^n - u\|\}$$

$$\longrightarrow \quad 0 \text{ as } n \to \infty.$$

This completes the proof.

Now, we formulate our main problem.

For each $i = 1, 2, j \in \{1, 2\} \setminus i$, let X_i be a q_i-uniformly smooth Banach space with norm $\|.\|_i$. Let $T_i, f_i : X_i \to X_i, p_i, N_i : X_i \times X_j \to X_i$ be single-valued mappings, $M_i : X_i \times X_i \to 2^{X_i}$ be $(H_i - \eta_i)-$ accretive mappings. Let $B_i, P_i, G_i : X_i \to C(X_i)$ be set-valued mappings. We consider the following system of generalized mixed variational-like inclusion problems (SGMVLIP): Find $(\mathrm{x}, \mathrm{u}, \mathrm{v}, \mathrm{t})$ where $\mathrm{x} \in \mathrm{X}, \mathrm{u} \in \mathrm{B}(\mathrm{x}), \mathrm{v} \in \mathrm{P}(\mathrm{x}), \mathrm{t} \in \mathrm{G}(\mathrm{x})$ such that

$$\left.\begin{aligned} 0 \in T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) + \lambda_1\Big(N_1(u_1, v_2) + M_1(x_1, t_1)\Big), \\ 0 \in T_2\Big(f_2(x_2) + p_2(x_2, x_1)\Big) + \lambda_2\Big(N_2(u_2, v_1) + M_2(x_2, t_2)\Big). \end{aligned}\right\} \tag{2.3}$$

Special Cases:

I. If in problem (2.3), $T_1 = T_2 \equiv I$, (an identity mapping), then problem (2.3) reduces to the following problem: Find (x_i, u_i, v_i, t_i) such that

$$\left.\begin{aligned} 0 \in f_1(x_1) + p_1(x_1, x_2) + \lambda_1\Big(N_1(u_1, v_2) + M_1(x_1, t_1)\Big), \\ 0 \in f_2(x_2) + p_2(x_2, x_1) + \lambda_2\Big(N_2(u_2, v_1) + M_2(x_2, t_2)\Big), \end{aligned}\right\} \tag{2.4}$$

which is an important generalization of the problem considered and studied by Peng and Zhu [16].

II. If in problem (2.3) $X_i \equiv H_i$ (a real Hilbert space), $T_1 = T_2 \equiv 0$,(a zero mapping), $\lambda_1 = \lambda_2 = 1$, then problem (2.3) reduces to the following problem: Find (x_i, u_i, v_i, t_i) such that

$$\left.\begin{aligned} 0 \in N_1(u_1, v_2) + M_1(x_1, t_1), \\ 0 \in N_2(u_2, v_1) + M_2(x_2, t_2). \end{aligned}\right\} \tag{2.5}$$

This type of problem has been considered and studied by Zeng *et al.* [25].

We remark that for appropriate and suitable choices of the above defined mappings, SGMVLIP (2.3) includes a number of variational and variational-like inclusions as special cases, see for example [1,2,11,18-21] and the related references cited therein.

3. Iterative Algorithm

First, we give the following technical lemma:

Lemma 3.1. Let X_i be a real q_i-uniformly smooth Banach space. Let $T_i, f_i : X_i \to X_i, p_i, N_i : X_i \times X_j \to X_i$ be single-valued mappings, $M_i : X_i \times X_i \to 2^{X_i}$ be $(H_i - \eta_i)-$ accretive mappings. Then (x_i, u_i, v_i, t_i) is a solution of SGMVLIP (2.3) where $x_i \in X_i, u_i \in B_i(x_i), v_i \in P_i(x_i), t_i \in G_i(x_i)$ if and only if

$$\left.\begin{aligned} x_1 &= R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1,x_2)\Big) - \lambda_1 N_1(u_1,v_2)\Big], \\ x_2 &= R^{H_2,\eta_2}_{M_2(.,t_2),\lambda_2}\Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2,x_1)\Big) - \lambda_2 N_2(u_2,v_1)\Big]. \end{aligned}\right\} \tag{3.1}$$

where $R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1} = (H_1 + \lambda_1 M_1(.,t_1))^{-1}$, $R^{H_2,\eta_2}_{M_2(.,t_2),\lambda_2} = (H_2 + \lambda_2 M_2(.,t_2))^{-1}$ are the resolvent operators.

Proof. Let (x_i, u_i, v_i, t_i) is a solution of (2.3), then we have

$$\begin{aligned} & x_1 = R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1,x_2)\Big) - \lambda_1 N_1(u_1,v_2)\Big] \\ \iff\quad & x_1 = (H_1 + \lambda_1 M_1(.,t_1))^{-1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1,x_2)\Big) - \lambda_1 N_1(u_1,v_2)\Big] \\ \iff\quad & H_1(x_1) + \lambda_1 M_1(x_1,t_1) = H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1,x_2)\Big) - \lambda_1 N_1(u_1,v_2) \\ \iff\quad & 0 \in T_1\Big(f_1(x_1) + p_1(x_1,x_2)\Big) + \lambda_1\Big(N_1(u_1,v_2) + M_1(x_1,t_1)\Big). \end{aligned}$$

Proceeding likewise by using (3.1), we have

$$\begin{aligned} & x_2 = R^{H_2,\eta_2}_{M_2(.,t_2),\lambda_2}\Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2,x_1)\Big) - \lambda_2 N_2(u_2,v_1)\Big] \\ \iff & 0 \in T_2\Big(f_2(x_2) + p_2(x_2,x_1)\Big) + \lambda_2\Big(N_2(u_2,v_1) + M_2(x_2,t_2)\Big). \end{aligned}$$

Notation 3.2. For $A \in X_1 \times X_2$, the symbol $A \cap K(S_1,S_2) \neq \emptyset$ means that there exists $(x_1,x_2) \in X_1 \times X_2$ such that $(x_1,x_2) \in A$ and $\{x_1,x_2\} \subset K(S_1,S_2)$, where S_1, S_2 are Lipschitz continuous.

Now, we suggest the following Remark for finding a common element of two different sets namely, the set of solutions of the system of generalized mixed variational-like inclusion problems and the set of fixed points of Lipschitz mappings S_1, S_2.

Remark 3.3. If $(x_1,x_2) \in$ SGMVLIP (2.3) and $\{x_1,x_2\} \subset K(S_1,S_2)$, then it follows from Lemma 3.1 that

$$\begin{aligned} x_1 = S_1(x_1) &= S_1\Big\{R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1,x_2) - \lambda_1 N_1(u_1,v_2)\Big)\Big]\Big\}, \quad \lambda_1 > 0, \\ x_2 = S_2(x_2) &= S_2\Big\{R^{H_2,\eta_2}_{M_2(.,t_2),\lambda_2}\Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2,x_1)\Big) - \lambda_2 N_2(u_2,v_1)\Big]\Big\}, \quad \lambda_2 > 0. \end{aligned}$$

Lemma 3.1 and Remark 3.3 are very important from the numerical point of view as it along with Nadler [14] allows us to suggest the following iterative algorithm for finding the approximate solution of SGMVLIP (2.3).

Iterative Algorithm 3.4. For each $i = 1, 2$, given $(x_i^0, u_i^0, v_i^0, t_i^0)$ where $x_i^0 \in X_i, u_i^0 \in B_i(x_i^0), v_i^0 \in P_i(x_i^0)$ and $t_i^0 \in G_i(x_i^0)$ such that $B_i, P_i, G_i : X_i \to C(X_i)$, compute the sequences $\{x_i^n\}, \{u_i^n\}, \{v_i^n\}, \{t_i^n\}$ defined by the iterative schemes:

$$x_1^{n+1} = (1-\alpha^n)x_1^n + \alpha^n S_1\Big\{R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big) - \lambda_1 N_1(u_1^n, v_2^n)\Big]\Big\}$$

$$x_2^n = S_2\Big\{R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2^n) - T_2\Big(f_2(x_2^n) + p_2(x_2^n, x_1^n)\Big) - \lambda_2 N_2(u_2^n, v_1^n)\Big]\Big\}$$

$$u_i^n \in B_i(x_i^n) : ||u_i^{n+1} - u_i^n|| \leq \mathcal{D}(B_i(x_i^{n+1}), B_i(x_i^n))$$

$$v_i^n \in P_i(x_i^n) : ||v_i^{n+1} - v_i^n|| \leq \mathcal{D}(P_i(x_i^{n+1}), P_i(x_i^n))$$

$$t_i^n \in G_i(x_i^n) : ||t_i^{n+1} - t_i^n|| \leq \mathcal{D}(G_i(x_i^{n+1}), G_i(x_i^n))$$

where $M_i^n : X_i \times X_i \to 2^{X_i}$ are $(H_i - \eta_i)-$accretive mappings for $i \in \{1, 2\}, n = 0, 1, 2, ...,$ and

$$R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1} = (H_1 + \lambda_1 M_1^n(., t_1^n))^{-1}, \qquad R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2} = (H_2 + \lambda_2 M_2^n(., t_2^n))^{-1},$$

and α^n be a sequence of real numbers such that $\alpha^n \in [0, 1]$ and $\sum_{n=0}^{\infty} \alpha^n = +\infty$.

4. Existence of Solution and Convergence Analysis

Now, we prove the existence of common element of solutions of SGMVLIP (2.3) and the set of fixed points of Lipschitz mappings S_1 and S_2.

Theorem 4.1. Let X_i be a real q_i-uniformly smooth Banach space. Suppose for each $i = 1, 2, j \in \{1, 2\} \setminus i$, $H_i : X_i \to X_i$ be k_i-strongly-η_i-accretive, $\eta_i : X_i \times X_i \to X_i$ be τ_i-Lipschitz continuous, $H_i, S_i, T_i : X_i \to X_i$ be Lipschitz continuous with constants s_i, m_i, γ_i, respectively. Let $N_i : X_i \times X_j \to X_i$ be (r_i, δ_i)-mixed Lipschitz continuous, $p_i : X_i \times X_j \to X_i$ be ξ_i-Lipschitz continuous in the second argument. Suppose, $M_i^n : X_i \times X_i \to 2^{X_i}$ be $(H_i - \eta_i)-$accretive mappings such that $M_i^n(., x_i^n) \xrightarrow{G} M_i(., x_i)$ as $n \to \infty$. Further, suppose $H_i, T_i, f_i : X_i \to X_i, p_i : X_i \times X_j \to X_i$ be such that $\Big[H_i(.) - T_i\Big(f_i(.) + p_i(., x_j^n)\Big)\Big]$ be $\mu_i - \eta_i-$ cocoercive. Let $B_i, P_i, G_i : X_i \to C(X_i)$ be set-valued mappings such that B_i is $L_{B_i} - \mathcal{D}-$Lipschitz continuous, P_i is $L_{P_i} - \mathcal{D}-$Lipschitz continuous and G_i is $L_{G_i} - \mathcal{D}-$Lipschitz continuous. In addition, if

$$\left.\begin{aligned} &\Big\{1 - m_2 L_2\Big[\frac{\tau_2}{\mu_2^{q_2-1}} + \lambda_2 r_2 L_{B_2}\Big]\Big\} > 0, \\ &0 < m_1 L_1\Big[\frac{\tau_1}{\mu_1^{q_1-1}} + \lambda_1 r_1 L_{B_1}\Big] + m_1 L_1\Big[\gamma_1\xi_1 + \lambda_1\delta_1 L_{P_2}\Big] \\ &\qquad \times\left(\frac{m_2 L_2\Big[\gamma_2\xi_2 + \lambda_2\delta_2 L_{P_1}\Big]}{\Big\{1 - m_2 L_2\Big[\frac{\tau_2}{\mu_2^{q_2-1}} + \lambda_2 r_2 L_{B_2}\Big]\Big\}}\right) < 1, \end{aligned}\right\} \tag{4.1}$$

where $L_i := \dfrac{\tau_i^{q_i-1}}{k_i}$ Then the sequences $\{x_i^n\}, \{u_i^n\}, \{v_i^n\}, \{t_i^n\}$ generated by Iterative Algorithm 3.4 converges strongly to x_i, u_i, v_i, t_i a solution of SGMVLIP (2.3) where $x_i \in X_i, u_i \in B_i(x_i), v_i \in P_i(x_i), t_i \in G_i(x_i)$ such that $(x_1, x_2) \in$ SGMVLIP (2.3) and $\{x_1, x_2\} \subset K(S_1, S_2)$.

Proof. From Lemma 3.1, we have

$$x_1 = R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2)\Big].$$

Therefore, from Lemma 3.1, Iterative Algorithm 3.4 and fixed point property of S_1, it follows that

$$\begin{aligned}
&\|x_1^{n+1} - x_1\|_1 \\
&= \Big\|(1-\alpha^n)x_1^n + \alpha^n S_1\Big\{R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big) - \lambda_1 N_1(u_1^n, v_2^n)\Big]\Big\} \\
&\quad -(1-\alpha^n)x_1 - \alpha^n S_1\Big\{R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2)\Big]\Big\}\Big\|_1 \\
&\leq (1-\alpha^n)\|x_1^n - x_1\|_1 \\
&\quad +\alpha^n m_1\Big\|R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big) - \lambda_1 N_1(u_1^n, v_2^n)\Big] \\
&\quad -R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2)\Big]\Big\|_1 \\
&\leq (1-\alpha^n)\|x_1^n - x_1\|_1 \\
&\quad +\alpha^n m_1\Big\|R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big) - \lambda_1 N_1(u_1^n, v_2^n)\Big] \\
&\quad -R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2)\Big]\Big\|_1 \\
&\quad +\alpha^n m_1\Big\|R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2)\Big] \\
&\quad -R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1}\Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2)\Big]\Big\|_1. \qquad (4.2)
\end{aligned}$$

Using Theorem 2.15, we have

$$\Big\|R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big) - \lambda_1 N_1(u_1^n, v_2^n)\Big]$$

$$
\begin{aligned}
&-R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1}\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2)\Big)-\lambda_1 N_1(u_1,v_2)\Big]\Big\|_1\\
\leq\ & L_1\Big\|\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)-\lambda_1 N_1(u_1^n,v_2^n)\Big]\\
&-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2)\Big)-\lambda_1 N_1(u_1,v_2)\Big]\Big\|_1\\
\leq\ & L_1\Big\|\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)\Big]\\
&-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big]\Big\|_1\\
&+L_1\Big\|\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big]\\
&-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2)\Big)\Big]\Big\|_1\\
&+L_1\lambda_1\Big\|N_1(u_1^n,v_2^n)-N_1(u_1,v_2)\Big\|_1. \qquad (4.3)
\end{aligned}
$$

Since $\Big[H_1(.)-T_1\Big(f_1(.)+p_1(.,x_2^n)\Big)\Big]$ is $\mu_1-\eta_1-$cocoercive, we have

$$
\begin{aligned}
&\Big\|\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)\Big]\\
&\quad-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big]\Big\|_1\ \Big\|\eta_1(x_1^n,x_1)\Big\|_1^{q_1-1}\\
\geq\ & \Big\langle\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)\Big]\\
&\quad-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big],J_{q_1}\Big(\eta_1(x_1^n,x_1)\Big)\Big\rangle_1\\
\geq\ & \mu_1\Big\|\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)\Big]\\
&\quad-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big]\Big\|_1^{q_1}.
\end{aligned}
$$

This implies

$$
\begin{aligned}
&\mu_1\Big\|\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)\Big]\\
&\quad-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big]\Big\|_1^{q_1}\\
\leq\ & \Big\|\Big[H_1(x_1^n)-T_1\Big(f_1(x_1^n)+p_1(x_1^n,x_2^n)\Big)\Big]\\
&\quad-\Big[H_1(x_1)-T_1\Big(f_1(x_1)+p_1(x_1,x_2^n)\Big)\Big]\Big\|_1\ \Big\|\eta_1(x_1^n,x_1)\Big\|_1^{q_1-1}
\end{aligned}
$$

$$\begin{aligned}
\implies & \Big\| \Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big)\Big] \\
& - \Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2^n)\Big)\Big] \Big\|_1^{q_1-1} \\
\leq & \quad \frac{\tau_1^{q_1-1}}{\mu_1} \|x_1^n - x_1\|_1^{q_1-1} \\
\implies & \Big\| \Big[H_1(x_1^n) - T_1\Big(f_1(x_1^n) + p_1(x_1^n, x_2^n)\Big)\Big] - \Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2^n)\Big)\Big] \Big\|_1 \\
& \leq \frac{\tau_1}{\mu_1^{q_1-1}} \|x_1^n - x_1\|_1. \qquad (4.4)
\end{aligned}$$

Also, since $T_1 : X_1 \to X_1$ is γ_1-Lipschitz continuous $p_1 : X_1 \times X_2 \to X_1$ is ξ_1-Lipschitz continuous in the second argument, we have

$$\begin{aligned}
& \Big\| \Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2^n)\Big)\Big] - \Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big)\Big] \Big\|_1 \\
\leq & \quad \Big\| T_1\Big(f_1(x_1) + p_1(x_1, x_2^n)\Big) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) \Big\|_1 \\
\leq & \quad \gamma_1 \Big\| p_1(x_1, x_2^n) - p_1(x_1, x_2) \Big\|_1 \\
& \leq \gamma_1 \xi_1 \|x_2^n - x_2\|_2. \qquad (4.5)
\end{aligned}$$

Again using (r_1, δ_1)-mixed Lipschitz continuity of $N_1 : X_1 \times X_2 \to X_1$, L_{B_1} and $L_{P_2} - \mathcal{D}$-Lipschitz continuity of B_1 and P_2 respectively, we have

$$\begin{aligned}
\Big\| N_1(u_1^n, v_2^n) - N_1(u_1, v_2) \Big\|_1 & \leq r_1 \|u_1^n - u_1\|_1 + \delta_1 \|v_2^n - v_2\|_2 \\
& \leq r_1 L_{B_1} \|x_1^n - x_1\|_1 + \delta_1 L_{P_2} \|x_2^n - x_2\|_2. \qquad (4.6)
\end{aligned}$$

Using (4.3)-(4.6) in (4.2), we have

$$\begin{aligned}
& \|x_1^{n+1} - x_1\|_1 \\
& \quad \leq \quad (1 - \alpha^n) \|x_1^n - x_1\|_1 + \alpha^n m_1 L_1 \Big[\frac{\tau_1}{\mu_1^{q_1-1}} + \lambda_1 r_1 L_{B_1} \Big] \|x_1^n - x_1\|_1 \\
& \qquad + \alpha^n m_1 L_1 \Big[\gamma_1 \xi_1 + \lambda_1 \delta_1 L_{P_2} \Big] \|x_2^n - x_2\|_2 + \alpha^n m_1 b_1^n,
\end{aligned}$$

where

$$\begin{aligned}
b_1^n = \Big\| & R^{H_1,\eta_1}_{M_1^n(.,t_1^n),\lambda_1} \Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2) \Big] \\
& - R^{H_1,\eta_1}_{M_1(.,t_1),\lambda_1} \Big[H_1(x_1) - T_1\Big(f_1(x_1) + p_1(x_1, x_2)\Big) - \lambda_1 N_1(u_1, v_2) \Big] \Big\|_1,
\end{aligned}$$

and $b_1^n \to 0$ as $n \to \infty$. Therefore, we have

$$\begin{aligned}
& \|x_1^{n+1} - x_1\|_1 \\
& \quad \leq \quad (1 - \alpha^n) \|x_1^n - x_1\|_1 + \alpha^n m_1 L_1 \Big[\frac{\tau_1}{\mu_1^{q_1-1}} + \lambda_1 r_1 L_{B_1} \Big] \|x_1^n - x_1\|_1
\end{aligned}$$

$$+\alpha^n m_1 L_1\Big[\gamma_1\xi_1+\lambda_1\delta_1 L_{P_2}\Big]\|x_2^n-x_2\|_2. \tag{4.7}$$

Again, using Lemma 3.1, Iterative Algorithm 3.4 and fixed point property of S_2, we have

$$\begin{aligned}
&\|x_2^n-x_2\|_2\\
&= \Big\|S_2\Big\{R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2^n)-T_2\Big(f_2(x_2^n)+p_2(x_2^n,x_1^n)\Big)-\lambda_2 N_2(u_2^n,v_1^n)\Big]\Big\}\\
&\quad -S_2\Big\{R^{H_2,\eta_2}_{M_2(.,t_2),\lambda_2}\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)-\lambda_2 N_2(u_2,v_1)\Big]\Big\}\Big\|_2\\
&\leq m_2\Big\|R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2^n)-T_2\Big(f_2(x_2^n)+p_2(x_2^n,x_1^n)\Big)-\lambda_2 N_2(u_2^n,v_1^n)\Big]\\
&\quad -R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)-\lambda_2 N_2(u_2,v_1)\Big]\Big\|_2\\
&\quad +m_2\Big\|R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)-\lambda_2 N_2(u_2,v_1)\Big]\\
&\quad -R^{H_2,\eta_2}_{M_2(.,t_2),\lambda_2}\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)-\lambda_2 N_2(u_2,v_1)\Big]\Big\|_2.
\end{aligned}\tag{4.8}$$

Now, using Theorem 2.15, we have

$$\begin{aligned}
&\Big\|R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2^n)-T_2\Big(f_2(x_2^n)+p_2(x_2^n,x_1^n)\Big)-\lambda_2 N_2(u_2^n,v_1^n)\Big]\\
&\quad -R^{H_2,\eta_2}_{M_2^n(.,t_2^n),\lambda_2}\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)-\lambda_2 N_2(u_2,v_1)\Big]\Big\|_2\\
&\leq L_2\Big\|\Big[H_2(x_2^n)-T_2\Big(f_2(x_2^n)+p_2(x_2^n,x_1^n)\Big)-\lambda_2 N_2(u_2^n,v_1^n)\Big]\\
&\quad -\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)-\lambda_2 N_2(u_2,v_1)\Big]\Big\|_2\\
&\leq L_2\Big\|\Big[H_2(x_2^n)-T_2\Big(f_2(x_2^n)+p_2(x_2^n,x_1^n)\Big)\Big]\\
&\quad -\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1^n)\Big)\Big]\Big\|_2\\
&\quad +L_2\Big\|\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1^n)\Big)\Big]\\
&\quad -\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1)\Big)\Big]\Big\|_2\\
&\quad +L_2\lambda_2\Big\|N_2(u_2^n,v_1^n)-N_2(u_2,v_1)\Big\|_2.
\end{aligned}\tag{4.9}$$

Since $\Big[H_2(.)-T_2\Big(f_2(.)+p_2(.,x_1^n)\Big)\Big]$ is $\mu_2-\eta_2-$cocoercive, therefore following the same steps as in (4.4), we have

$$\begin{aligned}
&\Big\|\Big[H_2(x_2^n)-T_2\Big(f_2(x_2^n)+p_2(x_2^n,x_1^n)\Big)\Big]-\Big[H_2(x_2)-T_2\Big(f_2(x_2)+p_2(x_2,x_1^n)\Big)\Big]\Big\|_2\\
&\quad\leq \frac{\tau_2}{\mu_2^{q_2-1}}\|x_2^n-x_2\|_2.
\end{aligned}\tag{4.10}$$

Again, as $T_2 : X_2 \to X_2$ is γ_2-Lipschitz continuous, $p_2 : X_2 \times X_1 \to X_2$ is ξ_2-Lipschitz continuous in the second argument, therefore proceeding as in (4.5), we have

$$\Big\| \Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2, x_1^n) \Big) \Big] - \Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2, x_1) \Big) \Big] \Big\|_2 \\ \leq \gamma_2 \xi_2 \|x_1^n - x_1\|_1. \tag{4.11}$$

Now, using (r_2, δ_2)-mixed Lipschitz continuity of $N_2 : X_2 \times X_1 \to X_2$, L_{B_2} and $L_{P_1} - \mathcal{D}$-Lipschitz continuity of B_2 and P_1 respectively, we have

$$\Big\| N_2(u_2^n, v_1^n) - N_2(u_2, v_1) \Big\|_2 \leq r_2 L_{B_2} \|x_2^n - x_2\|_2 + \delta_2 L_{P_1} \|x_1^n - x_1\|_1. \tag{4.12}$$

Using (4.9)-(4.12) in (4.8), we have

$$\|x_2^n - x_2\|_2 \leq m_2 L_2 \Big[\frac{\tau_2}{\mu_2^{q_2 - 1}} + \lambda_2 r_2 L_{B_2} \Big] \|x_2^n - x_2\|_2 \\ + m_2 L_2 \Big[\gamma_2 \xi_2 + \lambda_2 \delta_2 L_{P_1} \Big] \|x_1^n - x_1\|_1 + m_2 b_2^n.$$

This implies

$$\Big\{ 1 - m_2 L_2 \Big[\frac{\tau_2}{\mu_2^{q_2 - 1}} + \lambda_2 r_2 L_{B_2} \Big] \Big\} \|x_2^n - x_2\|_2 \leq m_2 L_2 \Big[\gamma_2 \xi_2 + \lambda_2 \delta_2 L_{P_1} \Big] \|x_1^n - x_1\|_1 + m_2 b_2^n.$$

or,

$$\|x_2^n - x_2\|_2 \leq \left(\frac{m_2 L_2 \Big[\gamma_2 \xi_2 + \lambda_2 \delta_2 L_{P_1} \Big]}{\Big\{ 1 - m_2 L_2 \Big[\frac{\tau_2}{\mu_2^{q_2 - 1}} + \lambda_2 r_2 L_{B_2} \Big] \Big\}} \right) \|x_1^n - x_1\|_1 \\ + \left(\frac{m_2}{\Big\{ 1 - m_2 L_2 \Big[\frac{\tau_2}{\mu_2^{q_2 - 1}} + \lambda_2 r_2 L_{B_2} \Big] \Big\}} \right) b_2^n. \tag{4.13}$$

where,

$$b_2^n = \Big\| R^{H_2, \eta_2}_{M_2^n(.,t_2^n), \lambda_2} \Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2, x_1) \Big) - \lambda_2 N_2(u_2, v_1) \Big] \\ - R^{H_2, \eta_2}_{M_2(.,t_2), \lambda_2} \Big[H_2(x_2) - T_2\Big(f_2(x_2) + p_2(x_2, x_2) \Big) - \lambda_2 N_2(u_2, v_1) \Big] \Big\|_2,$$

and $b_2^n \to 0$ as $n \to \infty$.

Using (4.13) in (4.7), we have

$$\|x_1^{n+1} - x_1\|_1 \leq (1 - \alpha^n) \|x_1^n - x_1\|_1 + \alpha^n m_1 L_1 \Big[\frac{\tau_1}{\mu_1^{q_1 - 1}} + \lambda_1 r_1 L_{B_1} \Big] \|x_1^n - x_1\|_1 \\ + \alpha^n m_1 L_1 \Big[\gamma_1 \xi_1 + \lambda_1 \delta_1 L_{P_2} \Big] \left(\frac{m_2 L_2 \Big[\gamma_2 \xi_2 + \lambda_2 \delta_2 L_{P_1} \Big]}{\Big\{ 1 - m_2 L_2 \Big[\frac{\tau_2}{\mu_2^{q_2 - 1}} + \lambda_2 r_2 L_{B_2} \Big] \Big\}} \right) \|x_1^n - x_1\|_1 \\ + \alpha^n m_1 L_1 \Big[\gamma_1 \xi_1 + \lambda_1 \delta_1 L_{P_2} \Big] \left(\frac{m_2}{\Big\{ 1 - m_2 L_2 \Big[\frac{\tau_2}{\mu_2^{q_2 - 1}} + \lambda_2 r_2 L_{B_2} \Big] \Big\}} \right) b_2^n.$$

$$
\begin{aligned}
\leq \quad & \Bigg[1-\alpha^n\Bigg\{1-m_1L_1\Big[\frac{\tau_1}{\mu_1^{q_1-1}}+\lambda_1r_1L_{B_1}\Big] \\
& -m_1L_1\Big[\gamma_1\xi_1+\lambda_1\delta_1L_{P_2}\Big]\left(\frac{m_2L_2\Big[\gamma_2\xi_2+\lambda_2\delta_2L_{P_1}\Big]}{\Big\{1-m_2L_2\Big[\frac{\tau_2}{\mu_2^{q_2-1}}+\lambda_2r_2L_{B_2}\Big]\Big\}}\right)\Bigg\}\Bigg] \ \|x_1^n-x_1\|_1 \\
& +\alpha^nm_1L_1\Big[\gamma_1\xi_1+\lambda_1\delta_1L_{P_2}\Big]\left(\frac{m_2}{\Big\{1-m_2L_2\Big[\frac{\tau_2}{\mu_2^{q_2-1}}+\lambda_2r_2L_{B_2}\Big]\Big\}}\right)b_2^n \\
& \leq [1-\alpha^n(1-h)]\|x_1^n-x_1\|_1+\alpha^nl^n, \qquad (4.14)
\end{aligned}
$$

where

$$
h=m_1L_1\Big[\frac{\tau_1}{\mu_1^{q_1-1}}+\lambda_1r_1L_{B_1}\Big]+m_1L_1\Big[\gamma_1\xi_1+\lambda_1\delta_1L_{P_2}\Big]\left(\frac{m_2L_2\Big[\gamma_2\xi_2+\lambda_2\delta_2L_{P_1}\Big]}{\Big\{1-m_2L_2\Big[\frac{\tau_2}{\mu_2^{q_2-1}}+\lambda_2r_2L_{B_2}\Big]\Big\}}\right),
$$

$$
l^n=L_1\left(\frac{m_1m_2\Big[\gamma_1\xi_1+\lambda_1\delta_1L_{P_2}\Big]}{\Big\{1-m_2L_2\Big[\frac{\tau_2}{\mu_2^{q_2-1}}+\lambda_2r_2L_{B_2}\Big]\Big\}}\right)b_2^n.
$$

Since $h<1$ from assumption (4.1), therefore we can rewrite inequality (4.14) as

$$
\|x_1^{n+1}-x_1^n\|_1\leq[1-\alpha^n(1-h)]\|x_1^n-x_1\|_1+\alpha^n(1-h)\frac{l^n}{(1-h)}. \qquad (4.15)
$$

If $\zeta^n=||x_1^n-x_1||_1,\ \nu^n=\dfrac{l^n}{(1-h)}$ and $\omega^n=\alpha^n(1-h)$, then we have

$$
\zeta^{n+1}\leq(1-\omega^n)\zeta^n+\omega^n\nu^n.
$$

Using Lemma 2.8, we have $\zeta^n\to0$ as $n\to\infty$ and thus $x_1^n\to x_1$ as $n\to\infty$, and therefore from (4.13) it follows that $x_2^n\to x_2$ as $n\to\infty$. Since B_i is $L_{B_i}-\mathcal{D}$-Lipschitz continuous, it follows from Iterative Algorithm 3.4 that

$$
\begin{aligned}
||u_i^n-u_i||_i &\leq \mathcal{D}(B_i(x_i^n),B_i(x_i)) \\
&\leq L_{B_i}||x_i^n-x_i||_i.
\end{aligned}
$$

This implies that

$$
u_i^n\to u_i \text{ as } n\to\infty.
$$

Further we claim that $u_i\in B_i(x_i)$

$$
d(u_i,B_i(x_i))\leq||u_i-u_i^n||_i+d(u_i^n,B_i(x_i))
$$

$$\leq \quad ||u_i - u_i^n||_i + \mathcal{D}(B_i(x_i^n), B_i(x_i))$$

$$\leq \quad ||u_i - u_i^n||_i + L_{B_i}||x_i^n - x_i||_i$$

$$\to \quad 0 \text{ as } n \to \infty.$$

Since $B_i(x_i)$ is compact, we have $u_i \in B_i(x_i)$.

Similarly, we can prove that $v_i \in P_i(x_i)$ and $t_i \in G_i(x_i)$.

Thus the approximate solution $(x_i^n, u_i^n, v_i^n, t_i^n)$ generated by Iterative Algorithm 3.4 converges strongly to (x_i, u_i, v_i, t_i) a solution of SGMVLIP (2.3) where $x_i \in X_i, u_i \in B_i(x_i), v_i \in P_i(x_i), t_i \in G_i(x_i)$ such that $(x_1, x_2) \in$ SGMVLIP (2.3) and $\{x_1, x_2\} \subset K(S_1, S_2)$. This completes the proof.

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Analysis on Rotational impacts of parabolic flow past an accelerated isothermal vertical plate with variable temperature and uniform mass diffusion.

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ABSTRACT

A Particular appraisal of Rotation effect of insecure figurative stream past of invulnerable and electrically driving fluid past a uniform revived unbounded isothermal perpendicular plate has been considered. The non-Dimension regulating Equation has been comprehended using Laplace Transform procedure and finally inverse performed. The Temperature profile, Concentration and briskness profile have been investigated for Distinct Physical Framework like warm Grashof number, mass Grashof , Schmidt number, Prandtl number, Rotational boundary and time. The examination have been thought of with faltering temperature and uniform mass dissemination and in the absence of MHD. At long last it is seen that the speed increases with the creating assessments of warm Grashof or mass Grashof number.

Keywords: parabolic flow past, isothermal, heat transfer, rotation ,mass transfer.

1.INTRODUCTION

Convective warmth move is worried about the exchange of warm vitality by the development of liquid as a results, for example, move is subject to the idea of the flow. It happens in the limit layer that is to or from over the surface as limit layer and inside conduits where the streams might be limit layers or completely developed. It must be stressed at the surface vitality streams simply by conduction even in conduction it is because of the way that is consistently a slender stale liquid layer on the outside of the warmth move. Yet, further continuing both conduction and dissemination mass development in an atomic level. As watched heat move through a liquid by convection within the sight of mass development and comparing to the instance of tranquil liquid.

Das U.N, Deka R and Soundalgekar VM contemplated Transient free Convective stream past an unbounded vertical plate with intermittent temperature variation.[1] further Soundalgekar V M, Akolkas S Gave brief thought on Effects of free convection flows and mass exchange on the stream past a perpendicular swaying plate [2]. Rajesh kumar B, Raghuraman D R Muthucumaraswamy R. introduced the Hydromagnetic stream and warmth move on a constant moving perpendicular plate surface [3]. Raptis A, G J Tzivanidis and C. P Perdikis clarified Hydromagnetic free convection stream past a quickened perpendicular plate with variable attractions and warmth transition [4]. R. Muthucumaraswamy. Tina lal Ranganayakulu Started demonstrating hypothetical answer for Effect of revolution on MHD stream past a quickened isothermal perpendicular plate with warmth and mass dispersion [5]. M.A. Hossain and H.S. Takhar introduced concentrate on Radiation consequences for blended convection along a perpendicular plate in with uniform surface temperature [6]. R. Muthucumaraswamy, et.al saw Radiative stream past an illustrative began isothermal Vertical plate with uniform mass motion. [7]. R.B. Hetnarski, gives nitty gritty portrayal for producing some converse Laplace change A calculation for creating some opposite Laplace Transform of Exponential Form [8]. Houghton E.L., and Boswell R.P. talk about some streamlined features for Engineering Students [9]. Suneetha, S., Bhasker Reddy, N. furthermore, Ramchandra Prasad, V manages the Radiation and mass exchange impacts on MHD free convection stream past a rashly begun isothermal perpendicular plate with dispersal [10]. In that capacity, it is proposed to dismembered the Rotational impacts of explanatory stream past of an invulnerable gooey and electrically arranging fluid past a constantly restored unbound isothermal plate in the region warmth and mass trade the closeness of magneto hydrodynamic

with the cut off condition faltering temperature and uniform mass spread without MHD is played out The Non-dimensional controlling condition are illuminated using Laplace change strategy and results in the form exponential and complementary errors.

2.MATHEMATICAL FORMULATION

Consider the unstable movement of an incompressible fluid past a reliably stimulated development of an isothermal perpendicular unbounded plate when the fluid and the plate rotate as a rigid body with a uniform exact speed Ω′ about z′-centre. It is observed that absence of MHD is performed. From the outset, the temperature and concentrate near the plate are believed to be $\boldsymbol{T'_\infty}$ and $\boldsymbol{C'_\infty}$ At time $\mathbf{t' > 0}$, the plate starts moving with a speed **u =(u_0 t^')^2** in its own plane and the temperature from the plate is raised to Tw and the centre level near the plate is made to raise legitimately with time. It is seen that the plate having the plane $\mathbf{z' = 0}$ is of perpetual degree, all the physical sums depend just upon $\mathbf{z'}$ and $\mathbf{t'}$**.** By then the feeble stream is spoken to by the standard Boussinesq's gauge in dimensionless structure as follows:

$$\frac{\partial U}{\partial t} - 2\Omega V = Gr\theta + GcC + \frac{\partial^2 U}{\partial Z^2} \quad \textbf{(1)}$$

$$\frac{\partial V}{\partial t} + 2\Omega U = \frac{\partial^2 V}{\partial Z^2} \quad \textbf{(2)}$$

$$\frac{\partial \theta}{\partial t} = \frac{1}{pr}\frac{\partial^2 \theta}{\partial Z^2} \quad \textbf{(3)}$$

$$\frac{\partial C}{\partial t} = \frac{1}{sc}\frac{\partial^2 C}{\partial Z^2} \quad \textbf{(4)}$$

With the accompanying starting and limit condition

$$u = 0, \quad T' = T'_\infty, \quad C' = C'_\infty \ for\ all\ y, t' \le 0$$
$$t' > 0 \ u = (u_0 t')^2, \quad T' = T'_w, \quad C' = C'_w \ at\ y = 0 \quad \textbf{(5)}$$
$$u \to 0, \quad T' \to T'_\infty, \quad C' \to C'_\infty \ at\ y \to \infty$$

On suggesting the subsequent dimensionless quantities:

$$U = \frac{u}{(Vu_0)^{\frac{1}{3}}} \quad V = \frac{v}{(Vu_0)^{\frac{1}{3}}} \quad t = t' \left(\frac{u_0^2}{v}\right)^{\frac{1}{3}} \quad Z = z\left(\frac{u_0}{v^2}\right)^{\frac{1}{3}}$$

$$\theta = \frac{T - T_\infty}{T_w - T_\infty} \quad Gr = \frac{g\beta(T_w - T_\infty)}{u_0} \quad C = \frac{C' - C'_\infty}{C'_w - C'_\infty} \quad \textbf{(6)}$$
$$Gc = \frac{g\beta^*(C'_w - C'_\infty)}{u_0}, \quad pr = \frac{\mu C_p}{k},$$
$$sc = \frac{v}{D}$$

The rotational impacts of allegorical stream past without magnetohydrodynamic have been considered and is illuminated by the endorsed differential condition from (1) to (4)with the cut off condition created in (5).further condition are difficult to deal with, recommending complex amount q=u+iv. on presenting complex amount these differential condition is illuminated and delivered single condition (7). further applying Laplace change system condition (7) is comprehended with recommended limit condition lastly backwards Laplace is determined for all profiles.

$$\frac{\partial q}{\partial t} = \mathrm{Gr}\theta + \mathrm{Gc}C + \frac{\partial^2 q}{\partial \mathrm{Z}^2} - mq \quad \textbf{(7)}$$

With the accompanying starting and limit condition in dimensionless quantities are follows

$$q = 0, \quad \theta = 0, \quad C = 0 \quad for\ all\ Z, t \le 0$$

$$t > 0 \quad q = t^2, \quad \theta = t, \quad C = 1 \quad at \ \ Z = 0 \qquad (8)$$

$$q \to 0, \quad \theta \to 0, \quad C \to 0 \quad Z \to \infty$$

where **m=2iΩ**

3.SOLUTION PROCEDURE

The condition q manages the quickness profiles for the issue. The literature study discusses the rotational impacts in explanatory stream past with MHD is like the situation arrived, the general thought is to decide the theoretical answer for different mix and quickness profiles and temperature and concentration profiles are obtained.

$$q = \left[\frac{(\eta^2+(2i\Omega)t)t}{4(2i\Omega)}\left[e^{2\eta}\sqrt{(2i\Omega)t}\ erfc\left(\eta+\sqrt{(2i\Omega)t}\right)+e^{-2\eta}\sqrt{(2i\Omega)t}\ erfc\left(\eta-\sqrt{(2i\Omega)t}\right)\right]+\right.$$

$$\frac{\eta\sqrt{t}(1-4(2i\Omega)t)}{8(2i\Omega)^{\frac{3}{2}}}\left[e^{-2\eta}\sqrt{(2i\Omega)t}\ erfc\left(\eta-\sqrt{(2i\Omega)t}\right)-e^{2\eta}\sqrt{(2i\Omega)t}\ erfc\left(\eta+\sqrt{(2i\Omega)t}\right)\right]-$$

$$\left.\frac{\eta t}{2(2i\Omega)\sqrt{\pi}}e^{-(\eta^2+(2i\Omega)t)}\right]+\left[\frac{Gr}{a(1-pr)}+\frac{Gc}{b(1-sc)}\right]\frac{1}{2}\left[\begin{matrix}e^{2\eta}\sqrt{(2i\Omega)t}\ erfc\left(\eta+\sqrt{(2i\Omega)t}\right)\\+e^{-2\eta}\sqrt{(2i\Omega)t}\ erfc\left(\eta-\sqrt{(2i\Omega)t}\right)\end{matrix}\right]+\frac{Gr}{a(1-pr)}\left[\left(\frac{t}{2}-\right.\right.$$

$$\left.\frac{\eta\sqrt{t}}{2(2i\Omega)}\right)\left(e^{2\eta\sqrt{(2i\Omega)t}}erfc\left(\eta-\sqrt{(2i\Omega)t}\right)\right)+\left(\frac{t}{2}+\frac{\eta\sqrt{t}}{2\sqrt{(2i\Omega)}}\right)\left(e^{2\eta\sqrt{(2i\Omega)t}}erfc\left(\eta+\sqrt{(2i\Omega)t}\right)\right)\Big]-$$

$$\left[\left[\frac{Gr}{(1-pr)}\right]\left[\frac{e^{at}}{2}\left[e^{2\eta}\sqrt{((2i\Omega)+a)t}\ erfc\left(\eta+\sqrt{((2i\Omega)+a)t}\right)\right]+\left[e^{-2\eta}\sqrt{((2i\Omega)+a)t}\ erfc\left(\eta-\right.\right.\right.\right.$$

$$\left.\left.\left.\left.\sqrt{((2i\Omega)a)t}\right)\right]\right]-\left[\frac{Gc}{a(1-sc)}\right]\left[\frac{e^{bt}}{2}\left[e^{2\eta}\sqrt{((2i\Omega)+b)t}\ erfc\left(\eta+\sqrt{((2i\Omega)+b)t}\right)\right]+\right.\right.$$

$$\left.\left.\left[e^{-2\eta}\sqrt{((2i\Omega)+b)t}\ erfc\left(\eta-\sqrt{((2i\Omega)-b)t}\right)\right]\right]-\frac{G_r}{a^2(1-pr)}erfc\left(\eta\sqrt{pr}\right)-\frac{G_r}{a(1-pr)}t\left[(1+\right.$$

$$2\eta^2Pr)erfc\left(\eta\sqrt{Pr}\right)-\frac{2\eta\sqrt{Pr}}{\sqrt{\pi}}e^{-\eta^2Pr}\Big]+\frac{G_r}{a^2(1-pr)}\left[\frac{e^{at}}{2}\left(e^{2\eta\sqrt{Prat}}erfc\left(\eta\sqrt{Pr}+\sqrt{at}\right)\right.\right.+e^{-2\eta\sqrt{Prat}}erfc\left(\eta\sqrt{Pr}-\right.$$

$$\left.\left.\sqrt{at}\right)\right]-\frac{G_c}{a(1-Sc)}erfc\left(\eta\sqrt{Sc}\right)+\frac{G_c}{b^2(1-Sc)}\left[\frac{e^{bt}}{2}\left(e^{2\eta\sqrt{Scbt}}erfc\left(\eta\sqrt{Sc}+\sqrt{bt}\right)+e^{-2\eta\sqrt{Scbt}}erfc\left(\eta\sqrt{Sc}-\sqrt{bt}\right)\right.\right] \quad (9)$$

$$\theta = t\left\{(1+2\eta^2Pr)erfc\left(\eta\sqrt{Pr}\right)-\frac{2\eta\sqrt{Pr}}{\sqrt{\pi}}e^{-(\eta^2Pr)}\right\} \qquad (10)$$

$$C = erfc(\eta\sqrt{sc}) \qquad (11)$$

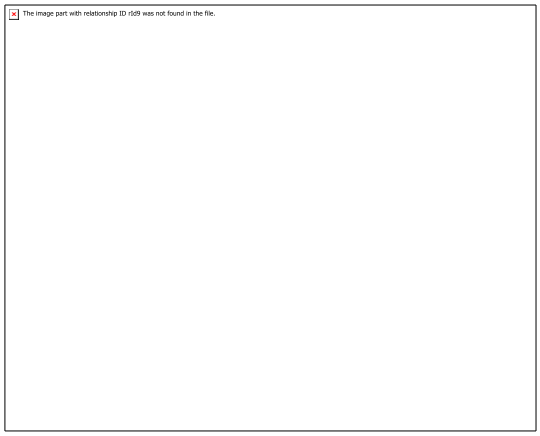
Where,$a = \frac{(2i\Omega)}{pr-1}\ and\ b = \frac{(2i\Omega)}{sc-1}\eta = \frac{Z}{2\sqrt{t}}$

$$erfc(a+ib) = \mathrm{erf}(a) + \frac{\exp(-a^2)}{2a\pi}[1-\cos(2ab)+isin(2ab)]$$
$$+\frac{2\exp(-a^2)}{\pi}\sum_{n=1}^{\infty}\frac{\exp(-\eta^2/4)}{\eta^2+4a^2}[f_n(a,b)+ig_n(a,b)]+\in(a,b)$$

while Assessing the announcement of q, it portrays that the conflict of the mistake work is astounding and consequently the verbalization is isolated into genuine and complex parts by using the condition procedure above.

4.RESULTS AND INTERPRETATION

For physical view of the issue, mathematical figuring is passed on for Distinct Criterion selected for warm Grashof, mass Grashof, Schmidt, Prandtl number and time. The temperature profile has been resolved from condition (10), the commitment of Prandtl number are picked for air is 0.71 and for water 7.0 and time 0.2 are depicted in figure 1. It is seen that the temperature increment with decline in Prandtl no. For calculation the assessment of Schmidt is relegated to be 2.01.



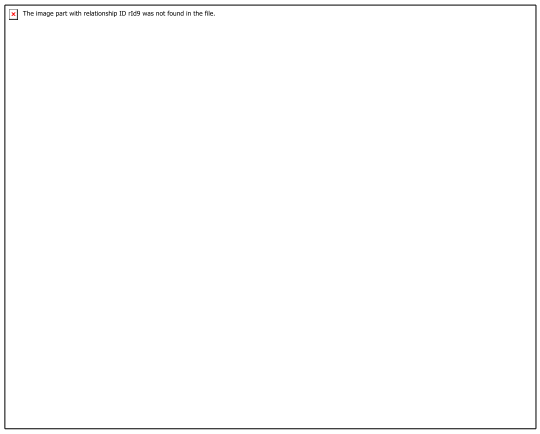
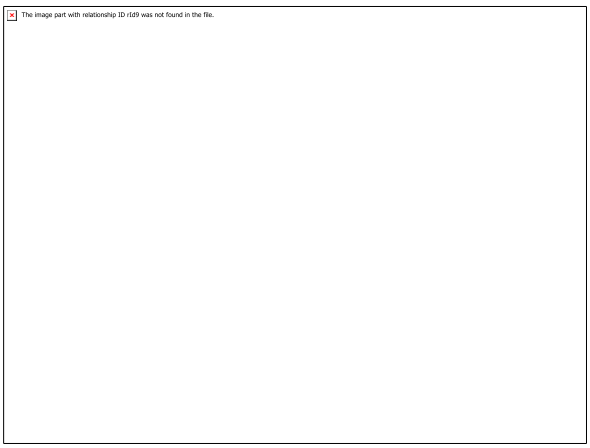


Fig 1. Temperature Profile for Various Value of **Pr** **Fig 2.** Concentration Profile for Various Value **Sc**

Figure 2 deals with the concentration profile for different input values corresponding to the Schmidt value is assigned to be 0.16,0.3, 0.6. The profile shows quickness decline with increase in Schmidt range.



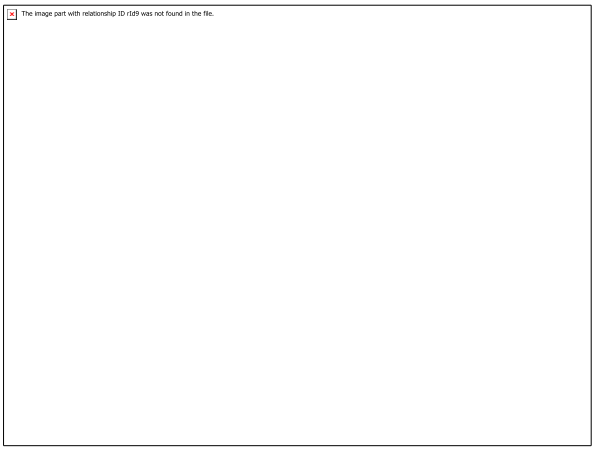
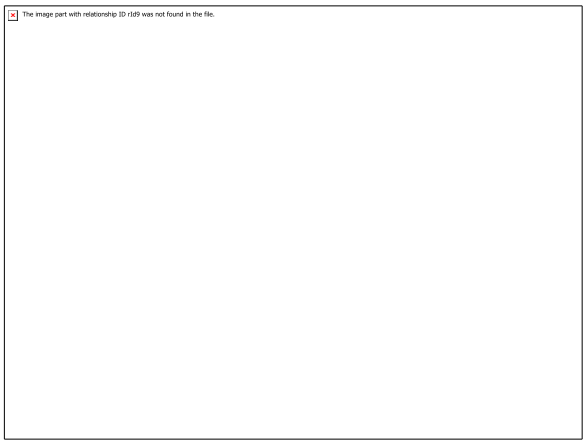


Fig 3. Primary Velocity Profile for Various **Gr** &Gc **Fig 4.** Primary Velocity Profile for Various **Ω**

Figure 3 portrays the impacts of primary velocity profile for distinct thermal Grashof is allotted 2,2,5 and mass Grashof is taken to be 2,5,5. further the rotational parameter is 0.5 with Pr is 7 and finally time t=0.4. It shows that quickness slowly growing up with growing estimation of Gr and Gc. Figure 4 illustrates the impact of primary velocity profile for rotational parameter. The value for **Ω** is taken to be 0.5,1,1.5 and thermal Grashof and Grashof is taken as 5 with t=0.4. It depicts quickness increment with lowering the estimation of Rotational Parameter.



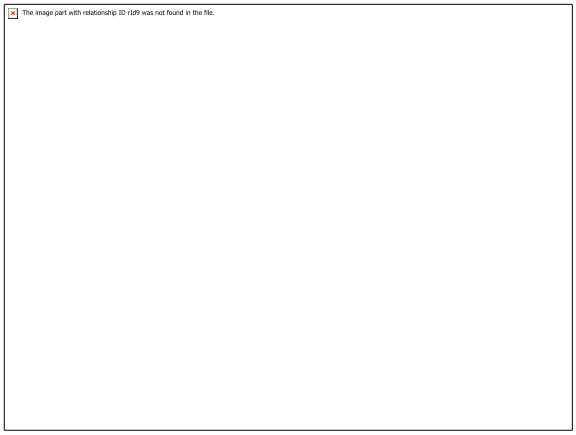


Fig 5. Secondary Velocity Profile for Various **Gr** &Gc **Fig 6.** Secondary Velocity Profile for Various **Ω**

The associate optional speed for different assessment of warm Grashof is considered as 4,4,5 and mass Grashof is taken as 4,5,5, Rotational worth clutched 0.5, Prandtl number is isolated 7 and time 0.2 are presented in figure 5. The example shows that the speed increase with expanding assessments of Grashof or mass Grashof number. The Secondary speed profile for different rotational boundary is appropriated as 1,1.5,2, warm Grashof number is consigned as 5 and mass Grashof number is also taken as 5, further Pr=7, and time is 0.4 are showed up in Figure 6. It is seen that the helper speed increase with decreasing assessment of Rotation boundary.

4.CONCLUSION

The hypothetical bearing of movement of allegorical flow past a reliably revived sizable isothermal Perpendicular plate inward observing variable mass spread were idea of inside the presence of wavering temperature and efficient mass dispersing without MHD is thought of. The dimensionless regulating condition are settled with the guide of Laplace trade strategy. The total of magnificent physical rule like warmth Grashof number, mass Grashof number, rotational boundary, Prandtl, Schmidt and time t are examined graphically. It is noticeable that the quickness increase with the creating assessments of the warm Grashof or mass Grashof wide variety. The occasion is essentially traded with acknowledge to the rotational boundary.

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First order chemical response impact of MHD flow past an infinite vertical plate with in the sight of exponentially with variable mass diffusion and thermal radiation

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Abstract: In this problem an approach of MHD regular heat transfer convective effect of mass transfer flow subject of initially an incompressible viscous flow past an attracted exponentially accelerated vertical plate with changeable external temperature, chemical response and thermal radiating are studied and the outcomes of speed profiles are studied for the development of this issue is to dissect the effect of a attractive order at the drift wonders with heat source and dangerous reaction for exponentially extended vertical plate. The fundamental profiles are read for unmistakable real parameters comprehensive of the Prandtl assortment, warm Grashof run, mass Grashof amount, Schmidt number and administering conditions have been admitted and understood through utilizing Laplace rework method. The estimation of float speed, mindfulness and temperature are gotten graphically. It is intriguing and found that the expense of augmentation of tendency edge of an executed attractive region bringing decreasing speed profile

Keywords: MHD, exponential, radiation, isothermal, vertical plate, heat and mass transfer

1. Introduction

In heat mass transfer flow situation magnetohydrodynamics move issues play an indispensable situation inside the recollect of innovation and period, the issue of free convection MHD float of a gooey not compressible electrically principal fluid with coordinated results of radiation action has been awesome thought in light of reality of its tremendous outcomes on the limit layer liquid oversee. Differing examines were accomplished right now various researchers practice a scope of go with the drift conditions, their dimensionless overseeing conditions had been understood by means of way of the standard Laplace seriously change approach. Convection heat move takes zone among a surface and a moving liquid, while they're at remarkable temperatures. In a severe vibe, convection isn't generally an essential method of warmth move as the glow change from the floor to the liquid comprises of two components running at the same time. The essential one is power switch because of sub-atomic development (conduction) through a liquid layer connecting to the surface zone, which stays fixed with respect to the steady surface spot in view of no-slip circumstance.Superimposed upon this conductive mode is power move through the plainly visible movement of liquid flotsam and jetsam through particular element of an outside weight, which might be created through a siphon or fan (constrained convection) or produced in view of lightness, coming about because of thickness inclinations. While liquid streams over a surface, its pace and temperature contiguous the floor are indistinguishable as that of the surface on account of the no-slip condition.

The speed and temperature far away from the surface may keep on being unaffected Chamber et.al [1958] dissected a first-request concoction reaction inside the area of a level plate and view of warmth and mass switch issues with compound reaction is of top notch reasonable significance to designers and researchers as a result of its about conventional rate in heaps of parts of science and building. Some advisor fields of diversion wherein consolidated warmness and mass switch related to compound response assume a significant job are found in concoction strategy ventures comprising of food preparing and polymer creation. about the loose-convection flows. It's been visible that there's an ascent in the quickness because of the nearness of an out of doors mass

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Soundalgekar (1982) mentioned on the results of mass switch on go with the flow past a uniformly accelerated vertical plate and studied a particular investigation of the effects of mass exchange on the Stokes problem for a boundless perpendicular plate has been introduced on thinking Anyways, a variety in Schmidt number, prompts a fall within the velocity. The pores and skin-erosion increments due to the nearness of a far flung mass.Muthukumaraswamy et.al (2006,2013) tried compound reaction results on a vertical influencing plate with changeable warm temperature and alluded to the effect of pivot and substance reaction of first request on precarious hydromagnetic free convection stream of a liquid past a consistently expanded isothermal vertical plate with variable mass dissemination and explored concentrated Radiative development past a symbolic initiated isothermal opposite plate with uniform mass progress conclusive outcomes imagined that speed increases with lessening estimations of the overall quite comfortable radiation parameter. With creating warm Grashof wide assortment or mass Grashof broad range anyway the style is essentially turned around with perceive to the warm radiation Criterion or Schmidt go. The temperature of the plate upward push with the decrease estimations of the warm radiation parameter. The plate mindfulness upward push with decrease estimations of the Schmidt range.The test is unmistakably turned around in regards to the warm Grashof amount or mass Grashof. Rajput and Gaurav Kumar(2019) examines the consequences of radiation action, concoction reaction and permeability of system on insecure progression of a thick, not compressible and current captivating in liquid past an exponentially expanded perpendicular plate with changeable divider temperature and constant mass dispersion. Anyway it's far proposed to find about the results of MHD accept the way things are with an exponentially beginning development of an innumerable isothermal vertical plate within the sight of warm radiation and synthetic chemical reaction has been studied. Those procedures show up in nuclear reactor security and consuming systems, picture voltaic finders as it ought to be as substance and metallurgical planning

Azzam (2002) explained an assessment about the warm diffraction of MHD convection shaft close t a semi bondless transferring vertical plate now the heat sorts are quite high.Nield et.al(2006) consider the related to normal convection monitoring stream or mass witch over between excess regarding a couple of geometrical our bodies. Ramachandra et al. (2007) considered the high energy particle caused ionization and mass switch results on a precarious MHD unrestricted convective skim past a warmed perpendicular plate in permeable system with thick dispersal. Mbeledogu et.al (2007) inspected uncertain magneto fluid dynamics regular convection movement within the fluid warmth and mass switch stream of a transmitting fluid past a perpendicular permeable plate system inside seeing warm radiation.Muthukumaraswamy et al. (2012) study of interaction between magnetic field and electrical conducting fluids is the self-control which examines the elements of electrically directing liquids. The significant method of Magneto hydrodynamics that is very fair area possible to catch about flows in a movable conduction fluid, which makes powers on the liquid, and moreover changes attractive subject parameter. Defeat et.al (2013) investigations the effect of compound impact and radiation effect on MHD liquid skim way a permeable model in a regular attractive control with changeable temperature and mass dissemination with warmness flexibly has been more and more growing past an exponentially quickened vertical plate. Manay et al (2014) a MHD weight or MHD propulsor is a methodology for impelling seagoing vessels the utilization of exclusively electric controlled and attractive fields with no moving parts. The working statute involves charge of the force (gas or water), which would then be able to be coordinated through an attractive field, pushing the vehicle the opposite way. MHD is utilized to balance out a stream contrary to the progress from laminar to fierce accept circumstances for what they are. Raju et al (2015) dissected shaky MHD drift underneath unique designs. Muthukumarasamy et.al (2015) contemplated the principal request substance reaction effect of more and more exponentially fast able perpendicular plate with changeable floor temperature and mass dispersion.

2. Mathematical Formulation

In current situation this problem play and think about an unsteady go with the flow of a viscous incompressible fluid with an exponentially elevated an countless isothermal willing vertical plate in the presence of thermal temperature diffusion and primary order chemical action has been studied. The magnetic discipline of uniform energy B_0 is utilized perpendicular to the plate. The fluid is believed to be x' - axis is taken alongside the plate in the vertically upward course and the y -axis is examine perpendicular to the plate at time $t' \leq 0$, the plate and fluid are at the same temperature T_∞ and concentration C'_∞ at time $t' \geq 0$. The plate is started with a speed $q = q_0 e^{wt}$

in its very own air plane towards the gravitational field, the temperature from the plate is increased to T_w and the attention ranges close to the plate are additionally raised to C'_w with time t, , the fluid is viewed a gray very interest produced electromagnetic waves, this viscous dissipation is thought to be not considerable. The impact is thought to identify the region virtually within the move. Then below normal Boussinesq's estimation the no steady initial movement is dominated with the aid of using the subsequent non dimensional equations

$$\frac{\partial q}{\partial t} = g\beta(T - T_\infty) + g\beta^*(C' - C'_\infty) + \nu\frac{\partial^2 q}{\partial y^2} - \frac{\sigma\beta_0{}^2 q}{\rho} \quad (1)$$

$$\frac{\partial \theta}{\partial t} = k\frac{\partial^2 \theta}{\partial y^2} - \frac{\partial q_r}{\partial y} - h(T - T_\infty) \quad (2)$$

$$\frac{\partial c}{\partial t} = \frac{\partial^2 c}{\partial Y^2} - K_1(C' - C'_\infty) \quad (3)$$

With the help of following preliminary and necessary boundary conditions

$q = 0,\ T = T_\infty,\ C' = C'_\infty$ for all $y, t' \le 0$

$t' > 0,\ q = q_0(e^{w't'}),\ T = T_\infty + (T_w - T_\infty)\alpha t'$ (4)

$C' = C'_\infty + (C'_w - C'_\infty)\alpha t', C' = C'_w$ at $y = 0$,

$q \to 0,\quad T \to T_\infty,\quad C' \to C'_\infty$ at $y \to \infty$ and $A = \frac{q_0^2}{\nu}$

On initiate the subsequent require non-dimensionless quantities

$$q' = q\left(\frac{q_0}{\nu^2}\right)^{\frac{1}{3}},\ t = t'\left(\frac{q_0^2}{\nu}\right)^{\frac{1}{3}}, Y = y\left(\frac{q_0}{\nu^2}\right)^{\frac{1}{3}}, \theta = \frac{T - T_\infty}{T_w - T_\infty},\ Gr = \frac{g\beta(T_w - T_\infty)}{q_0}, C = \frac{C' - C'_\infty}{C'_w - C'_\infty},$$

$$Gc = \frac{g\beta^*(C'_w - C'_\infty)}{u_0}, M = \frac{\sigma B_0^2}{\rho}\left(\frac{\nu}{q_0^2}\right)^{\frac{1}{3}}, pr = \frac{\mu C_p}{k}, Sc = \frac{\nu}{D},\ K_2 = K_1\left(\frac{\nu}{q_0{}^2}\right)^{\frac{1}{3}},\ K = k_0\left(\frac{q_0}{\nu}\right)^2, \quad (5)$$

$$R = \frac{16\sigma^* T_\infty^3}{3k_p k},\quad Y = \frac{q_0 y}{\nu},\ N = \frac{\nu h}{q_0^2 \rho_c p},$$

By use of the Rosseland approximation $q_r = \frac{4\sigma^*}{3k_p}\frac{\partial T^4}{\partial y}$ where σ^* and k_p stefan-Boltzban not changeable constant and the Rossenland mean immersion constant quantity ,Taylor series fail to provide that higher order terms we can given T^4as a linear characteristic temperature of the format style $T^4 = 4T_\infty^3 - 3T_\infty^4$

We get $\frac{\partial q_r}{\partial y} = -\frac{16\sigma^* T_\infty^3}{3k_p}\frac{\partial^2 T}{\partial y^2}$

Eqns (1) – (3) reduce the following non dimensional forms

$$\frac{\partial q'}{\partial t} = Gr\theta + GcC + \frac{\partial^2 q'}{\partial Y^2} - Mq' \quad (6)$$

$$\frac{\partial \theta}{\partial t} = \left(\frac{1+R}{pr}\right)\frac{\partial^2 \theta}{\partial Y^2} - N\theta \quad (7)$$

$$\frac{\partial c}{\partial t} = \frac{1}{Sc}\frac{\partial^2 c}{\partial Y^2} - K_2 C \quad (8)$$

The initial and boundary conditions in non dimensional forms

$$t > 0:\ q = e^{wt}, \theta = t, C = taty = 0 \qquad \begin{matrix} q = 0, \theta = 0, C = 0\ \ forally, t \le 0, \\ q \to 0,\ \ \theta \to 0,\qquad C \to 0\ \ asy \to \infty \end{matrix} \quad (9)$$

3.Solution Method

The non dimensional governing equations (6)-(8) difficulty to corresponding preliminary and boundary prerequisites eqns (4) are solved by means of the usage of the Laplace transform change technique, the answer is acquired below.

$$
\begin{aligned}
q(t) = \quad & \frac{e^{wt}}{2}\left[e^{-2\eta\sqrt{(M+w)t}}erfc\left(\eta-\sqrt{(M+w)t}\right)+e^{-2\eta\sqrt{(M+w)t}}erfc\left(\eta+\sqrt{(M+w)t}\right)\right] \\
& -\frac{G_r}{a^2(1-A)}\frac{1}{2}\left[\left\{e^{-2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}-\sqrt{Nt}\right)+e^{2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}+\sqrt{Nt}\right)\right\}\right. \\
& \left.-\left\{e^{-2\eta\sqrt{Mt}}erfc\left(\eta-\sqrt{Mt}\right)+e^{2\eta\sqrt{Mt}}erfc\left(\eta+\sqrt{Mt}\right)\right\}\right] \\
& -\frac{G_r}{a(1-A)}\left[\frac{t}{2}\left\{e^{-2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}-\sqrt{Nt}\right)+e^{2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}+\sqrt{Nt}\right)\right\}\right. \\
& -\frac{\eta\sqrt{At}}{2\sqrt{N}}\left\{e^{-2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}-\sqrt{Nt}\right)-e^{2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}+\sqrt{Nt}\right)\right\} \\
& -\frac{t}{2}\left\{e^{-2\eta\sqrt{Mt}}erfc\left(\eta-\sqrt{Mt}\right)+e^{2\eta\sqrt{Mt}}erfc\left(\eta+\sqrt{Mt}\right)\right\} \\
& \left.-\frac{\eta\sqrt{t}}{2\sqrt{M}}\left\{e^{-2\eta\sqrt{Mt}}erfc\left(\eta-\sqrt{Mt}\right)-e^{2\eta\sqrt{Mt}}erfc\left(\eta+\sqrt{Mt}\right)\right\}\right] \quad (10) \\
& +\frac{G_r}{(1-A)a^2}\frac{e^{at}}{2}\left[\left\{\mathrm{e}^{-2\eta\sqrt{\mathrm{A(a+N)t}}}\mathrm{erfc}\left(\eta\sqrt{\mathrm{A}}-\sqrt{(\mathrm{a}+\mathrm{N})\mathrm{t}}\right)\right.\right. \\
& +\quad \left.\mathrm{e}^{2\eta\sqrt{\mathrm{A(a+N)t}}}\mathrm{erfc}\left(\eta\sqrt{\mathrm{A}}+\sqrt{(\mathrm{a}+\mathrm{N})\mathrm{t}}\right)\right\} \\
& \left.-\left\{\mathrm{e}^{-2\eta\sqrt{(\mathrm{a}+\mathrm{M})\mathrm{t}}}\mathrm{erfc}\left(\eta\sqrt{\mathrm{M}}-\sqrt{\mathrm{at}}\right)+\quad \mathrm{e}^{2\eta\sqrt{(\mathrm{a}+\mathrm{M})\mathrm{t}}}\mathrm{erfc}\left(\eta\sqrt{\mathrm{M}}+\sqrt{\mathrm{at}}\right)\right\}\right] \\
& -\frac{G_c}{b^2(1-Sc)}\frac{1}{2}\left[\left\{e^{-2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}-\sqrt{K_2t}\right)+e^{2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}+\sqrt{K_2t}\right)\right\}\right. \\
& \left.-\left\{e^{-2\eta\sqrt{Mt}}erfc\left(\eta-\sqrt{Mt}\right)+e^{2\eta\sqrt{Mt}}erfc\left(\eta+\sqrt{Mt}\right)\right\}\right] \\
& -\frac{G_c}{b(1-Sc)}\left[\frac{t}{2}\left\{e^{-2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}-\sqrt{K_2t}\right)+e^{2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}+\sqrt{K_2t}\right)\right\}\right. \\
& -\frac{\eta\sqrt{Sct}}{2\sqrt{K_2}}\left\{e^{-2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}-\sqrt{K_2t}\right)-e^{2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}+\sqrt{K_2t}\right)\right\} \\
& -\frac{t}{2}\left\{e^{-2\eta\sqrt{Mt}}erfc\left(\eta-\sqrt{Mt}\right)+e^{2\eta\sqrt{Mt}}erfc\left(\eta+\sqrt{Mt}\right)\right\} \\
& \left.-\frac{\eta\sqrt{t}}{2\sqrt{M}}\left\{e^{-2\eta\sqrt{Mt}}erfc\left(\eta-\sqrt{Mt}\right)-e^{2\eta\sqrt{Mt}}erfc\left(\eta+\sqrt{Mt}\right)\right\}\right]
\end{aligned}
$$

$$
\begin{aligned}
& +\frac{G_c}{b^2(1-Sc)}\frac{e^{bt}}{2}\left[-\left\{e^{-2\eta\sqrt{Sc(b+K_2)t}}erfc\left(\eta\sqrt{Sc}-\sqrt{(b+K_2)t}\right)\right.\right. \\
& \left.\left.+e^{2\eta\sqrt{Sc(b+K_2)t}}erfc\left(\eta\sqrt{Sc}+\sqrt{(b+K_2)t}\right)\right\}\right. \\
& \left.-\left\{e^{-2\eta\sqrt{(b+M)t}}erfc\left(\eta-\sqrt{(b+M)t}\right)+e^{2\eta\sqrt{(b+M)t}}erfc\left(\eta+\sqrt{(b+M)t}\right)\right\}\right]
\end{aligned}
$$

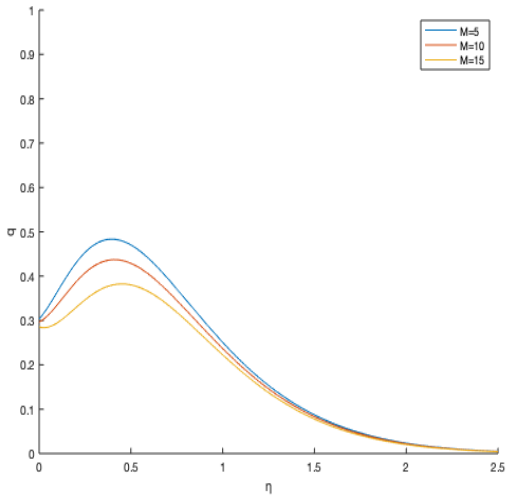
Where $A=\frac{P_r}{1+R}$, $a=\frac{AN-M}{1-A}$, $b=\frac{S_cK_2-M}{1-S_c}$, $\eta=\frac{y}{2\sqrt{t}}$

$$
\begin{aligned}
C=\frac{t}{2}&\left[e^{-2\eta\sqrt{SK_2t}}erfc\left(\eta\sqrt{Sc}-\sqrt{K_2t}\right)+e^{2\eta\sqrt{Sct}}erfc\left(\eta\sqrt{Sc}+\sqrt{K_2t}\right)\right]+ \\
&\frac{\eta\sqrt{Sc}}{2\sqrt{K_2}}\left[e^{-2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}-\sqrt{K_2t}\right)-e^{2\eta\sqrt{ScK_2t}}erfc\left(\eta\sqrt{Sc}+\sqrt{K_2t}\right)\right] \quad (11)
\end{aligned}
$$

$$
\theta=\frac{t}{2}\left[e^{-2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}-\sqrt{Nt}\right)+e^{2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}+\sqrt{Nt}\right)\right]+
$$

$$
-\frac{\eta\sqrt{A}}{2\sqrt{N}}\left[e^{-2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}-\sqrt{Nt}\right)-e^{2\eta\sqrt{ANt}}erfc\left(\eta\sqrt{A}+\sqrt{Nt}\right)\right] \quad (12)
$$

4.Result and Discussion



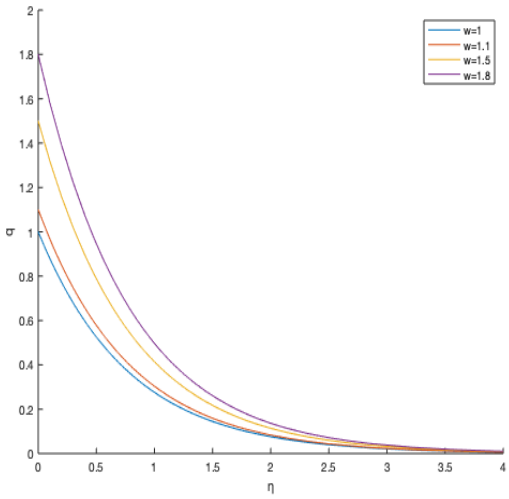


Fig.1(a).Velocity profiles studyvariate for some values of M.Fig.1(b).Velocity profile study variate some values ofw

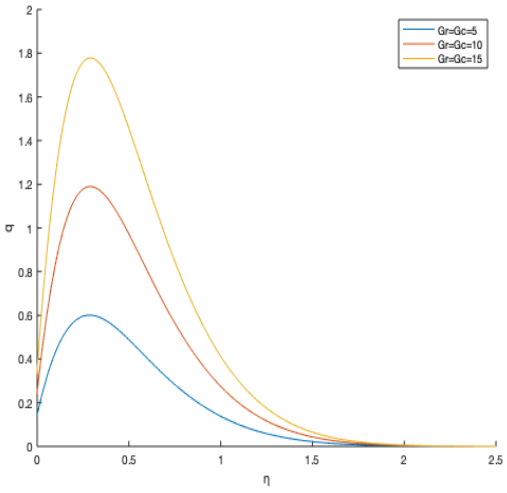


Fig.1 (a). The speed profiles for explicit estimations of M =5, 10, 15 and Gr = Gc = 5 R = 0.2, t =0.4, w=1, are considered and expressed graphically in Fig.1, and it is support that speed profile diminishes with reach out in attractive control parameter

Fig.1 (b) .The speed profiles for explicit estimations of w = 1, 1.1, 1.5, 1.8 and Gr = 5 and Gc = 5 and R = 0.2 at t =0.4 are contemplated and explained in .Fig.2. It is support that the speed increments with developing estimations of w.

Fig.1(c).. Effect of the speed for few estimations of Gr = 5, 10, 15 and Gc = 5, 10, 15 and K2 = 5, w = 1, R = 0.2 t = 0.4. The speed increases with extending estimations of the warm Gr or mass Gc

Fig.1(c). Velocity profiles for few values of Gr ,Gc

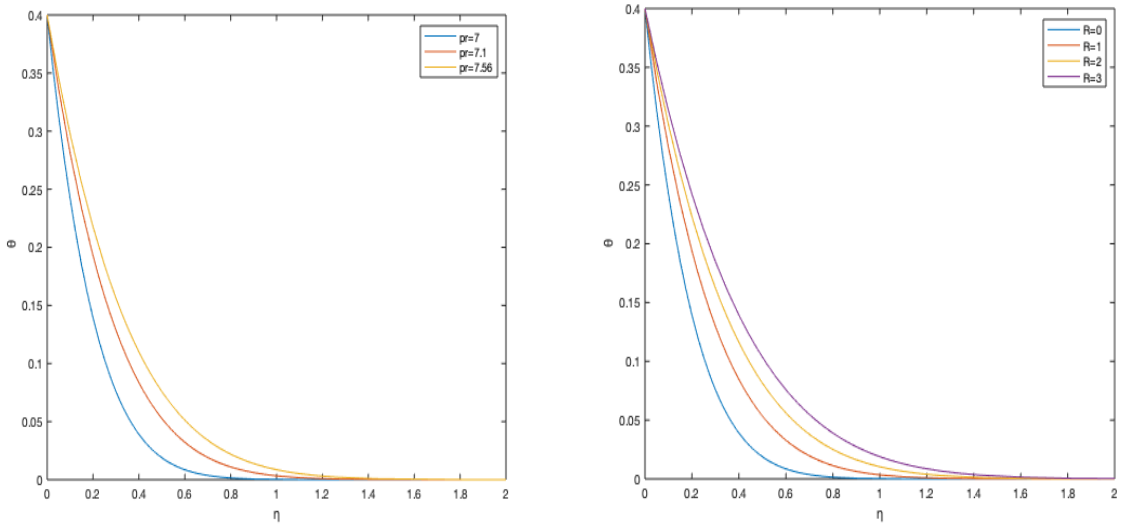


Fig.2(a).Temperature variation for different values of PrFig.2 (b). Temperature variation for few valuesof R

Fig.2 (a), Demonstrates the effect of temperature for different values of Pr *=7, 7.1, 7.56.* It is observed that the wall concentration increases with increasing values of *t*.

Fig.2 (b). The temperature vitiate for scarcely any estimation of the heat radiation mathematical constant parameter R = 0, 1, 2, 3 in the exact work sight of air at time t = 0.4, N= 0.1, Pr = 7.1 are constructed in Fig.5.The have an impact of the warmabsorption mathematicallimitation parameter is vital in warm variate. It is resolved that the warm level will increment with diminishing radiation constant limitation.

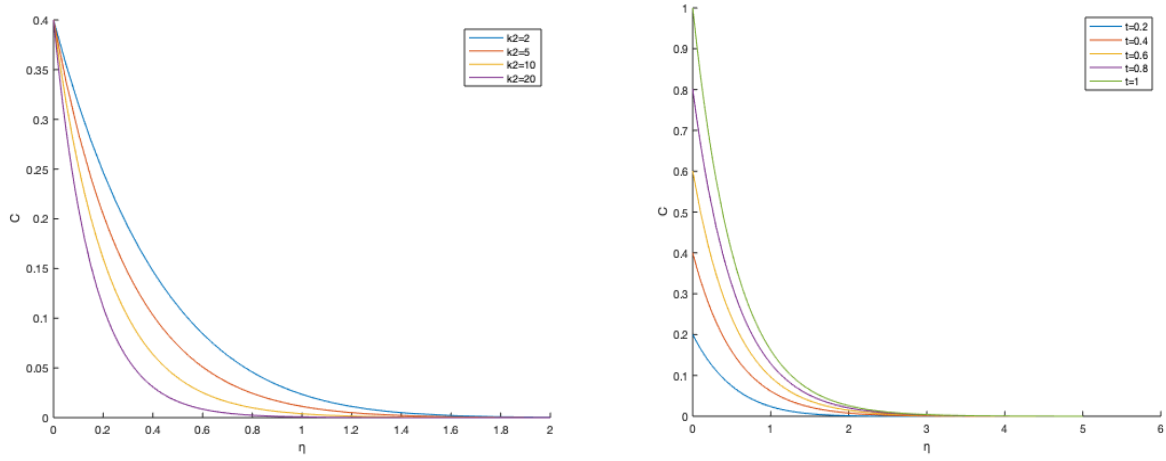


Fig.3 (a).Concentration profile ranges for some values of K_2Fig.3(b). Concentration variate for some values of t

Fig.3(a).The impact of concentration for one of a kind values of the chemical response mathematical limitation K2 = 2, 5, 10, 20 at t = 0.4 The impact of the chemical action response mathematical limitation is essential in the attention field. The variation have the frequent function that the awareness will decrement in a un interesting movement from the over surface area to zero free a long process in the system.It is determined that the focus of study will increase with reducing values of the chemical action response constant mathematical parameter.

Fig.3(b). The attention profiles variate for one kind of values of thet =.2, 0.4, 0.6, 0.8,1 and K_2 =5, S_c 0.6. Requirement of the fluid with appreciate to time is detailed in figure-3 and it is located that the need of profile variation will increase with make bigger in the period.

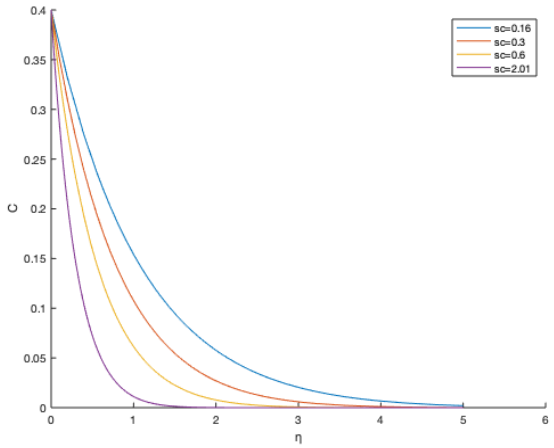


Fig.3(c). Concentration profile for different values of Sc

Fig.3(c). The attention profiles for one kind of values of the Schmidt integer Sc = *0.16*, *0.3*, *0.6*, *2.01* and K_2=*5*at time *t = 0.4* are established in Fig.8. The impact of the Schmidt integer is important in the concentration field, as expected, the concentration increases with reducing values of the Schmidt number.

4.1 Conclusion

An evaluation of MHD regular free convection stream flow with an exponentially beginning improvement of a boundless isothermal inclined vertical plate in observing warm radiation and substance response The dimensionless managing conditions are applied by techniques for the customary Laplace-change methodology. The impact of remarkable limitation, for instance, the warm number Gr, mass number Gc, invention response parameter, radiation constant parameter, appealing control mathematical parameter and t are focused figural. The finishes of the find out about are Temperature of the flow stream increments as increment in radiation parameter and intriguing seen is watched that warmth source of constant parameter and Pr whole number diminish the temperature profile. The extend in the intensity of substance responding materials as precisely correctly Schmidt number thought processes to decrease the fixation profile. The limit layer thickness and speed are augmentation with developing assessment of mass Grashof number. The speed profile diminishes with developing tendency point of attractive field parameter.

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Nomenclatures

A Constants
B_0 external magnetic field
C dimensionless concentration
C_p specific heat at constant pressure J k g^{-1} k
C' species concentration in the fluid k g m^{-3}
C'_w wall concentration in the fluid
C'_∞ concentration in the fluid far away from the plate
D mass diffusion coefficient m^2s^{-1}
Gc mass Grashof number
Gr thermal Grashof number
g acceleration due to gravity m^2s^{-1}
k thermal conductivity W $m^{-1}k^{-1}$
Pr Prandtl number
Sc Schmidt number
T temperature of the fluid near the plate
T_w temperature of the plate
T_∞ temperature of the fluid far away from the plate
t dimensionless time
t' time s
u velocity of the fluid in the x' – direction ms^{-1}
u_0 velocity of the plate ms^{-1}
U dimensionless velocity
y co-ordinate axis normal to the plate m
Y dimensionless coordinate axis normal to the plate
M magnetic field parameter

Greek Symbols

β volumetric coefficient of thermal expansion K^{-1}
β^* volumetric coefficient of expansion with concentration K^{-1}
μ coefficient of viscosity Ra s
v kinematic viscosity m^2s^{-1}
σ electrical conductivity
ρ density of the fluid kgm^{-3}
τ dimensionless skin- friction k gm^{-3}
θ dimensionless temperature
μ similarity parameter
erfc complementary error function

Subscripts

w conditions at the wall
∞ free stream conditions

Rotational effect of Parabolic flow past in the presence of Isothermal Vertical plate with variable temperature and mass diffusion

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Abstract:

An appropriate specific testing of rotation impact of wavering parabolic stream past of incomprehensive and electrically forceful fluid over and done a standardized quickened abundant isothermal perpendicular plate in the lack of magneto hydrodynamic has been described in the analysis. The dimensionless equation has been assimilated by means of Laplace transform technique. The temperature profile, concentration and velocity profile have been used for various physical models like warm Grashof number, mass Grashof number, Schmidt number, prandtl number, rotational parameter and time. It is noticed that the velocity will step with the rising appraisal of warm Grashof value. It is further more tested that the velocity steps up with diminishing rotational parameter.

Keywords: Heat and mass transfer, isothermal, vertical plate, flow past

1 Introduction:

A heat transmission issue on a constant moving exterior is important in plentiful pragmatic relevance occurrence in a number of manufacturing processes. Models of handle integrate retention, build up the strengthening, dealing, freezing and taking of paper, pertinent and oils, containers, repeated throwing, ejection of plastics and polymeric, equipment of stream and mass transmission is practical in Aeronautics, atomic reactor, liquid fuel and numerous edifice product in which the liquid is the operational intermediate.

Agarwal A.K., Sarma N.K and Gupta S.N [1] studied about temperature and magnitude transmit elapsed a parabolic on track immeasurable vertical plate. Jha B.K., Prasad.R and Rai.S[2] gave a thought on pile shift property on the dirft onwards an exponentially accelerated vertical plate with persistent heat up change. KafousiasN.G. and RaptisA[3] analyzed about mass transmission and free convective impact on the stream past an accelerated vertical countless plate with inconsistent suction on injecting plate. Muthucumaraswamy R and Neel Armstrong A[8] studied about mass transmit parabolic vertical plate with Inconsistent high temperature and lump dispersion. Muralidharan M and MuthucumaraswamyR[4] studied about hydro magnetic impact on stream elapsed an increased isothermal perpendicular plate in the existence of thermal radiation.

Muthucumaraswamy R, Sundar Raj M and Subramanian [9] discussed about erratic MHD emerge elapsed an accelerated vertical plate with inconsistent hotness and lump dispersion. Muthucumaraswamy R and Ganesan P [6] analyzed about an erratic tide past an impetuously on track vertical plate with roast and pile transmit. Ramesh Babu K and Shankar [11] studied about hotness and mass transformation on a erect plate in the occurrence of a fascinating subject. RevankarS.T [13] discussed about free convective impression on a gush onwards on spontaneously happening oscillating vertical plate. Muthucumaraswamy R and SenthilVadivel V [14] discussed about transmission of heat effect on emotive perpendicular plate outward in the occurrence of fascinating subject. Soundalgekar V.M [15] analyzed impact of lump transmission and free convective on the gush past an imperiously vertical plate.

1.1 Related Work

Dhanasekar N analyzed about rotation impact on erratic fluid in an increased Isothermal vertical plate below an activity of crossways enforced captivating field. Here the value of plate degree is increased to T_w as well as the level of concentration adjacent to the plate is further increased toC'_w. It was realized that the value of velocity rises along raising values of thermal or mass grashof number. Also it was realized that the value of velocity rises along reducing charismatic field parameter (or) rotation parameter.

Sundara Raj M discussed about an unstable Magetohydrodynamics fluid past in an increased vertical plate along varying heat and mass dispersion. In this paper the value of plate degree is increased as well as the level of concentration adjacent to the plate value is also increased. Furthermore the investigation about the increment in the value of velocity with increment value of thermal (or) mass Grashof number. It was noticed that the heat value of concentration raised value of time, also the value increase along raising value of time, also the value of concentration raised along raising value of time t.

Soundalgekar V.M investigates about charismatic field as well as electric field on heat transformation in the medium along metameric electrodes has been approved. And also discussed about an impact of lump transfers in the free convective on the emerge precedent and precipitately vertical plate. It has been noticed that there is a gradient in the pace as of the closeness of an outside mass. In all the cases the value of Schmidt number increases and in an instantaneous reduction in the value of speed.

Kafousias N.G et.al studied about an impact of convective excitement and pile transfer on the surge giving out of an incompressible gooey destructive fluid exposed to patchy suction and inoculation gone an inestimable vertical permeable plate accelerated in its individual flat surface are checked. Logical explanation for the speed, hotness as well as size concentration are accessed on the core of equations for mass, impulse, power absorption and accumulation transmission contained by a consolidation, edge level. Those formulations are further more to compute the skin friction and the rate of heat transfer using dimensionless quantities.

Revankar S.T analyzed about flood past an on impulse on immeasurable horizontal plate or a never ending oscillating vertical plate. Fluid was implicit to be gluey and incompressible. In this paper discussed about free convective property on the stream line of work for two personal belongings (i) once a flooded immeasurable plate is frozen into movement on impulse along oscillatory plate fever. (ii) After the flooded immeasurable plate is frozen into movement along one dimensional harmonized oscillatory analogous to itself along oscillatory heat (or) warmth.

2 Mathematical formulation

Examine the inadequate evolution of an incompressible liquid past a systematically quickened movement of an isothermal perpendicular limitless plate at what times the liquid as well as the plate as formal fixed body with the homogeneous accurate hustle Ω' over z' hut. At first the hotness of the plate and focus firm to the plate are deliberation to be $T'_\infty$and C'_∞ . At time $t' > 0$ the plate begins emotive with a velocity u in its confess flat surface and the heat from the plate is constructed. $T_w$and the focus stage familiar to the plate is ended to being up immediately with time. Since the plate possessing the plate $z' = 0$ is of boundless degree, the whole substantial amounts rely right upon $z'$and t'. At that intention the fragile stream is represented by the measure of Boussinesq's estimation in the dimensionless constitution as follows:

$$\frac{\partial u}{\partial t} - 2\Omega V = Gr\theta + GcC + \frac{\partial^2 U}{\partial Z^2} \quad (1)$$

$$\frac{\partial \mathrm{V}}{\partial \mathrm{t}} - 2\Omega \mathrm{V} = \frac{\partial^2 \mathrm{V}}{\partial \mathrm{Z}^2} \quad (2)$$

$$\frac{\partial \theta}{\partial \mathrm{t}} = \frac{1}{\mathrm{Pr}} \frac{\partial^2 \theta}{\partial \mathrm{Z}^2} \quad (3)$$

$$\frac{\partial \mathrm{C}}{\partial \mathrm{t}} = \frac{1}{\mathrm{Sc}} \frac{\partial^2 \mathrm{C}}{\partial \mathrm{Z}^2} \quad (4)$$

With the accompanying starting and limit condition

$$u = 0,\ T = T_\infty,\ C' = C'_\infty \qquad for\ all\ \ y, t' \le 0$$
$$t' > 0: u = (u_0 t')^2,\quad T = T'_w,\ \ C' = C'_w\ at\ y = 0 \quad (5)$$
$$u \to 0, T \to T'_\infty, C' \to C'_\infty\ \ as\ \ y \to \infty$$

On proposing the next non-dimensional quantities:

$$U = \frac{u}{(vu_0)^{1/3}},\ V = \frac{V'}{(vu_0)^{1/3}},\ t = t'\left(\frac{u_0^2}{v}\right)^{1/3},\ Z = z\left(\frac{u_0}{v}\right)^{1/3},$$
$$\theta = \frac{T - T_\infty}{T_w - T_\infty},\qquad Gr = \frac{g\beta(T_w - T_\infty)}{u_0},\ C = \frac{C' - C'_\infty}{C'_w - C'_\infty},\ Gc = \frac{g\beta^*(C'_w - C'_\infty)}{u_0} \quad (6)$$
$$Pr = \frac{\mu C_p}{k},\qquad Sc = \frac{v}{D},\qquad A = \left(\frac{u_0^2}{v}\right)^{1/3}$$

The analytical flood past with spinning free convective flood past an invigorate conflicting plate is depict by differential equation (1) to (4) with opening and bring to an end off consideration. Since the authorized restriction is hard to relax accordingly we acquaint with a complex speed $q = u + iv$ so that the primarily and second are comprehended and coupled into solo acclimatize separate stipulation.

$$\frac{\partial q}{\partial t} == Gr\theta + GcC + \frac{\partial^2 q}{\partial Z^2} - mq \quad (7)$$

With the accompanying first and frontier restriction in dimensionless quantities are follows

$$q = 0, \theta = 0, c = 0\ for\ all\ z, t \le 0$$
$$t > 0 \quad q = t^2, \theta = t, c = t\ \ at\ \ z = 0 \quad (8)$$
$$q \to 0, \theta \to 0, c \to 0\ \ as\ \ z \to \infty$$

Where$m = 2i\Omega$

3 Coupled Equation

The dimensionless administering conditions with respect with respect to the equation seven are solved using Laplace transform and finally inverse is derived. The coupled velocity profile is given by

$$q = 2\left\{\frac{(\eta^2 + 2i\Omega t)}{4(2i\Omega)} t\left[e^{2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta + \sqrt{2i\Omega t}\right) + e^{-2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta - \sqrt{2i\Omega t}\right)\right]\right.$$
$$+ \frac{\eta\sqrt{t}(1 - 4(2i\Omega t)}{8(2i\Omega)^{3/2}}\left[e^{-2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta - \sqrt{2i\Omega t}\right) - e^{2\eta\sqrt{Mt}}\operatorname{erfc}\left(\eta + \sqrt{2i\Omega t}\right)\right.$$
$$\left.\left. - \frac{\eta t}{2(2i\Omega)\sqrt{\pi}} e^{-(\eta^2 + 2i\Omega t)}\right]\right\}$$
$$+ \left[\frac{G_r}{a^2(1 - pr)}\right.$$
$$\left. + \frac{G_c}{b^2(1 - sc)}\right]\left(\frac{1}{2}\right)\left[e^{2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta + \sqrt{2i\Omega t}\right) + e^{-2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta - \sqrt{2i\Omega t}\right)\right]$$
$$+ \left[\frac{G_r}{a(1 - pr)} + \frac{G_c}{b(1 - sc)}\right]\left[\left(\frac{t}{2} - \frac{c}{2\sqrt{2i\Omega}}\right)\left(e^{-2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta - \sqrt{2i\Omega t}\right)\right)\right.$$
$$\left. + \left(\frac{t}{2} + \frac{c}{2\sqrt{2i\Omega}}\right)\left(e^{2\eta\sqrt{2i\Omega t}}\operatorname{erfc}\left(\eta + \sqrt{2i\Omega t}\right)\right)\right]$$
$$- \frac{G_r}{a^2(1 - pr)}\left(\frac{e^{at}}{2}\right)\left[e^{2\eta\sqrt{(2i\Omega + a)t}}\operatorname{erfc}\left(\eta + \sqrt{(2i\Omega + a)t}\right)\right.$$
$$\left. + e^{-2\eta\sqrt{(2i\Omega + a)t}}\operatorname{erfc}\left(\eta - \sqrt{(2i\Omega + a)t}\right)\right]$$
$$- \frac{G_c}{b^2(1 - Sc)}\left(\frac{e^{bt}}{2}\right)\left[e^{2\eta\sqrt{(2i\Omega + b)t}}\operatorname{erfc}\left(\eta + \sqrt{(2i\Omega + b)t}\right)\right.$$
$$\left. + e^{-2\eta\sqrt{(2i\Omega + b)t}}\operatorname{erfc}\left(\eta - \sqrt{(2i\Omega + b)t}\right)\right] - \frac{G_r}{a^2(1 - pr)}\operatorname{erfc}(\eta\sqrt{Pr})$$
$$- \frac{G_c}{b^2(1 - Sc)}\operatorname{erfc}(\eta\sqrt{Sc})$$
$$+ \frac{G_r}{a^2(1 - pr)}\left(\frac{e^{at}}{2}\right)\left[e^{2\eta\sqrt{Prat}}\operatorname{erfc}\left(\eta\sqrt{Pr} + \sqrt{at}\right) + e^{-2\eta\sqrt{Prat}}\operatorname{erfc}\left(\eta\sqrt{Pr} - \sqrt{at}\right)\right]$$
$$+ \frac{G_c}{b^2(1 - Sc)}\left(\frac{e^{bt}}{2}\right)\left[e^{2\eta\sqrt{Scbt}}\operatorname{erfc}\left(\eta\sqrt{Sc} + \sqrt{bt}\right) + e^{-2\eta\sqrt{Scbt}}\operatorname{erfc}\left(\eta\sqrt{Sc} - \sqrt{bt}\right)\right]$$
$$- \frac{G_r}{a(1 - pr)} t\left[(1 + 2\eta^2 Pr)\operatorname{erfc}\left(\eta\sqrt{Pr}\right) - \frac{2\eta\sqrt{Pr}}{\sqrt{\pi}} e^{-\eta^2 Pr}\right]$$
$$- \frac{G_c}{b(1 - Sc)} t\left[(1 + 2\eta^2 Sc)\operatorname{erfc}\left(\eta\sqrt{Sc}\right) - \frac{2\eta\sqrt{Sc}}{\sqrt{\pi}} e^{-\eta^2 Sc}\right] \quad (9)$$

Where

$$\theta = t\left\{(1 + 2\eta^2 Pr)\operatorname{erfc}\left(\eta\sqrt{Pr}\right) - \frac{2\eta\sqrt{Pr}}{\sqrt{\pi}} e^{-(\eta^2 Pr)}\right\} \quad (10)$$

$$C = t\left\{(1 + 2\eta^2 Sc)\operatorname{erfc}\left(\eta\sqrt{Sc}\right) - \frac{2\eta\sqrt{Sc}}{\sqrt{\pi}} e^{-(\eta^2 Sc)}\right\} \quad (11)$$

4 Results and Interpretation

The represent review has been an inspected codify and derived via Laplace approach.the resultant requirement compose of three ultimately high temperature profile, concentration and velocity profile on Grashof number for warm and mass, Schmidt value, Prandtl value and time. Entire pictures are automated in MATLAB and the yield pictures been tracked recorded below.

The part of Pradtlnumber are selected for atmosphere is 0.71 and for run 7.0 and time 0.2 portrayed in figure 1. It is seen that the hotness increases with lessening in prandtl value for calculate the appraisal of Schmidt is assigned to be 2.01.

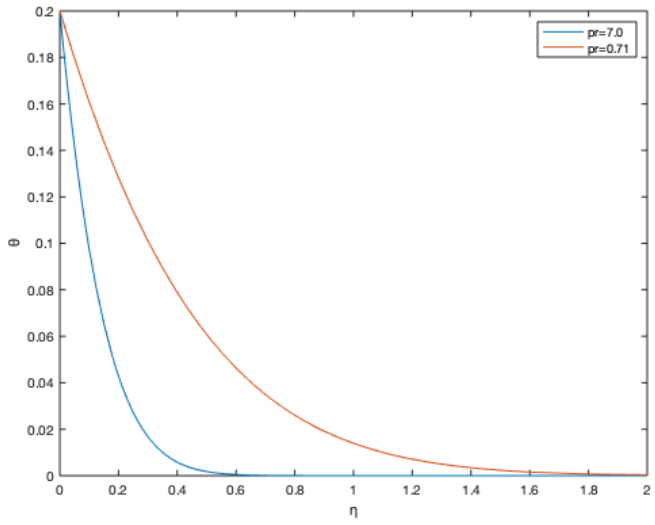

Figure 1 Temperature profiles to various Prandtl number

Figure 2 describe the impact of concentration profile at time 0.2 for evident Schmidt numeral is full to be 0.16, 0.3,0.6. it is apparent that the dividing wall focus increase with abate appraisal of Schmidt value. The portrait has the elemental divide that the center reduces in a constancy tactic from the zilch particular pair of division pattern with in the relaxed flood.

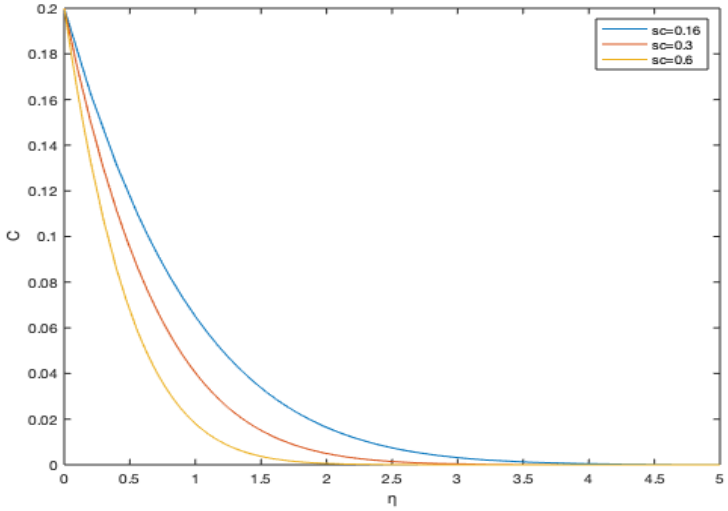

Figure 2 Concentration Profiles to various Schmidt number

Figure 3 exhibition the stimulate of dominent velocity profile for divergent amiable Grashof value is regard as to be 2 , 2, 5 and accumulation Grashof value is full to 2, 5, 5 and spinning boundary is 0.5, extend prandtl dispatched as 7 and time is 0.2. it is seen that the boost up with the build estimations of the warm (or) mass Grashof value.

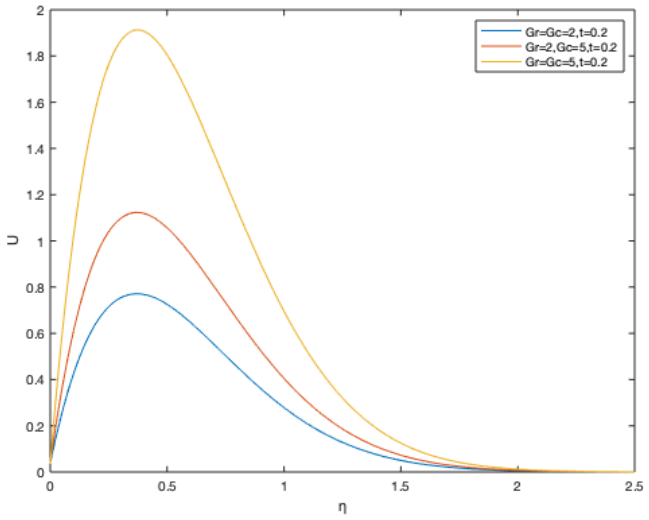

Figure 3 Primary velocity Profiles for various thermal Grashof value and mass Grashof value

Figure 4 charts the impact of rotating parameter on the quickness when warm Grashof is 5, mass Grashof value as 5 and rotation parameter is allotted as 0.5, 1, and 1.5 about prandtl value as 7 and time is 0.2. it is seen that the run growth with decrease estimations of the rotating parameter. This resultant is increase in the quickness.

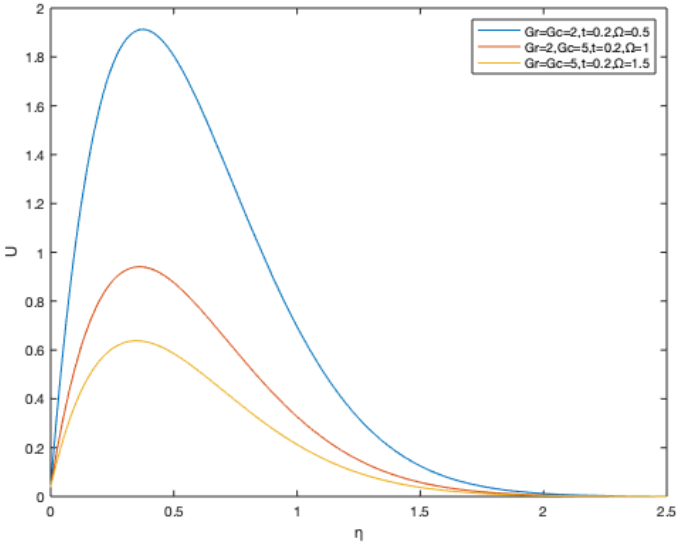

Figure 4 Primary velocity Profiles to various value of Ω

Figure 6 layouts about the Secondary velocity profile for various rotational parameter is appropriated as 1, 1.5, 2 , warm Grashof number value is 5 and mass Grashof number value is also 5 additionally taken as further Pr=7, and time is 0.2 are shown. It was noticed such the velocity step up by get down number inΩ.

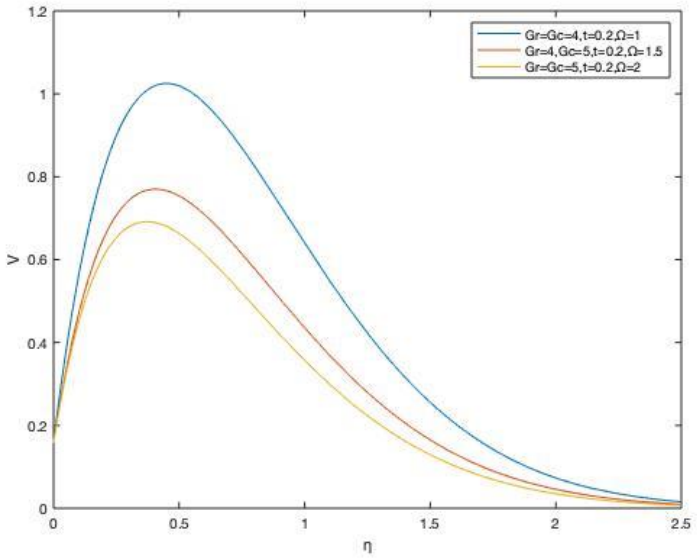

Figure 5 secondary velocities to various rotation parameters

Figure 6 layouts about the velocity for various estimation of warm Grashof is considered as 4, 4, 5 and mass Grashof is taken as 4, 5, 5. Rotational value is 0.5,Prandtl value is taken as 7 and times 0.2 are estimated. From this resultant shows about the soeed increases with increased estimations of warm (or) mass Grashof number.

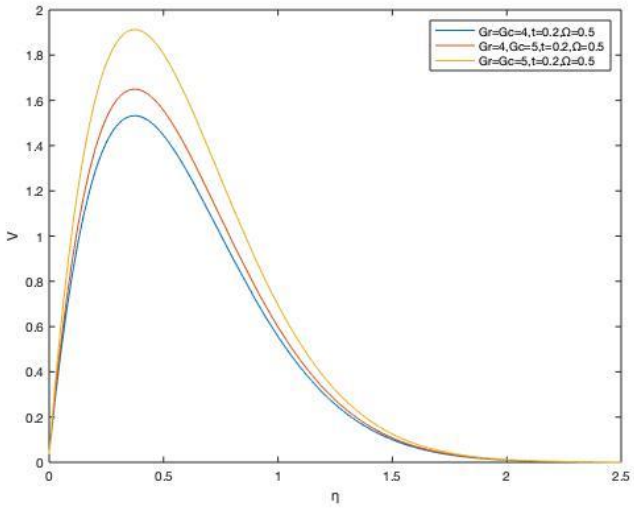

Figure 6 secondary velocities to various mass Grashof number and thermal Grashof number

5 Conclusion:

The hypothetical volume of the action reveals parabolic flood ancient a consistenly quickened huge isothermal vertical in the occurrence of rotation with the non-existence of magnetic hydromagnetic. The dimensionless dispense condition are developed by Laplace convert technique. The arrangement of

different physical criterion of the warmupGrashof value, mass Grashof value, Rotational parameter , t is inspected graphically. The illustration is in essence exchanged with respect to the rotational parameter.

(i) It is considerably noticeable that the heat enhance with fall in Prandtl value.
(ii) It is further noticeable that the partition value increase with bringing time estimation of Schmidt value.
(iii) It is noticeable that the velocity increases with the rising estimations of the warm (or) mass Grashof number.
(iv) It is evident that the rate increases with time decrement value of rotation parameter.

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Topic : “Engaging students in Science Learning using I.C.T”

WORD COUNT :3000

Title : Engaging and Empowering student , teacher’s learning process in IBDP Physics IA & EE through Modeling Tool aided with inquiry based Simulations technology for Physics Education !!

Abstract :

The new mantra in the digital age is “Go Digital” .Teach the way which the students are more comfortable with “ Children today are digital natives and we as 21st century educators have to keep pace with them. We have to bridge the digital divide hence we as educators need to “GO DIGITAL” Technology Integration in Teaching-Learning is more appreciated by students of the digital age. . Thus ICT aids enhance the teaching learning process .

One of the objectives of the present paper is to provide better understanding and appreciation of the role of ICT through Loggers in teaching and learning systems. Several viewpoints of integrating ICT in teaching and learning systems have been discussed. Learning is not a transfer of knowledge, rather an active construction. Personalised Example in Grade 9 Physics class related to Electricity ,sample experiment examples related to a particular ,Engaging and Empowering student , teacher’s learning process in IBDP Physics IA & EE using ICT through Modeling Tool are discussed.

Introduction :

What is ICT ?

ICTs stand for information and communication technologies and are defined, for the purpose of this primer, as a “diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information.”[1]information. ICT has become part of everyday life and all sectors from banking to tourism now depend heavily on ICT for carrying out their transactions. The National curriculum framework 2005 (NCF 2005) has highlighted the importance of ICT in school education. ICTs can enhance the quality of education in several ways: by increasing learner motivation and engagement in the learning process, by facilitating the acquisition of basic skills, and by enhancing teacher training.

Current status of Teaching and learning(T&L):

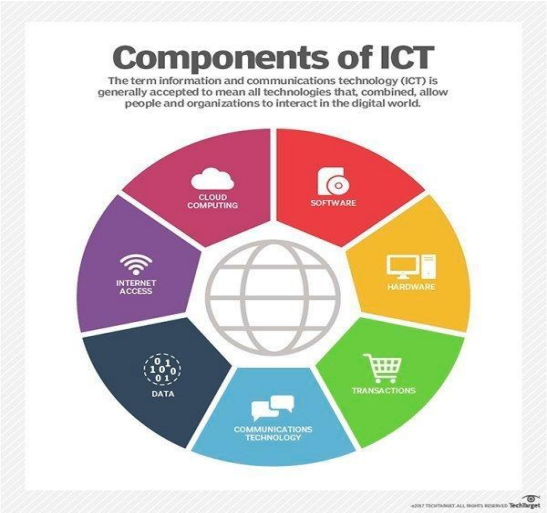
21st century learners are commonly described as ‘digital natives’ and their approach to learning is influenced by “their expectations of 24 hour a day, seven days a week, three hundred and sixty five days a year multiple media communications” (MCEETYA 2005, p.4).

The scenario of 21st century education is dynamic and has brought a lot of change in the education system. Rote memorization and retention of facts is no longer useful in this technology-driven era. Technology can be a powerful tool for transforming long hours of boring learning into fun learning. It can help affirm and advance relationships between educators and students, reinvent our approaches to learning and collaboration, shrink long-standing equity and accessibility gaps, and adapt learning experiences to meet the needs of all learners.Inquiry based teaching has being a great support to

[1] "What is ICT (information and communications technology, or ...." https://searchcio.techtarget.com/definition/ICT-information-and-communications-technology-or-technologies. Accessed 6 Aug. 2018.

enhance the teaching learning process.Technology is an important component of all the T&L processes involved in education. It brings the "holistic transformation of education in a digital era".[2]

Components of ICT:[3]



Technology Integration:

"When the Internet can provide easy access to entertaining conspiracy theories and pseudo-scientific articles, there is more need than ever to enable young people to engage in rational scientific discourse and practices." (Anastopoulou, Sharples, Ainsworth, Crook, O'Malley and Wright., 2012, p. 252)

Technology to promote inquiry based teaching :

"It is time we shifted our focus from technology integration per se, to promoting technology - enabled learning" (Ertmer & Ottenbreit-Leftwich, 2012, p. 175).

Technology has lead to shift away from teacher-centred, lecture oriented towards learner centred, interactive and constructivist learning environment. ICTs such as videos, television and multimedia computer software that combine text, sound, and colorful, moving images can be used to provide challenging and authentic content that will engage the student in the learning process. The visual's combined with chalkboard method aided judiciously with the textbook and syllabus, can work wonders in getting across abstract concepts and logics to the children in a short span of time.[4] With this paradigm, students take on more active roles in learning, they design and they learn from each other by interacting with each other in group work. Students have taken the baton of constructing knowledge Teachers, on the other hand, play the roles of an arranger, a guide and a leader rather than a source of correct answers

[2] "ICT Tools for STEM Teaching and Learning - Stem Alliance." http://www.stemalliance.eu/documents/99712/104016/STEM_A_and_MS_ICT_Tools_in_Edu_paper_v06_Final.pdf. Accessed 6 Aug. 2018.

[3] "https://www.google.com.ph/imgres?imgurl=http://cdn.ttgtmedia.com ...." https://empowermenttech12.wordpress.com/tag/httpswww-google-com-phimgresimgurlhttpcdn-ttgtmedia-comrmsonlineimagesict_components_desktop-jpgimgrefurlhttpsearchcio-techtarget-comdefinitionict-information-and-communications/. Accessed 6 Aug. 2018.

[4] "Importance of ICT in Education - IOSR journals." http://www.iosrjournals.org/iosr-jrme/papers/Vol-1%20Issue-4/B0140308.pdf. Accessed 12 Aug. 2018.

in the classroom (Anderson, 1997). Multimedia and ICT can play the role of catalyst for such educational reforms. Multimedia courseware can promote effective instruction that is more engaging; learner centred, interdisciplinary and more closely related to real life events and processes and adaptive to individual learning styles and needs. It also encourages higher order thinking skills and help to construct knowledge socially. [5]

Personalised Example in Grade 9 Physics class :

Topic:Electricity

Learning objective: Students will be able to explain how electric current flows in a circuit.

Steps to be followed to encourage collaboration ,contribution,community :

1. **Group work using video as a tool :**Students are put into group to first have hand on experience of all electrical instruments used to make circuits.(Traditional lab supported with visual/video to get familiar with electrical instruments used to make circuits)-Video as a learning tool to collaborate.
2. **Inquiry based teaching using Simulation as an ICT tool :**Once students are aware of the components then they will be made to make electric circuits using simulation. (https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab)
3. **Collaboration skill used with technology:** Group work to build different circuits using presentation to explain Series /parallel combination further building it through simulation .
4. **Problem /Project based teaching through collaboration :** Students finally solve numericals based on the topic and finally prepare a prezi presentation online to reflect on the learning.https://prezi.com/
5. **Formative assessment using online tool for quizzing using kahoot .** https://kahoot.it/
6. **Summative assesment: using Google form / online quiz sites** (Eg: https://gradegorilla.com/micro/circuits/M_circuits1.php

In the inquiry based - constructivist classroom, both teacher and students think of knowledge as a dynamic, ever-changing view of the world we live in and the ability to successfully stretch and explore that view - not as inert factoids to be memorized. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. As students explore the topic, they draw conclusions, and, as exploration continues, they revisit those conclusions. Exploration of questions leads to more questions.

Science curriculum can be best understood when inquiry method aided with ICT TOOL is at the forefront.

Student engagement with science:

The issue of student engagement with the subject of science remains a key concern for educators both internationally and nationally. In the Australian context, Tytler (2007) calls for a 're-imagining' of science education in order to combat the evidence of a continuing decrease in student enthusiasm for science subjects and related career pathways. The draft national K-10 Australian Curriculum for

[5] "Enhancing Teaching & Facilitating Learning ... - UNESCO-UNEVOC." https://unevoc.unesco.org/fileadmin/up/emergingtrendsinictforeducationandtraining.pdf. Accessed 12 Aug. 2018.

Science (Australian Curriculum, Assessment and Reporting Authority 2010, p.1) states that "an issue for science education in Australia is not so much the performance of our students on international tests, but rather student engagement and interest in science". [6]

Use of a simple simulation (https://phet.colorado.edu/en/simulations/category/physics).PhET Interactive simulations incorporates research-based practices on effective teaching to enhance the learning of science and mathematics concepts therby making the students an inquirer.

These are: mobile technologies, social media, simulations / virtual environments,/Loggers/sensors and digital video. Various software packages, computer based instruction, drill-practice and simulation, microcomputers, multimedia, multimedia journal, hypermedia, Intel training program „Teach to the Future", affable reading tutor, online learning, synchronous and asynchronous learning, blended learning, web 2.0 tools, MOODLE module, CDROM, Macromedia Flash MX and lean media e-learning instructional material, distance-learning module etc. can be use to make learning more meaningful.

Sample Experiment Examples with Topic

In my 9th grade Physics / IBDP class, I do the following experiments using Logger Pro and sensor probes:

1. **Motion Detector**: Topic: **Mechanics**

   Used to teach students how distance and velocity graphs work. Students must move in front of a sonar to make a graph display different types of motion. They learn that slope is speed and that curved graphs imply acceleration on a distance vs. time graph.
2. **Force sensor/accelerometer**: Topic: **Mechanics**

   when these probes are attached to a cart, shaking the cart with the force sensor causes an acceleration. Graphing force and acceleration yields a nice straight line graph in support of F=ma: Newton's Second Law.
3. **Brightness vs. distance using Intensity meter**: Topic :**Light ,Astrophysics**

   students use a light sensor to measure the brightness of a small light bulb as a function of distance to discover the inverse-square law for light and also apply this relationship to gravity.
4. **Voltage and current sensors**: Topic **Electricity , Astrophysics**

   students use a variable-voltage power supply to change the voltage on a fixed resistor. The sensors detect voltage and current, and are used to discover Ohm's law, V=IR.
5. **Picket fence**: Topic: **Mechanics**
   When a transparent object with a series of regularly spaced black bars (the pickets) falls through a photogate, the computer can detect how far and how fast it falls to measure the motion of a falling object.
6. **Temperature vs. time for melting ice**: Topic: **Thermal Physics**

   Activity to understand specific heat capacity, latent heat capacity shows how temperature changes occur during the phase change of solid to liquid to gas.[7]
7. **Pressure sensor:** students can draw P,V,T graphs to understand gas laws.

[6] (n.d.). Exploring ICT integration as a tool to engage young people at a .... Retrieved August 3, 2018, from http://eprints.jcu.edu.au/19735/6/19735_Wilson_and_Boldeman_accepted_version_.pdf

[7] "Using Logger Pro for Experiments | Low End Mac." 21 Dec. 2000, http://lowendmac.com/2000/using-logger-pro-for-experiments/. Accessed 7 Aug. 2018.

Engaging and Empowering student , teacher's learning process in IBDP Physics IA & EE using ICT through Modeling Tool :

One of the most important aspects of technology in education is its ability to level the field of opportunity for students. —John King, U.S. Secretary of Education .

Technology can be a powerful tool for transforming learning. It can help affirm and advance relationships between educators and students, reinvent our approaches to learning and collaboration, adapt learning experiences to meet the needs of all learners.

(A) Modeling Tool /Simulations / virtual environments for Physics Education:

1. **Tracker software & Motion Sensor:** [8]

   Tracker is a free video analysis and modeling tool built on the Open Source Physics (OSP) Java framework. It is designed to be used in physics education.Tracker is a free, open source video analysis and modeling tool that enables students to create particle model simulations real-world objects .

2. **Geogebra:**

   GeoGebra is a Dynamic Mathematics Software (DMS) for teaching and learning .GeoGebra was created to help students gain a better understanding of the content since it supports the competency "Mathematical Modelling".

3. **Graphical Analysis™ for Chrome™ :**It enables science students to collect and analyze data from one of Vernier's direct-to-Chromebook USB devices or a LabQuest® 2 interface.

4. **Logger Pro:**[9]Logger Pro: is data-collection and analysis software for Windows and Mac computers.

Benefits of Loggers :

- Loggers is one such software that has provided convenience in the collection of math and science data. Its interactive features equipped with visuals makes learning an intuitive process for the students.
- Logger is intuitive, straightforward, and inexpensive .Logger Pro allows students and teachers to have a very straightforward analysis of the data you collect in lab.

Student Friendly

- Students can Write labs in Logger Pro or export data to Word or Excel.
- Loggers Includes over 1,000 experiment files supported by our library of lab books.
- Students have an opportunity to develop your own experiment files to match your curriculum.
- Loggers can help students to collect live data from more than 80 different sensors and devices.
- Use a variety of data-collection modes, as needed, for your experiment: time-based data, selected events, events with typed-in entries, photogate, radiation counting, and more.
- Manually enter data for graphing and analysis of graphs, tables, and text to describe your experiment.
- Read values and slope from graphs using examine and tangent line tools.
- Print graphs and data tables.

[8] "Tracker Video Analysis and Modeling Tool ...." https://physlets.org/tracker/. Accessed 6 Aug. 2018.

[9] "Logger Pro® | Vernier - Vernier Software & Technology." https://www.vernier.com/products/software/lp/. Accessed 6 Aug. 2018.

- Model data with user-adjustable functions.Extract data from movies using frame-by-frame video analysis.

Advantages of using Modelling in Physics Laboratory Reports:

- Model Builder creates kinematic and dynamic models of point mass particles and two-body systems.
- External models animate and overlay multi-point data from separate modeling programs such as spreadsheets and Easy Java Simulations.
- Model overlays are automatically synchronized and scaled to the video for direct visual comparison with the real world.[10]

Few Personalised Examples showing use of ICT tools:

Example 1:

Internal Assessment Physics SL (IBDP Exam May 2017)

Topic: Study of the effect of size on the projectile drag of a basketball (for a given angle and force)

Aim

To find out whether a change in ball size and weight will affect the projectile drag of a basketball being shot from the free throw line (15 feet away from the hoop horizontally).

Research Question

How will varying the size of a basketball (sizes 3, 4, 5, 6 and 7) affect the projectile drag in order to make the ball reach the hoop at a height of 3.05 meters (+ 0.0005) and horizontal distance of 4.57 meters (+ 0.0005)?

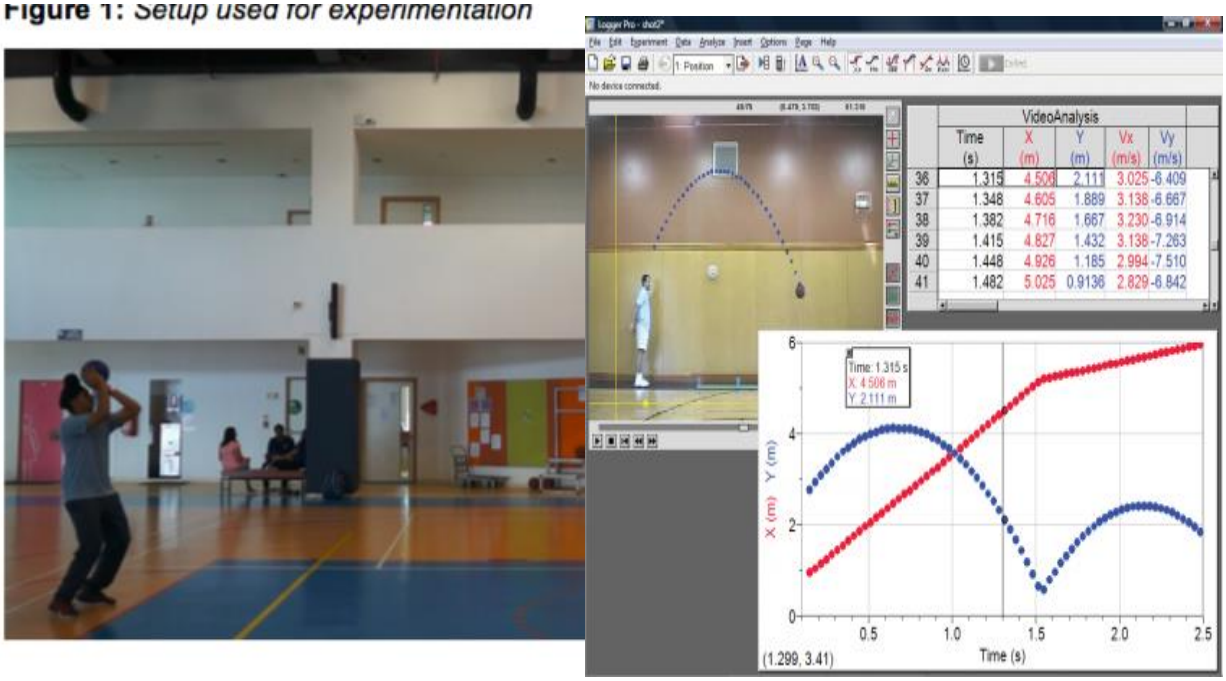
Background Information (in appendix)

Methodology for Data Collection

1. First, I will shoot a basketball size 3 from the free throw line (15 feet away from the hoop) into the ring. The initial and final velocity of the ball will be measured using force sensors and recorded. The angle at which the ball is released will also be recorded via the camera.
2. This will be repeated 4 more times for precision.
3. This process (steps 1 and 2) will be repeated for basketball sizes 4, 5, 6 and 7.

[10] "Tracker Video Analysis and Modeling Tool ...." https://physlets.org/tracker/. Accessed 11 Aug. 2018.

Figure 1: *Setup used for experimentation*



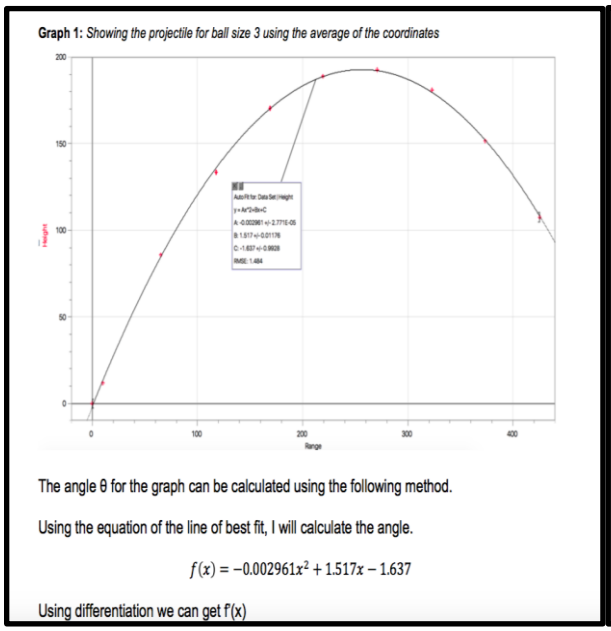
Analyze videos to study two-dimensional motion.

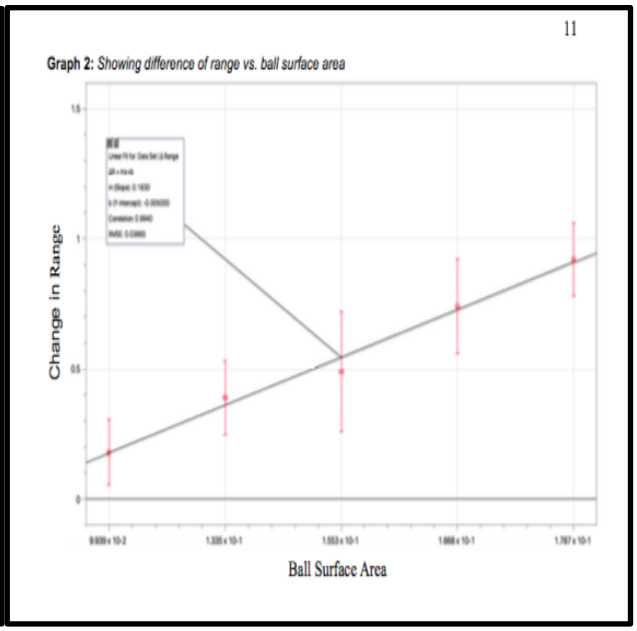
4. The uncertainty in the time: Will be 0.01 seconds, since this is the least count of the time, which is calculated digitally and not using a stopwatch.
5. The uncertainty of the 'X' and 'Y' coordinates: will be 0.01 cm, since this too is measured **digitally using the tracker software.**

Processed Data(Data table in Appendix)

We can use the above information by plotting the points on a graph in using logger pro /graphical analysis to calculate the final velocity, maximum height and the range of the ball. The line of best fit will allow us to calculate the angle at which the ball is released and also the maximum height.

Use of logger pro in combination with tracker software/Graphical Analysis & Motion sensor help to get detailed characteristics of the complete throw.Every minute detail and motion including horizontal velocity ,vertical velocity can be traced to visualise the whole motion in totality.





The graph on right (Graph 2) shows how as the ball size (the surface area) increases, the difference between the actual range and the theoretical range changes.

Summary of Example 2 :

As the surface area of the ball increases, the projectile drag on the ball increases .The equation on the graph shows us that as the surface area of the ball being shot in the basket increases, the air resistance acting on the ball, i.e. the projectile drag on the ball is greater.

Example 2:

Extended Essay Physics HL (IBDP Exam May 2017)

Research Question: How does the Shearing Stress of Motor Oils affect the Work done by the Piston in a 4-stroke Internal Combustion Engine used in Automobiles?

Abstract:

The research topic relates to the subject Physics from my core curriculum. This research paper explores the question, "How does the shearing stress of motor oils affect the work done by the piston in a 4-stroke internal combustion engine used in automobiles?" Shearing stress is mainly affected by temperature, among other factors, and that is the only factor used in this research.An experimental approach was used. Three experiments were conducted to answer the research question.

Experiment 1 was conducted to find the rpm of the two motors at different voltages. (use of photogate sensor to study various kinds of motion. With six modes of operation, time, velocity or acceleration can be measured with one or two photogates and associated timing cards, as well as showing pictorially the status (digital 1 or 0) of the voltage output of the photogate as timing cards pass through it.)

Experiment 2 was used to find the efficiency of one of the motors to input into the torque formula. (use of vernier current ,voltage sensor)

Experiment 3 was used to find the current required by the motor to run at different temperatures in the motor oil to calculate the torque. The current values from this experiment were used to calculate the torque on the motor shaft and obtain the effect of shearing stress on work done.Results suggested that an increased shearing stress caused a greater torque on the motor shaft.

Introduction -

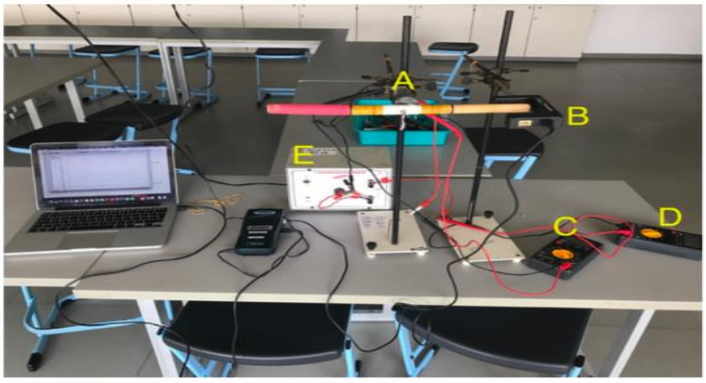
(a) Context and Significance of research: (in appendix..)

(b) **Experimental Data collection :**(in appendix)

(C) **Procedure :**(in appendix)

Methodology

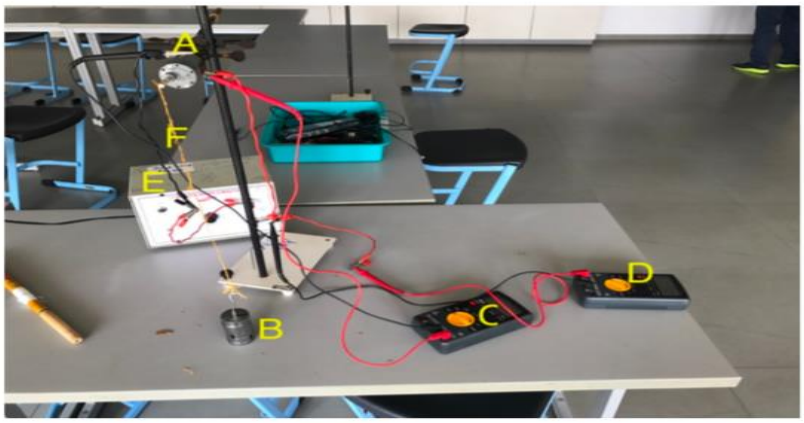
i] Experiment 1: Determine the rpm of the two motors at different voltages



A = Motor
B = Photogate
C = Multimeter measuring voltage
D = Multimeter measuring current
E = Power Supply

Image 2 – Experiment 1 Set-up (Self 2016)

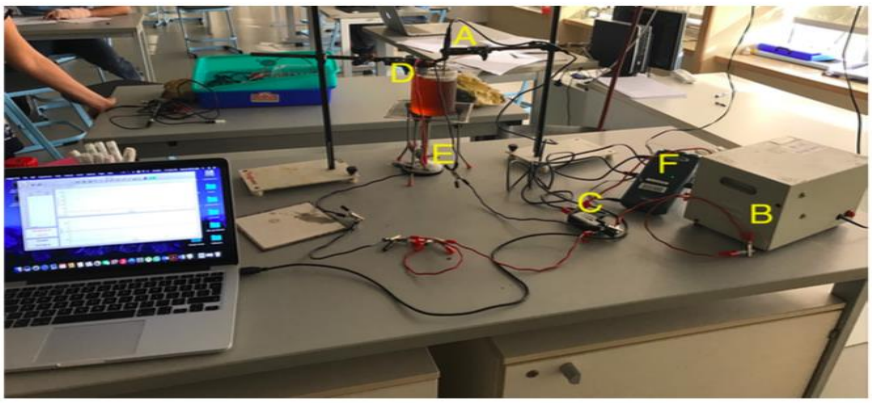
ii] Experiment 2: Calculate the efficiency of the 12V motor



A = Motor
B = 6kg Mass
C = Multimeter (Voltage)
D = Multimeter (Current)
E = Power Supply
F = Thread length l / height h

Image 3 - Experiment 2 Set-up (Self 2016)

iii] Experiment 3: Calculating torque on motor shaft due to different shearing stress



A = Vernier Thermometer
B = Battery Eliminator
C = Vernier Ammeter
D = 3V Motor with shaft dipped in 5W-30 motor oil
E = Bunsen Burner
F = Vernier Interface

Image 4 - Experiment 3 Set-up (Self 2016)

Summary of Example 2 :

It was discovered that decreasing the shearing stress decreased the work done by a motor. Due to the increased temperature, the torque due to oil decreased. Hence, the motor had to do lesser work to rotate inside the oil. To maintain the efficiency, the power input and output both decreased which reduced the current inside the circuit, answering the research question.

Conclusion and Findings:

In Today's instructional world student's ought to think ,rethink ,discover , discover construct and reconstruct .ICT and its tools in education offers the following advantages:

1. Students study real objects ,identifying forces with tracking and analyzing motion.
2. Visual comparisons are rapid, intuitive and capable of discerning fine differences.
3. Visual agreement may validate models more convincingly than numerical or graphical comparisons for students.
4. Visual disagreement leads naturally to explorations of limitations and refinements of models.
5. Quantitative analysis of model and/or video data can support and extend the visual comparison. In addition to the modeling capabilities described in this paper,

Science is a field of study, an applied body of knowledge, a way of living and a competitive tool and strategy that is not only important to individual, but to national goals and posterity.Teachers of science therefore have a great responsibility in ensuring that students understand and appreciate the nature of science (NOS) as they have appreciated the nature of technology (NOT) and its values. Loggers have made the work easy ,accurate and user friendly for both students and teachers.[11]

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[11] (2013, September 25). Understanding the Challenges of Science Education in the ... - SciPress. Retrieved August 3, 2018, from https://www.scipress.com/ILSHS.4.35.pdf

References:

Link for the 2 Examples discussed:
https://drive.google.com/drive/folders/1W5PvR8K93EAxIHlDfCuuD-uyX2LnPdNY?usp=sharing

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Appendices:

Link for the 2 Examples discussed:
https://drive.google.com/drive/folders/1W5PvR8K93EAxIHlDfCuuD-uyX2LnPdNY?usp=sharing

Section A:

Following is one of the method ICT can improve and enhance learning, both in formal learning and in informal settings.

(A)**Modeling Tool for Physics Education /Simulations / virtual environments :**

5. **Algodoo:**[12]

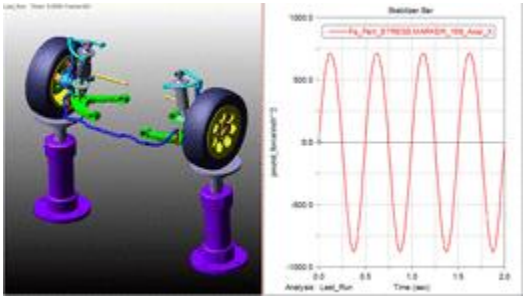
   Algodoo is a unique 2D-simulation software from Algoryx Simulation AB. Algodoo is designed in a playful, cartoony manner, making it a perfect tool for creating interactive scenes. Explore physics, build amazing inventions, design cool games or experiment with Algodoo in your science classes. Algodoo encourages students and children's own creativity, ability and motivation to construct knowledge while having fun. Making it as entertaining as it is educational. Algodoo is also a perfect aid for children to learn and practice physics at home.

6. **Comsol Multiphysics:**[13]

   COMSOL Multiphysics is a simulation software using finite element analysis to solve various problems in engineering, physics and chemistry. The uniqueness of COMSOL Multiphysics, over other FEA software packages is its ability to solve coupled phenomena.These are phenomena for which the solution of each individual physical problem cannot be obtained independently of the others. Examples of these include combined fluid dynamics/chemical engineering or heat transfer/mechanical engineering problems.

7. **Adams :**[14]

   The Multibody Dynamics Simulation Solution Adams helps engineers to study the dynamics of moving parts, and how loads and forces are distributed throughout mechanical systems.



(B)Mobile Technology :

1. **Dropbox:** Put your creative energy to work with Dropbox https://www.dropbox.com/ Can access their files from other devices they've connected to their personal networks, meaning they never leave an important digital document at home.
2. **Science 360:** Android and iDevice owners listen to audio and watch video on all the sciences here, making it an absolutely perfect resource for sharing with students and boosting personal knowledge.

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[12] "Tracker Video Analysis and Modeling Tool ...." https://physlets.org/tracker/. Accessed 6 Aug. 2018.
[13] "Comsol Multiphysics." https://www.sp.se/en/index/services/calculations/comsolmultiphysics/Sidor/default.aspx. Accessed 6 Aug. 2018.
[14] "Adams - The Multibody Dynamics Simulation Solution - MSC Software ...." http://www.mscsoftware.com/product/adams. Accessed 6 Aug. 2018.

3. **Google Apps: (Google forms,Google sheets,Google docs)**More of a spacious suite of multiple apps rather than just one, these offerings by Internet juggernaut Google enhance any classroom with access to an Android, iPad, iPhone, Blackberry, Windows Phone, or other mobile gadget.
4. **Edmodo:** If social media outlets like Facebook and Twitter don't provide enough privacy for discussions and sharing classroom materials, Edmodo might fill that gap because it specifically targets teachers hoping to work closely with their students online.
5. **Google classroom :Google Classroom** is a free web service developed by Google for schools that aims to simplify creating, distributing and grading assignments in a paperless way. The primary purpose of Google Classroom is to streamline the process of sharing files between teachers and students. [https://classroom.google.com
6. **Quizlet:** Quizlet makes simple tools for learning. Improve your grades by studying with flashcards, games and more.
7. Kahoot : **Kahoot**! is a free game-based learning platform that makes it fun to learn – any subject, in any language, on any device, for all ages!https://kahoot.it/
8. **Popplet** : **Popplet is a tool for the iPad and web to capture and organize your ideas. Mind mapping game.popplet.com/ For School. In the classroom and at home, students use Popplet for learning. Used as a mind-map,Popplet helps students think and learn visually.**
9. **Padlet :** Padlet is like paper for your screen. Start with an empty page and then put whatever you like on it. Upload a video, record an interview, snap a selfie, write your own text posts or upload some documents, and watch your padlet come to life. Once others add to it, the page will update in real time. https://padlet.com/

Section B :

Link for the Example1,2 discussed:
https://drive.google.com/drive/folders/1W5PvR8K93EAxIHlDfCuuD-uyX2LnPdNY?usp=sharing

Example 1:

Background Information (in appendix)

In projectile motion, the horizontal and vertical components are independent. However, when applied in a practical situation, air resistance must be taken into account. By increasing the size of the object, the air resistance will also increase due to the change in surface area. This results in projectile drag of the ball.

To derive the equations of motion for a projectile traveling through the air, Newton's Second Law will be used, which states:

$F = ma$…….... (1)

Where *'F'* is the sum of all the forces applied, *'m'* is the mass of the object, and *'a'* is the acceleration of the object. The velocity can be split into two components- horizontal and vertical. However, only the horizontal component will be required. The equations for the horizontal components are:

$V_{(x)} = V_{(xo)}$..... (2)

$x = V_{(x)}\, t$ …….(3)

Where *'$V_{(x)}$'* is the velocity along the x-axis (horizontal) and *'$V_{(xo)}$'* is the initial velocity along the x-axis. This will remain constant through the projectile, since the horizontal component is unaffected by the vertical component. *'x'* is the horizontal distance, and *'t'* is the time taken.
I will also be using a few mathematical concepts, such as calculus, which will be used in order to find the angle at which the ball is released. Lastly, I will be using the SUVAT equations. The one which will be used is:
$V=s/t$ ……..(4) Where *'s'* is the displacement and *'t'* is the time taken.
Using these equations, I will derive how the projectile drag will increase due to the change in size of the object, and by how much.

Equipment

Table 1: *Equipment list for experimentation*

Sr. Number	Equipment	Quantity
1	Basketball size 3 (Radius- 3.50 in)	1
2	Basketball size 4 (Radius- 4.06 in)	1
3	Basketball size 5 (Radius- 4.38 in)	1
4	Basketball size 6 (Radius- 4.54 in)	1
5	Basketball size 7 (Radius- 4.70 in)	1
6	High-Speed Camera	1
7	Laptop with *Tracker* software (version 4.8)	1
8	Measuring tape	1

Variables

Table 2: *List of dependent and independent variables*

Type of Variable	List of Variables
Independent Variable	• Ball size • Angle at which ball is released
Dependent Variable	• Maximum height of projectile • Projectile drag on ball

Table 3: *Control variables*

Variable	How is it controlled
Horizontal Displacement	The ball was shot from a fixed position (the free throw line), which is 4.57 meters from the hoop horizontally.
Vertical Displacement	The basketball hoop is 3.05 meters high from the ground, and I shall shoot the ball from a height of 2.10 meters from the ground. Hence the vertical displacement is controlled.
Force applied on ball	The action while shooting the ball is the same for all the trials. This being the same, the force applied on the ball is assumed to be constant.

Raw Data Table

The following tables show the average of the time and position of the ball.

For 0.49 seconds, the average of the x-coordinates for ball size 3 is:

$$\frac{10.05 + 10.04 + 9.84 + 9.77 + 10.35}{5} = 10.01\ cm$$

For 0.49 seconds, the average of the y-coordinates for ball size 3 is:

$$\frac{12.11 + 11.48 + 11.91 + 11.68 + 11.97}{5} = 11.83\ cm$$

Table 4: Average of *data collected for ball size 3*

Time (s)	X-coordinate (cm)	Y-coordinate (cm)
0.00	0.00	0.00
0.49	10.01	11.83
0.92	65.15	85.82
1.29	117.74	133.40
1.66	168.99	170.35
2.19	219.25	188.93
2.59	270.84	192.57
2.92	323.04	180.92
3.45	373.44	151.58
3.61	425.37	107.47

Table 5: Average of *data collected for ball size 4*

Time (s)	X-coordinate (cm)	Y-coordinate (cm)
0.00	0.00	0.00
0.44	31.47	43.00
0.84	60.38	73.09
0.93	118.63	120.52
1.27	147.36	138.06
1.61	189.53	156.71
1.99	217.51	165.30
2.39	238.78	167.91
2.60	273.86	169.03
2.97	294.01	166.42
3.26	328.71	157.83
3.65	356.69	145.89
3.92	398.49	122.01
4.38	412.29	112.31
4.49	435.06	98.88

Table 6: Average of *data collected for ball size 5*

Time (s)	X-coordinate (cm)	Y-coordinate (cm)
0.00	0.00	0.00
0.89	16.78	26.40
1.02	27.47	44.08
1.28	54.63	71.79
1.47	96.75	110.04
1.95	139.43	137.20
2.26	169.37	152.17
2.52	198.88	162.12
2.87	229.23	169.27
3.03	258.01	171.97
3.36	304.61	168.45
3.85	350.77	153.06
4.06	381.11	139.42
4.26	426.00	116.69

Table 7: Average of *data collected for ball size 6*

Time (s)	X-coordinate (cm)	Y-coordinate (cm)
0.00	0.00	0.00
0.23	16.83	26.27
0.26	41.25	57.56
0.72	68.98	84.36
1.02	95.79	108.54
1.36	123.66	128.00
1.61	152.05	143.77
1.97	192.01	159.54
2.30	232.86	167.71
2.62	260.36	165.35
2.99	273.95	160.77
3.22	301.36	154.44
3.75	326.91	142.30
4.05	355.26	128.07
4.52	380.80	108.73
4.87	409.39	88.11
4.93	421.81	77.16

Example 2 :

Introduction - (a) Context and Significance of research:

Shearing stress is an important factor be considered when deciding the optimal motor oil for a 4-stroke engine. A motor oil serves various purposes inside an engine. These oils act as lubricants to increase the life cycle of the engine, absorb the heat from the moving parts inside the engine and act as a coolant, and also prevent the corrosion of the internal parts of the engine (Brian 2017). Hence, the shearing stress of the oil needs to be suitable to ensure smooth running of the engine and not harm the performance of the internal components. Clearly, if not of the right shearing stress, an oil can affect the efficiency of an automobile.When studying electricity in IBDP-2, I realised that resistance to a circuit component has an effect on the circuit's power output (Hamper 2014). Having an interest in automobiles, I was reading about engines when I got thinking about motor oils. Due to the importance they carry in the working of an automobile, it is important to study and understand them in detail to ensure that they aid and not harm an engine. Shearing stress is one of less explored areas raising the question, "How does the shearing stress of motor oils affect the work done by the piston in a 4-stroke internal combustion engine used in automobiles?"

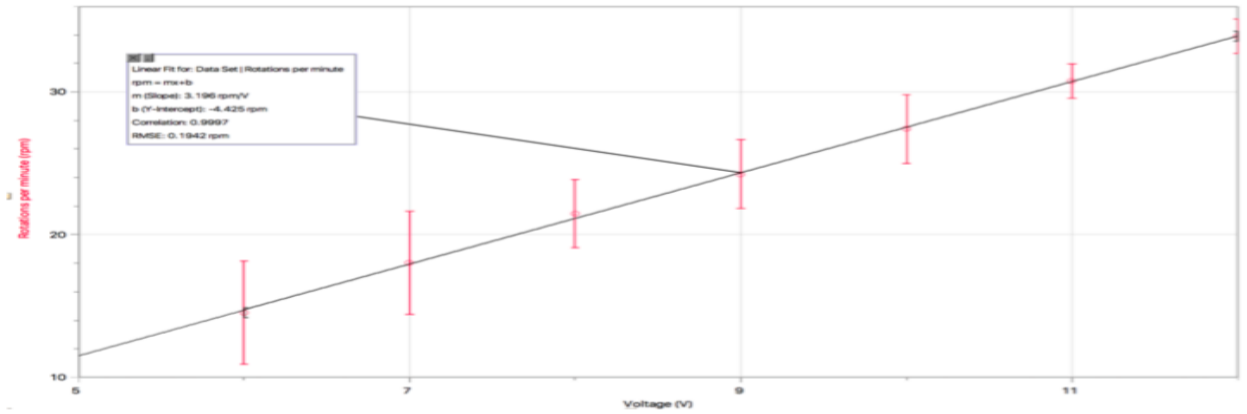
(b) **Experimental Data collection :**(in appendix)

The three experiments were performed to determine the effect of shearing stress on the work done by the machinery inside a 4-stroke engine. All three experiments were performed with two motors with different rpms and voltage ranges and the data obtained from both was compared. The aim of the first experiment was to establish a relationship between the voltage being supplied to a motor and the rpm of the motors. The second experiment was conducted to determine the efficiency of the motors. The results from these two experiments allowed the torque of motors at different voltages to be calculated and relationship between the current and torque was established. The aim of the third experiment was to find the current output of the motors during interaction with different motor oils at different temperatures, to be able to calculate the torque on the shaft of the motors, within the oil, and answer the research question.

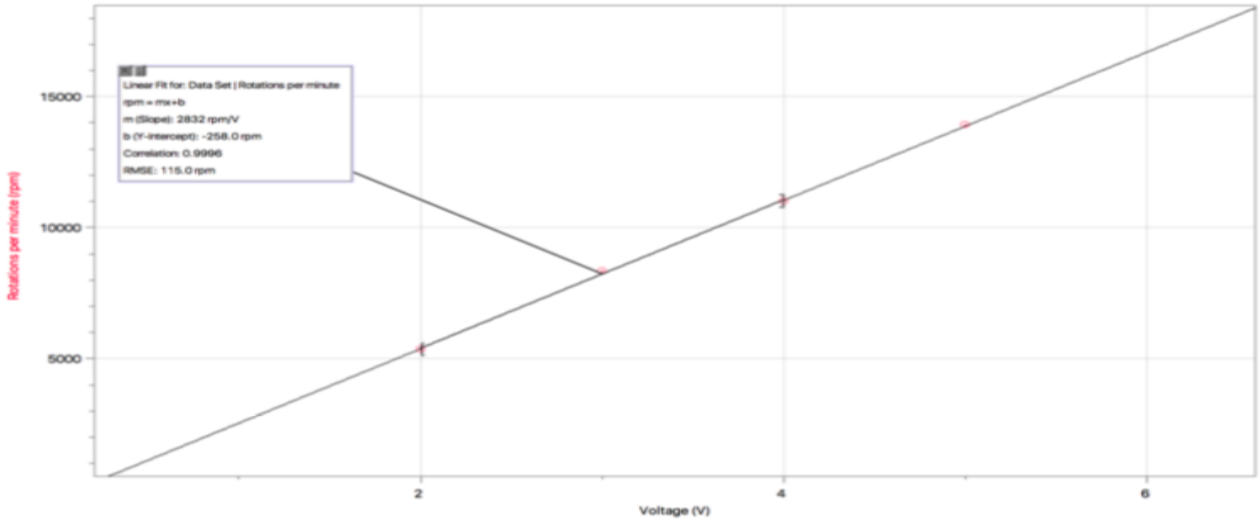
(C) **Procedure :**

Two motors, 12V 30rpm and 3V 8000 rpm were used in this and all following experiments. The procedure described mentions only the 12V motor but was followed for both the motors. A power supply with the capacity to supply varying voltages was taken. The motor was connected to the two terminals of the power supply using crocodile wires and the connections were tested. A wooden beam with a hole in the centre was taken. This beam was then fitted on the shaft of the 12V motor (fan blade in case of the 6V motor). A metal string was also passed through the hole in the shaft and around the beam to tighten the connection. The motor was then fit on a clamp stand and the two clamps were tightened to hold the motor firmly in place. A Vernier photogate was used to measure the time taken to complete half a revolution. The photogate was also placed on a clamp stand and positioned in such a way that the rotating object on the shaft of the motor would block the beam of light. **The photogate was then configured to measure the time difference between half rotations for 15 seconds.** The experiment was first conducted at a supply voltage of 6V which was then increased by 1V till the supply reached 12V (2V till 5V for the other motor). The motor was allowed to rotate for some time after the supply was switched on to allow the voltage to stabilize. Only then was the photogate started to collect data. Since the time taken for half rotation was measured using the photogate, the rpm of the motor could be mathematically calculated.

Graphical representation:

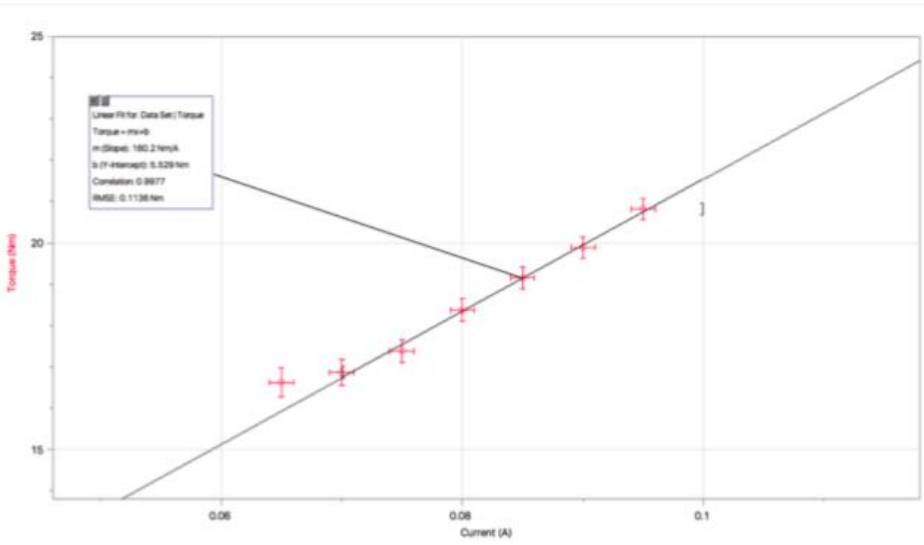


Graph 3 - Rotations per minute v/s Voltage for 12V motor (Self 2016)

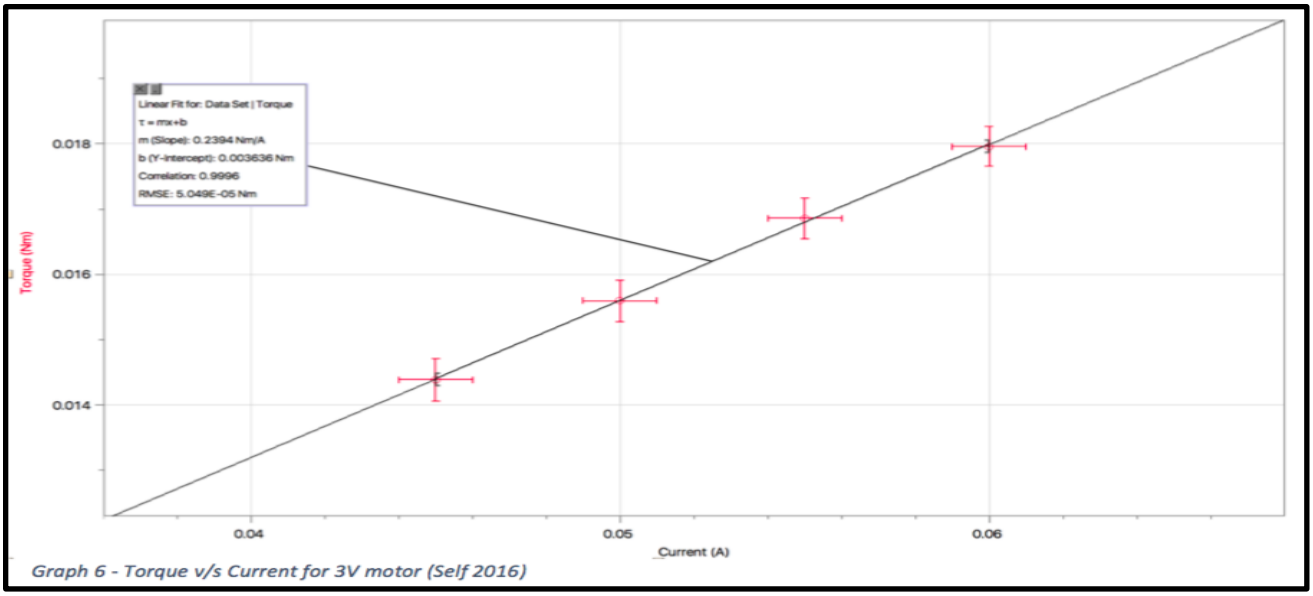


Graph 4 - Rotations per minute v/s Voltage for 3V motor (Self 2016)

Graphical Representation:

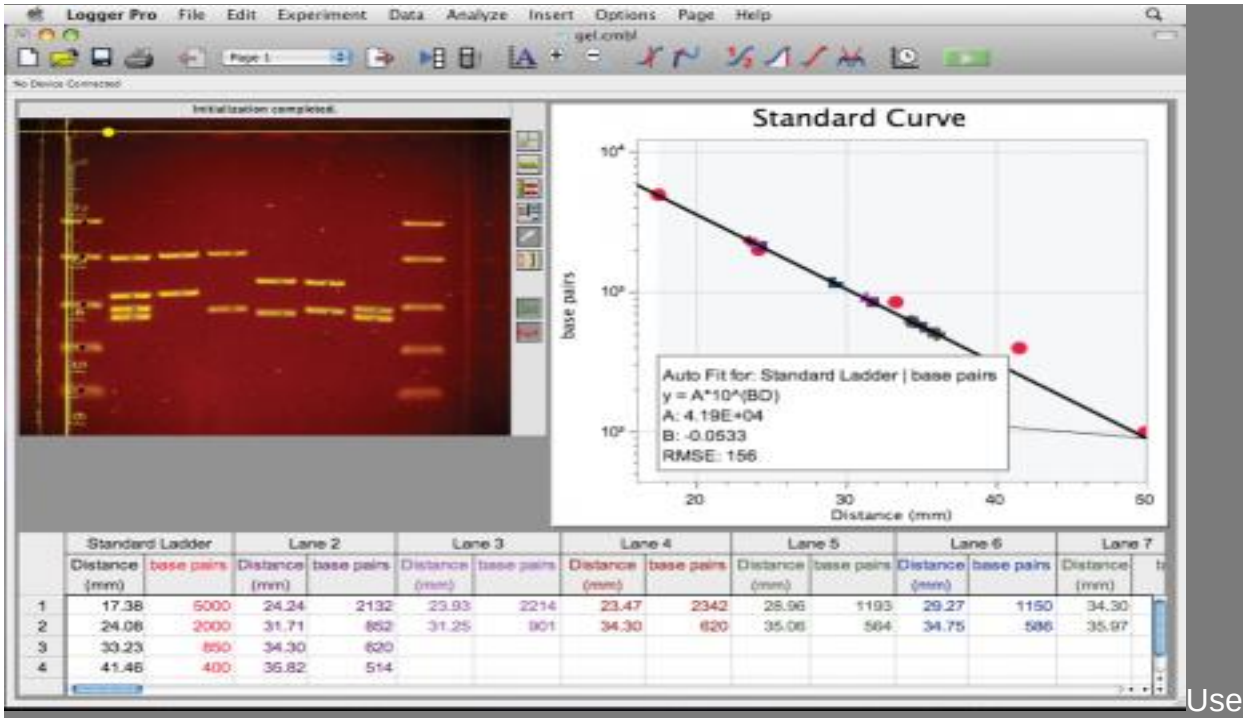


Graph 5 - Torque v/s Current for 12V motor (Self 2016)

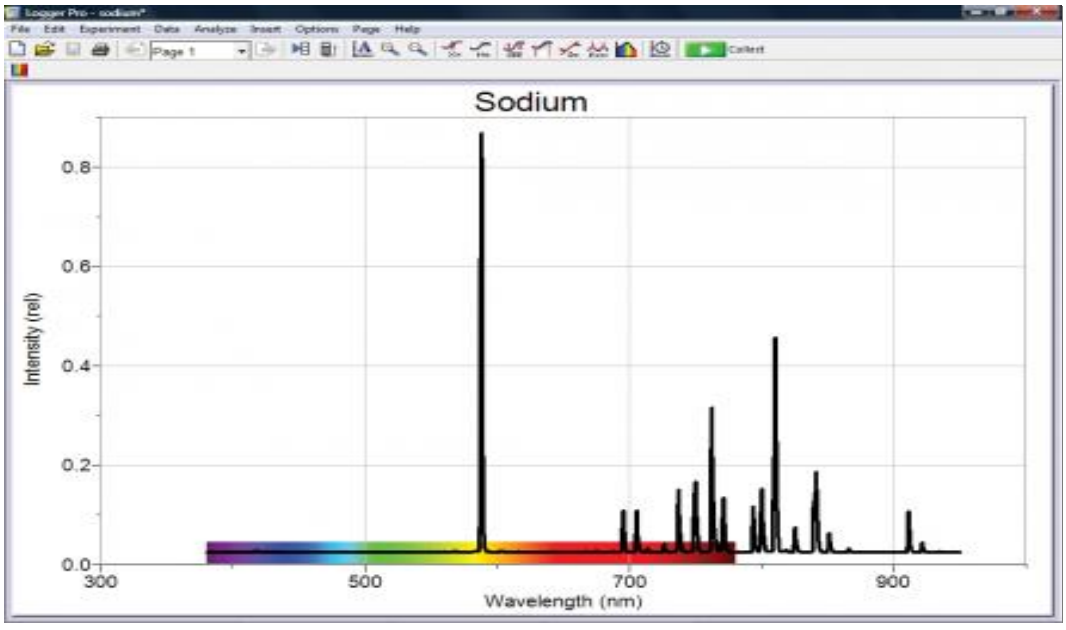


Graph 6 - Torque v/s Current for 3V motor (Self 2016)

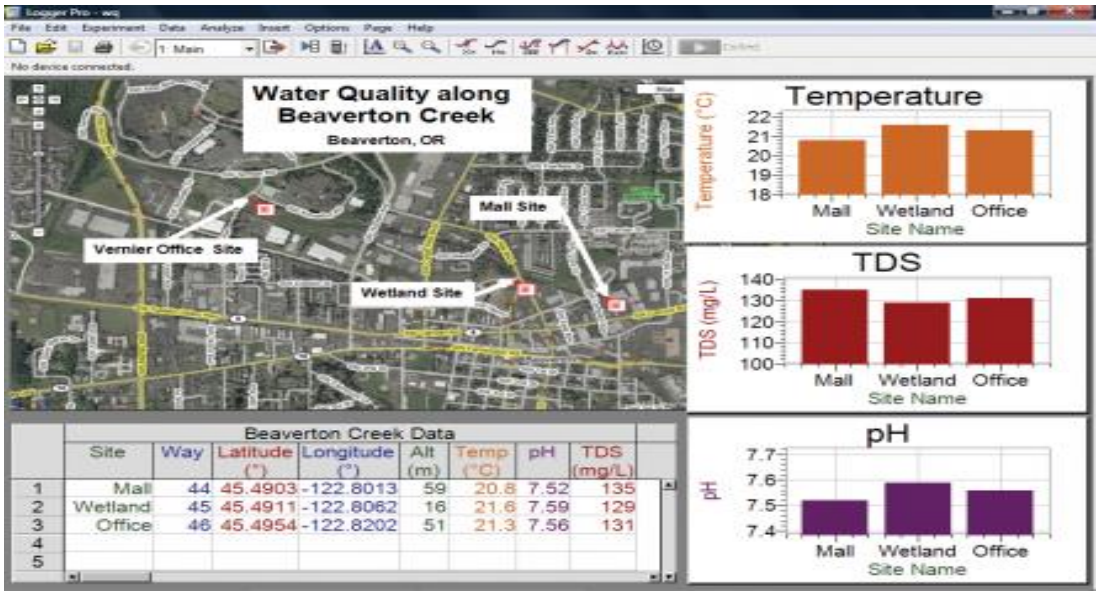
Section C : Graphical representation to represent various Physical phenomenon in Physics lab work using Data Loggers:



Use one of our digital bioimaging systems, along with Logger *Pro*, to analyze gel electrophoresis data.



Use the Ocean Optics Red Tide Spectrometer to study emission lines from discharge lamps.



Export water quality data to Google Maps and incorporate the result into a Logger *Pro* page

Properties and Applications of Carbon Nanotubes: A Review

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Abstract

Having outstanding properties, such as high melting point, high chemical stability, high aspect ratio, high mechanical strength, good electrical and thermal conductivity, carbon nanotubes (CNTs) represent one of the most unique inventions in the field of nanotechnology that has potential applications in many fields. CNTs are seamless cylinder of rolled up graphene with sp^2 hybridization. CNTs have potential applications in the field of nanotechnology, nanomedicine, transistors, actuators, sensors, membranes, and supercapacitors. There are various techniques which can be used for the synthesis of CNTs. These include the arc-discharge method, chemical vaporize deposition (CVD) and the laser ablation method. CNTs can be single-walled, double-walled and multi-walled. CNTs have unique mechanical, electrical and thermal properties, all of which have been extensively studied. The present review is focused on the properties and applications of CNTs.

Keywords: Nanotechnology, carbon nanotubes, properties, applications.

1. Introduction

In recent years, much research has focused on nanoscience and nanotechnology. Researchers uses CNTs for various research works such as cold cathode based field emission, nanocomposites, supercapacitors, sensors, actuators, energy storage devices, targeted drug delivery, nanoelectronics and many more applications. Nanotechnology may bring evolutionary changes to everyday life.

1.1 Nanotechnology

The word “nano” is from the Greek, meaning dwarf (small); scientific treatment at the nano level (atomic level) with the help of special scientific instruments is known as nanotechnology, which has become a well-known field in the last three decades. The word “nanotechnology” was coined by Norio Taniguchi in 1974, in Japan. He stated that, “nanotechnology mainly consists of the processing steps of the separation, consolidation and deformation of materials by one atom or one molecule [1]. Nanotechnology is a vast field which explores many facts about the structures and properties of materials.

1.2 Carbon nanotubes (CNTs)

CNTs, also called buckytubes, are cylindrical carbon molecules with unique properties that make them potentially useful in a wide variety of applications. These include applications in nano-electronics, optics, and materials applications. CNTs exhibit extraordinary strength as well as unique electrical, mechanical and thermal properties. CNTs are the members of the fullerene family, which was discovered by Kroto et al. [2] in 1985. Buckyballs are spherical fullerenes, whereas CNTs are cylindrical, with at least one end typically capped with a hemisphere with the buckyball structure. The name CNT derives from the size, as the diameter of a nanotube is on the order of a few nanometers. Iijima [3] first synthesized multi-walled carbon nanotubes (MWCNTs) in 1991 using a simple arc-evaporation method. CNTs, also known as tubular fullerenes, are cylindrical graphene sheets of sp^2-bonded carbon atoms.CNTs can be divided into three categories on the basis of the number of tubes present in the CNTs. These are, Single-walled CNTs (SWCNTs) are made of a single graphene sheet rolled upon itself with a diameter of 1–2 nm. The length can vary depending on the preparation methods, Double-walled CNTs (DWCNTs) are made of two concentric carbon nanotubes in which the outer tube encloses the inner tube and Multi-walled CNTs (MWCNTs) consist of multiple layers of graphene rolled upon itself with diameters ranging from 2 to 50 nm depending on the number of graphene tubes having an approximate inter-layer distance of 0.34 nm. CNTs can be prepared by various methods, such as the arc-discharge method, chemical vapor deposition (CVD), and laser ablation.

2. Properties

CNTs reportedly have extremely high surface areas, large aspect ratios, and remarkably high mechanical strength. The tensile strength of CNTs is 100 times greater than that of steel, and the electrical and thermal conductivities approach those of copper. CNTs are also good incorporating agents due to their unique electrical, mechanical and thermal properties.

2.1. Electrical properties of CNTs

CNTs show electrical properties in chiral forms. Researchers have demonstrated that CNTs exhibit unique conductive properties. These results were the first to suggest that geometric differences such as defects, chirality, different diameters and the degree of crystallinity of the tubular structure greatly influence the electronic properties of CNTs. SWCNTs are metals with resistivities that range from 0.34×10^{-4} to 1.0×10^{-4} ohm-cm. Considering the bonding of the carbon atoms in CNTs, arranged in a hexagonal lattice, each carbon atom is covalently bonded to three neighbor carbons via sp^2 molecular orbitals. Thus, the fourth valence electron remains free in each unit, and these free electrons are delocalized over all atoms and contribute to the electrical nature of CNTs. Thus, CNTs can be conducting or semi-conducting types depending on the type of chirality. Semiconducting SWCNTs are usually in the form of p-type semiconductors. MWCNTs are composed of many tubes of SWCNTs and therefore are not likely to be strictly one-dimensional conductors. A pseudo-gap was observed in I –V measurements, which attributes to its conducting nature. From the above discussion, we note that the electrical properties of both SWCNTs and MWCNTs have been relatively well explored. This area has been a field of great interest since the last decade. SWCNTs, due to the ballistic nature of electron transport, can be described as quantum wires. On the other hand, transport in MWCNTs is found to be fairly diffusive or quasi-ballistic. CNTs, due to their electronic nature, can be used in transistors and other switching applications in advanced electronics. The most recent application of nanotubes was as an emitter. The important aspect of CNT emitters is that the emission can be obtained at a lower threshold voltage. CNTs can also be used in sensors, micron-scale on-chip triodes at a high frequency (>200 MHz), vacuum microelectronics, and for X-ray generation.

2.2. Mechanical properties of CNTs

CNTs are considering as the strongest materials in nature at this point. The literature suggests that CNTs are very strong materials, especially in the axial direction. The Young's modulus ranges from 270 to 950 GPa, while the tensile strength is also very high, in the range of 11–63 GPa. Several reports have shown that in the radial direction, CNTs are rather soft. The first TEM observation of radial elasticity showed that Vander Waal's forces can deform two adjacent nanotubes. Later, nano-

indentations with an atomic force microscope (AFM) were performed by different groups of researchers to measure the radial elasticity of MWCNTs quantitatively, and tapping/contact mode AFM was recently used to examine SWCNTs. The results showed that CNTs are in fact very soft in the radial direction. The radial direction elasticity of CNTs is important, especially for the formation of CNT nanocomposites and their mechanical properties, in which embedded tubes are subjected to large deformation in the transverse direction when a load is applied to a composite structure. Because the carbon-carbon bonds observed in graphite are among the strongest in nature, CNTs have excellent potential as they are the stiffest and toughest structure ever synthesized by scientists. Studying CNTs under TEM has shown that these materials are flexible and do not break upon bending. Earlier theoretical calculations were carried out to predict the mechanical properties of CNTs. The first attempt to determine the Young's modulus for individual MWCNTs was performed by Treacy et al. [23], who measured the amplitudes of thermal vibrations in CNTs under TEM. They demonstrated that nanotubes possess an average Young's modulus of Y = 1–1.8 TPa, which is extremely high compared to commercially available carbon fibers (Y ≥ 800 GPa). Various research groups performed direct measurements of the bending forces of MWCNTs as a function of the displacement inside an AFM. The values for the Young's modulus were found to be between 0.32 and 1.47 TPa [4]. Falvo et al. [4] observed that MWCNTs could be bent at sharp angles without undergoing any structural fracturing using an AFM tip. Endo et al. observed that while breaking vapor-grown CNTs in liquid nitrogen, an inner tubule could survive this pressure. Zhu et al. applied high pressures (50 GPa) at room temperature, using shock waves, to arc-discharge MWCNTs and noted that the tubes do not break but collapse; that is, the outer shells transform into curled graphene domains while the inner cores display structural defects. More theoretical work on the mechanical properties of CNTs was carried out by Sinnot et al., who found that SWCNTs could exhibit a Young's modulus as high as that of diamond. Yakobson [5] and Ru [6] proposed a mechanism of CNT transformation under uniaxial tension, leading to pentagon-heptagon defects in these tubes under high stress. Guanghua et al. [7] also showed theoretically that the mechanical properties of SWCNTs are mainly dependent on the diameter. They estimated the theoretical Young's modulus of nanotubes, of »1 nm diameter, is in the range of 0.6–0.7 TPa. Hernandez et al. [8] also obtained theoretical values of the Young's modulus which were in close agreement with those obtained experimentally for MWCNTs (1–1.2 TPa). They also reported that the increase in diameter is proportional to the enhancement of the mechanical properties and that if the diameter is increased to a certain value, the Young`s moduli of the tubes approach those of planar graphite. Yu et al. measured the Young's modulus of individual SWCNTs, reporting values between 320 and 1470 GPa and determining a breaking strength of SWCNTs on the perimeter of each rope ranging from 13 to 52 GPa.

2.3. Thermal properties of CNTs

As rolled graphitic structures, CNTs are of great importance and interest not only for their electronic and mechanical properties, but also for their thermal properties. Although their size is very small, the quantum effects are important and the low-temperature specific heat and thermal conductivity show direct evidence of the 1-D quantization of the phonon band structure in CNTs. The incorporation of pristine and functionalized nanotubes to different materials can double the thermal conductivity for a loading of only 1%, showing that nanotube composite materials may be useful for thermal management applications in industries. Kim et al. [9] measured the thermal conductivity of individual MWCNTs and found it to be 3,000 W/K (higher than that of graphite) at room temperature. Beside this they also determined that the value is two orders higher than the magnitude those obtained for bulk MWCNTs. A similar study was carried for SWCNTs, with this result being greater than 200 W/m K for SWCNTs. There are several factors which influence the thermal properties such as the number of phonon-active modes, the length of the free path for the phonons, and boundary surface scattering. These properties also depend on the atomic arrangement, the diameter and length of the tubes, the number of structural defects and the morphology, as well as the presence of impurities in the CNTs.

3. Applications of CNTs

Nanotechnology is one of the latest and the most developed technologies, presenting many advantages and benefits for new materials with significantly improved properties. Nanotechnology can be used in different applications in various fields, including nano-medicine, energy storage and in sensors. Although the fields of nanotechnology are vast and new materials come into use regularly, the potential of CNTs is most promising. Since their discovery by Iijima [3] in 1991, CNTs are the most rapidly growing nanomaterials in the field of nanotechnology due to their various applications. Many investigators and researchers have dedicated much effort to the creation of novel properties and to expanding the number of novel applications in diverse fields, from materials science, medicine, electronics and energy storage. More attractive applications of CNTs can be achieved through the use of CNTs for applications that require conductivity and a high absorption capacity and for the creation of high-strength composites, fuel cells, energy conversion devices, field-emission devices, hydrogen storage devices, and semiconductor devices [10]. Wastewater treatment by CNTs is also a rapidly growing field for those who are interested in adsorption studies. The major problem associated with CNTs is their high cost and non-renewable characteristic. At present, special efforts are in progress to develop certain preparation methods for CNTs which minimize their cost. Some of the very important and promising applications of CNTs are discussed below in detail.

3.1. Cold cathode based field-emitter

CNTs can be used in electric devices as field-emission sources. This can be done when a potential is applied between the CNT surface as cathode and the anode. Electrons are easily emitted from their tips due to the curvature present in the CNTs in the form of pentagons or due to the presence of oxidized tips. With this principle, CNTs can be used for the fabrication of multiple electronic devices, including flat-panel displays, intense light sources, bright lamps [10], and X-ray sources. Although CNTs are good emitters, nanocomposites of CNTs are also excellent electron-emission surfaces which are vacuum stable. There are many advantages when using CNTs as an electron emitter. These include long lifetimes of the components, stable field-emission over prolonged time periods, low emission threshold potentials, the absence of the need for an ultra-high vacuum, and high current densities. It has been reported that large current densities as high as 4 A/cm^2 [11] can be achieved.

3.2. Batteries

Lithium (Li) is a useful element, as it offers unique properties due to its lowest electronegativity and because electrons are easily donated from Li. Thus, it is the best candidate for the fabrication of lightweight and efficient batteries. However, despite the above advantages, the high reactivity of Li limits its applicability, as the metal loses its efficiency. This problem can be solved by the combining an application of CNTs and Li by intercalating Li ions within CNTs. This enables Li^+ ions to migrate from a graphitic anode to the cathode. A separating medium is required between the anode and cathode, usually polyolefin. The theoretical Li storage capacity is expected to be 372 mAh/g when intercalated with CNTs. The charge and discharge phenomena in these batteries are controlled by the Li^+ intercalation and de-intercalation rates. Recently, Frackowiak and Beguin [12] showed that CNTs could be used in Li ion batteries. According to these authors, a high irreversible capacity is possible for CNTs. Meunier et al. [13] carried out calculations to determine the charging and discharging phenomenon in Li+ batteries. They suggested that by damaging the surface of the SWCNT materials chemically or mechanically, one can increase the electrochemical storage of these batteries. On the basis of such possibilities, many electronics companies have begun to use carbon nanofibers and nanotubes as the electrodes in Li+ batteries to enhance their storage capacity and lifetimes.

3.3. Supercapacitors

Due to their large surface area as well as their high electrical conductivity, CNTs are excellent materials for use in electrochemical devices [11]. Niu et al. [14] and Ma et al. [15] were the first to demonstrate that with sheet electrodes of pyrolytically grown MWCNTs, it is possible to achieve

very high specific capacitances in individual cells in devices containing 38 wt% of H_2SO_4 as the electrolyte. The cells could reach power densities that exceeded 8,000 W/kg. Recently, a similar study was carried out by Frackowiak and Beguin [12] and Ma et al. [15], who demonstrated that MWCNT-polypyrrole composites are able to reach specific capacitances of 163 F/g. CNT supercapacitors are used in applications to devices that require high power capabilities and higher storage capacities. The power densities approach 20 kW/kg at energy densities of 7 Wh/kg [12]. CNT-embedded supercapacitors can be used to provide fast acceleration and to store braking energy electrically for hybrid electric vehicles.

3.4. Sensors

Sensors are important detecting devices that are now widely used in different fields. The efficiency of biosensors and molecular sensors can be enhanced by attaching CNTs onto them. With chemical force microscopy techniques, Wong et al. [16] were the first to demonstrate that it is possible to sense functional chemical groups attached onto the ends of CNTs. Thus, it is possible to construct various types of sensors containing nanotube composite pellets, which are very sensitive to gases and which can be used to monitor leaks in chemical plants. Collins et al. [17] reported after working in a similar field that SWCNTs are extremely sensitive to air and vacuum conditions by noting large variations in the electrical resistance levels of their SWNT samples. They also added that MWCNTs can be used as efficient sensors for NH3, H2O, CO2 and CO. Varghese et al. [18] detected changes in the resistance and capacitance levels of CNTs when the environment was slightly modified. In 2002, highly sensitive and fast-responsive microwave-resonant sensors were prepared for detecting NH3 using either SWCNTs or MWCNTs. In addition to gas sensing, CNTs and its composites can be used as sensitive environmental pressure sensors. Wood and Wagner noted that CNTs are very sensitive to liquid immersion or polymer-embedding processes, as the nanotubes slightly deform in the presence of different liquid media [19].

3.5. Energy storage

Due to their hollow cylindrical nature, CNTs can act as efficient gas and metal containers. It has been found that many important chemical species, such as metals, metal carbides, and oxides, can be introduced into CNT core by different methods, including (a) chemical treatments, arc-discharge methods, solid-state reactions and electrochemical techniques. However, the major issues pertaining to these techniques are related to the fact that CNTs are not able to encapsulate gaseous substances. Recent studies have revealed that H_2 and Ar can be stored in SWCNTs and MWCNTs, respectively. Terrones et al. [21] demonstrated experimentally that it is possible to introduce gaseous nitrogen inside MWCNTs using a single-step process. They also reported that MWCNTs can be loaded via the spray pyrolysis of ferrocene and benzyl amine solutions. Similar work was carried out by

Trasobares et al. [22], but they used a powder pyrolysis of ferrocene and camphor under an ammonia atmosphere. The storage of different chemical species in CNTs may be advantageous for the fabrication of fuel cells for use mainly to power electric vehicles. It is important to emphasize that the hydrogen storage capacity of CNTs ranges from 0.1 to 66 wt %. Hirscher et al. [23] proved that the influence of impurities (coming from the CNT synthesis methods) may be responsible for reported previously results showing uptake levels as high as 7%. From a theoretical point of view, density functional theory has been used to calculate the H_2 storage capacity in CNTs. Different mechanisms by which CNTs possibly adsorb hydrogen molecules were proposed, including chemisorption, adsorption at interstitial sites, and the swelling of the nanotube array. The adsorption of other gases such as He, NH3, N2, and SF6 in CNTs as well as carbon foams, was recently achieved by Tanaka et al. [24].

3.6. Scanning probe tips

Scanning probe tips are of great importance as they can be used to obtain images with better resolutions. If a MWNT-bound scanning probe is used instead of a normal probe, it becomes possible to obtain a better image resolution as compared to earlier results. Presently, Seiko Instruments and Daiken Chemical Company are attempting to commercialize these probes. Chemically modified nanotube tips can be used as sensors for detecting specific chemical and/or biological groups [20]. These sensors are important to detect added or even illegal substances. Kim and Lieber [25] determined experimentally that it is possible to fabricate nanotube tweezers by attaching two nanotubes onto a probe tip. This nano-tool operates according to the electrostatic interactions between two carbon cylinders. These achievements show clear advance regarding the use of nanotubes in current technologies, and it is clear that in the near future, further advances will be achieved.

3.7. Nanoelectronics

CNTs are important nanomaterials that can be used in electronic devices to improve the properties of these devices. Tans et al. [33] fabricated a three-terminal switch-able device based upon SWCNTs. The SWCNT molecule was semiconducting and connected to metal nanoelectrodes. The performance at a low capacitance level was excellent. The major problem associated with nanotubes is the difficulty in manipulating them; thus, another method was devised to control the length and the electronic properties of individual nanotubes by STM nanostructuring. Postma et al. [26] described that crossings and bends with SWCNTs could be generated by means of AFM. This technique allows us to cut nanotubes into shorter sections using controlled voltages applied at the STM tips and to fabricate tiny nanotube devices that could be useful for the future construction of molecular machinery, nano-scale circuits and other nanoelectric materials. There are many

examples of experimental evidence indicating that CNTs can carry current densities of 10^9 A/cm$_2$; these values are much lower than those observed in metals [12]. Bachtold et al. [27] and Huang et al. [28] demonstrated for the very first time the fabrication of field-effect transistors that exhibit a high favourable gain, a large on-off ratio and room-temperature operation. The researchers showed that one, two and three-transistor circuits exhibit a range of digital logic operations. Examples include an inverter, a logic NOR, a static random-access memory cell, and an AC ring oscillator. A Harvard group in a similar way produced crossed nanowire p-n junctions and junction arrays that were configured as key OR and NOR logic-gate structures, showing substantial gain. They can be used for the development of novel computer technologies in the near future. Derycke et al. [29] demonstrated that CNTs can be used as a FET. The researchers also showed that pristine CNTs always behave as p-type transistors, whereas doped-nanotubes act as n-type devices. Both types could be integrated to fabricate voltage inverters [25]. Javey et al. [30] demonstrated that it is possible to generate logic rings as well as NOR and OR logic gates using arrays of p- and n-type nanotube FETs, as it is difficult to control the chirality of the tubes with the electronic properties. Collins et al. [31] demonstrated that it is possible to peel the outer layers of arc-discharged-produced MWCNTs until the desired electronic properties of the outer shell are obtained. However, controlled growth in order to achieve selective chiralities needs to be investigated and exploited for more electrical applications. Blase et al. [32] also worked with a similar hypothesis and demonstrated that the electronic properties of CNTs can be utilized within polymeric materials to realize desired electrical applications.

3.8. Medical applications

Given the increased profits associated with medical technology related to gene therapy, cancer treatments, and innovative new answers for life-threatening diseases, the science of nanomedicine has become the most rapidly growing field. The unique properties and characteristics of CNTs enable scientists to develop new areas in nanomedicine. SWCNTs and MWCNTs have already proven their potential to serve as safer and effective alternatives to previous drug delivery methods. They can pass through membranes, carrying therapeutic drugs, vaccines, and nucleic acids deep into the cell to the substrate targets. They serve as ideal non-toxic vehicles, which in some cases, increase the solubility of the drug, resulting in greater efficiency and safety. Overall, recent studies of CNTs have shown a very promising future for them in medicine [33].

4. Conclusion

The properties as well as different applications of CNTs were reviewed in this paper. Some of the well-known properties of CNTs were also reviewed and presented and it was concluded that CNTs have a unique set of electrical, mechanical and thermal properties. Due to the greatest potentials of

CNTs, it is clear that novel technologies such as low-cost gas sensors, field emission display, nano composite materials, supercapacitors, targeted drug delivery, energy storage and nanoelectronics will emerge in the near future.

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INVESTIGATIONS ON THE GROWTH AND CHARACTERIZATION STUDIES OF NONLINEAR OPTICAL SINGLE CRYSTAL L-PROLINE ZINC ACETATE

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Abstract

A nonlinear optical material L-Proline Zinc acetate was synthesized and grown as single crystals by slow evaporation method. The grown crystals were subjected to structural, elemental, thermal, optical and dielectric studies. The structural analysis reveals that L-Proline Zinc acetate belongs to the monoclinic crystallographic system with space group P_{21}. Optical transparency of the grown crystals was investigated by UV-vis-NIR spectrum. The thermal analyses reveal that L-Proline Zinc acetate is thermally stable up to 163°C. The dielectric constant and dielectric loss of the crystals were studied as a function of frequency. The nonlinear optical property of the doped crystal was confirmed by the Kurtz-powder second harmonic generation test.

Keywords: Growth from solution, Nonlinear optical crystal, X-ray diffraction, Semi organic compound, Thermal and Dielectric.

1. Introduction

The growth of nonlinear optical (NLO) crystal has become a focus of current research in view of their potential applications in various photonic technologies such as optical communication, optical data storage and information processing, etc..[1-5]. Currently the need is to find and to grow new NLO crystals which are transparent in the visible region and possessing enhanced hyperpolarizabilities and satisfying at the same time all the technological requirements for applications[6-8]. Research in the development of NLO crystals, is being carried out under three different areas such as: Discovery of new efficient NLO materials, Bulk growth of promising NLO crystals to explore the various optical behaviour and Improving the characteristics of NLO crystal by suitable doping. Motivated by the above considerations and based on the literature survey, this paper has been formulated with the following objectives: To synthesize the material and to grow L-Proline Zinc acetate **(LPZA)** ($Zn(C_5H_9NO_2).(CH_3COO)_2$), to characterize the grown crystals in order to understand its structural, vibrational, elementals, optical, thermal, electrical and mechanical properties based on the following studies: X-ray diffraction analysis (by the single crystal and by the powder method), FTIR spectral analysis, Elemental analysis, UV spectral studies, Thermal analysis (TGA/DTA/DSC), Dielectric studies, Microhardness studies and Nonlinear measurements (SHG).

2. Experimental

2.1. Materials and Methods

The starting materials L-Proline ($C_5H_9NO_2$) and zinc acetate ($Zn(CH_3COO)_2$) (analytical grade reagents) were taken in the equimolar ratio. The calculated amount of L-Proline was first dissolved in double distilled water. Then zinc acetate was slowly added to the solution with continuous stirring using magnetic stirrer. The prepared homogeneous mixture of solution was let to dry at room temperature. LPZA salt was synthesized according to the reaction:

$(CH_2\text{-}CH\text{-}CH_2\text{-}CH\text{-}NH_2\text{-}COOH) + Zn\ (CH_3COO)_2 \rightarrow Zn\ [CH_2\text{-}CH\text{-}CH_2\text{-}CH\text{-}\ NH_3\text{-}COO].[CH_3COO]_2$

The purity of the synthesized salt was improved by the successive recrystallization process. Care was taken during heating of the solution and a maximum temperature of 50°C was maintained in order to avoid decomposition. The melting point of LPZA salt was observed to be 216.2°C.

2.2. Solubility diagram

The solubility test gives us idea to select the suitable solvent and temperature to grow good quality single crystals. The solubility of a material in a solvent decides the amount of the material which is available for growth and hence determines the size of the crystal that can be grown [9]. This solubility procedure was repeated for water, ethanol and methanol in the range 30-50°C. The solubility curve was drawn between temperature and concentration. The solubility curve of LPZA is shown in Fig. 1. It is found that the sample exhibits a positive temperature gradient and water is found to be the best solvent to grow the single crystals by slow evaporation technique.

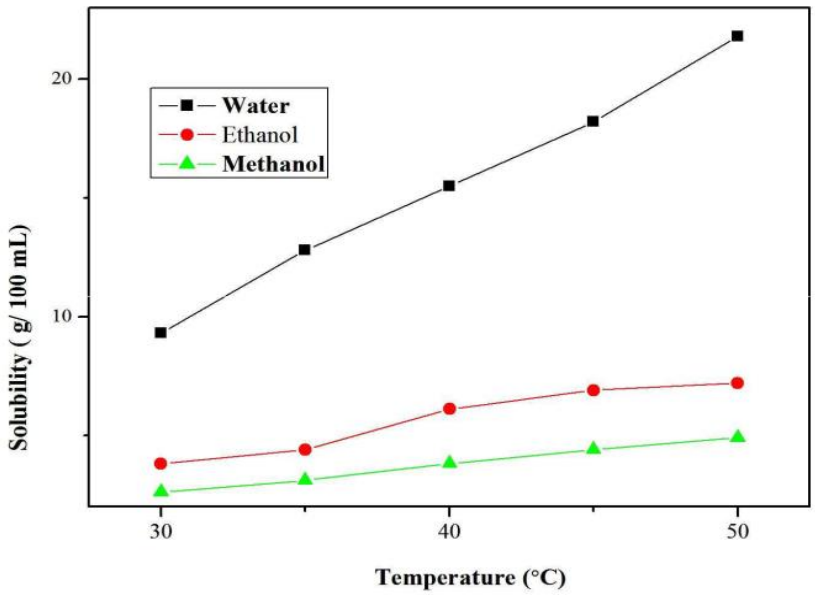

Fig. 1: Solubility curve of LPZA

2.3. Crystal growth of LPZA

Saturated solution was prepared (pH = 5.08) using recrystallized salt of LPZA with double distilled water as solvent at 35°C temperature. The prepared solution was

filtered using Whatmann 41 filter paper to remove the suspended impurities. The solution was taken in beaker and covered with perforated paper. The covered beaker with saturated solution was kept in CTB at 35°C with accuracy of ± 0.01°C. LPZA single crystal of size 24 × 26 × 16 mm^3 was grown by slow evaporation technique and harvested in a growth period of 25 days and is shown in Fig. 2.

Fig. 2: Photograph of as grown crystal of LPZA

2.4. Characterization

The Grown single crystal LPZA was subjected to X-ray diffraction studies using a Bruker AXS Kappa APEX II single crystal CCD diffractometer equipped with graphite monochromated Mo(Kα) (λ = 0.7107 Å). The CHNS analysis for all the grown crystal was carried out using an instrument Elementar Vario EL III-GERMANY, CHNS analyzer. HIOKI 3532 – 50 LCR HITESTER was used for the dielectric study. The sample of size 3 x 3 x 2 mm^3 was prepared and mounted between copper electrodes. In order to ensure good electrical contact between the crystal and the electrodes, the crystal faces were coated with silver paint. The dielectric measurements were carried out in a frequency range 100 Hz – 5 MHz and temperature range 35 – 95 ºC.

The Thermo gravimetric and Differential thermal analyses (TG, DTA & DSC) response curves was drawn for LPZA powder sample in the temperature range from 20 to 1400 °C using the instrument NETZSCH STA 409C at the heating rate of 10 K/min. in nitrogen atmosphere. The optical transmission spectra were recorded using

Shimadzu model - 1601 in the wavelength range of 300 – 1200 nm. The study of NLO conversion efficiency was carried out by the powder technique of Kurtz and Perry. The sample was ground into fine powder and tightly packed in a micro capillary tube. It was mounted in the path of the laser beam. A Q-switched flash lamp pumped Nd:YAG laser of power 3.2 mJ with a wavelength of 1064 nm, pulse duration of 8 ns, a repetition rate of 10 Hz and a spot size of 1 mm diameter was used for SHG test. Vickers hardness study was made on the as grown crystal using Leica-Reichert Polyvar2 model hardness tester fitted with a diamond indentor.

3. Results and discussion

3.1. Single crystal XRD analysis of LPZA

Lattice parameters of LPZA crystal were obtained by single crystal XRD analysis and shown in Table 1. These parameters are compared with L-Proline [10]. From this study it was found that the LPZA crystallizes in monoclinic system (β = 112.73°). The volume of the cell is 792 $Å^3$.

Table 1: Lattice parameters of LPZA

Samples	a (Å)	b (Å)	c (Å)	β (°)	Unit Cell Volume $(Å)^3$	Crystal System
LPZA	10.02	6.43	13.33	112.73	792	Monoclinic
L-Proline	9.701	5.261	11.953	90.66	610	Monoclinic

3.2. Powder XRD analysis of the grown crystals

X-ray diffraction pattern was recorded by crushing the grown crystal into fine powder and the powder sample was scanned over the 2θ range 10-80° at a rate of 1° per minute. All the reflection planes are identified and the obtained 2θ values are used for indexing using Check cell software package. The indexed powder X-ray diffraction pattern of the LPZA crystal is shown in Fig. 3. The well defined and sharp peaks imply the good crystalline nature of the compounds.

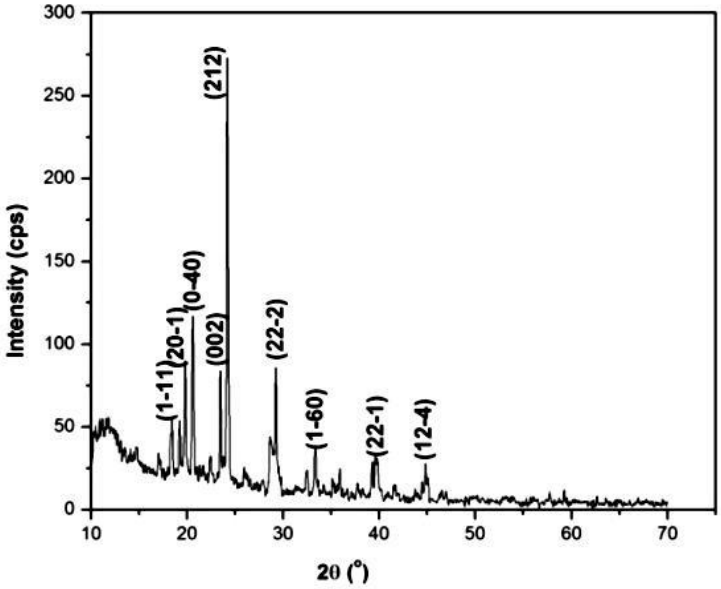

Fig. 3: Powder XRD spectrum of LPZA

3.3. FTIR spectral studies of LPZA

The recorded FTIR spectrum of LPZA is shown in Fig. 4. Considering the molecular structure of L-Proline, the vibrations of crystalline L-Proline zinc acetate may be arised due to internal vibration of functional groups NH_3^+, CH, CH_3 and COO^-. The presence of broad band in high wave number region indicates the presence of hydrogen bonds [11]. A broad strong absorption in the region 3400 - 2100 cm^{-1} corresponds to the NH_3^+ ion of the amino acid. Generally N-H and O-H bonds participate in hydrogen bonding. In LPZA crystal, the valine molecule is protonatedat amino group (NH_3^+) and deprotonated at the carboxylate group (COO^-). The protonation of amino group can be proved because of the presence of strong band at 1611 cm-1 (asymmetric deformation of NH_3^+). The asymmetric stretching vibration of NH_3^+ ion for L-Proline appeared at 3089 cm^{-1}. This band is shifted in LPZA at 3060 cm^{-1}. Moreover, the presence of absorption bands at 2632, 2431, 2213, 2019 and 1896 cm^{-1} can be attributed to the overtone and combination bands of NH3+ bending and C-H stretching vibration overlapping. The presence of COOH is indicated by a sharp absorption band at 1706 cm^{-1}, which is due to the C=O stretching mode of COOH group [12].

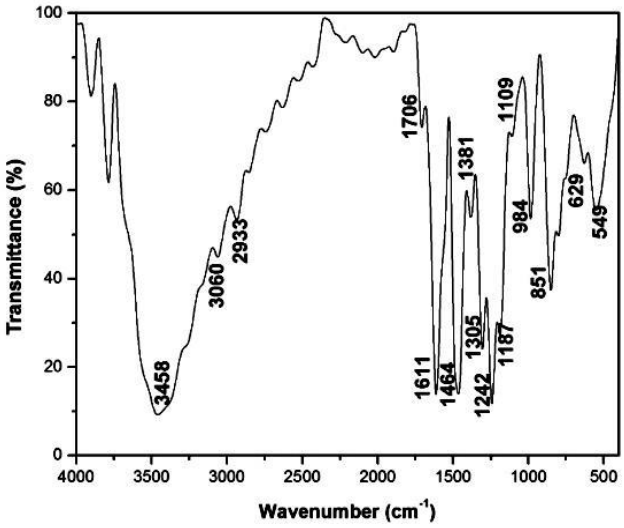

Fig. 4 : FTIR spectrum of LPZA crystal

3.4. Elemental Analysis

Before starting the experiment, the instrument was calibrated carefully and the measurements has a precision of 0.05% by weight. The experimental values obtained are compared with the calculated values and presented in Table 2. The experimental value of the grown crystal is in good agreement with the calculated values. Thus elemental analysis fairly confirms the formation of the new crystal compounds.

Table 2: Elemental analysis of the grown crystals

Sample	Weight (mg)	Carbon (%)		Hydrogen(%)		Nitrogen (%)	
		Expt.	Cal.	Expt.	Cal.	Expt.	Cal.
LPZA	8.6243	40.89	41.17	4.01	4.22	5.08	5.33

3.5. Thermal analysis of LPZA

The recorded TGA/DTA spectra of the LPZA sample are shown in Fig. 4.1. Heating was carried out at a rate of 20°C /min. The initial mass of the material subjected to analysis was 2.9970 mg and the final was only 0.3630% of the initial mass at temperature of about 1100°C indicating bulk decomposition occurring into LPZA crystals. From the TGA curve, the thermal stability of the sample is realized up to 163°C and there after the material shows loss in weight due to the molecules, which are loosely bounded to the metal ion. The major 70% of weight loss between 208°C to 279°C is due to the liberation of volatile substances.

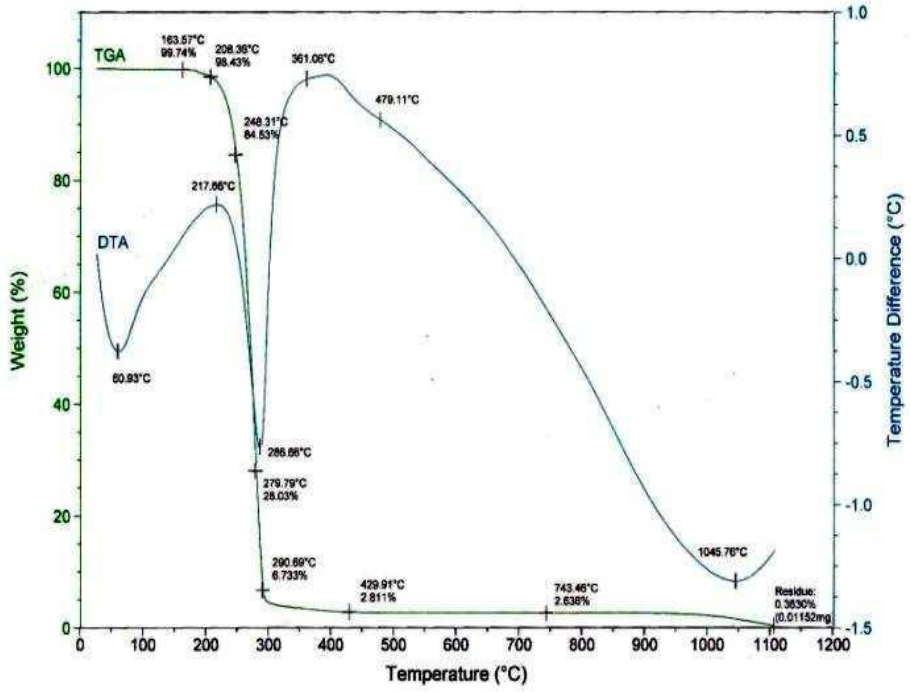

Fig. 5: TGA/DTA curves of LPZA

It is observed from DTA curve, that the material undergoes exothermic transition at about 217°C where the decomposition s tarts. The material is fully decomposed at an irreversible endothermic transition at about 286°C. It is inferred that the melting point of the material takes place in the vicinity of 217°C. The sharpness of the endothermic peak shows good degree of crystallinity of the grown LPZA. The observed DSC spectrum of the LPZA crystal is shown in Fig. 4.2. From DSC spectrum, the specific heat capacity of the LPZA crystal is 649 J/g/°C observed at 286°C.

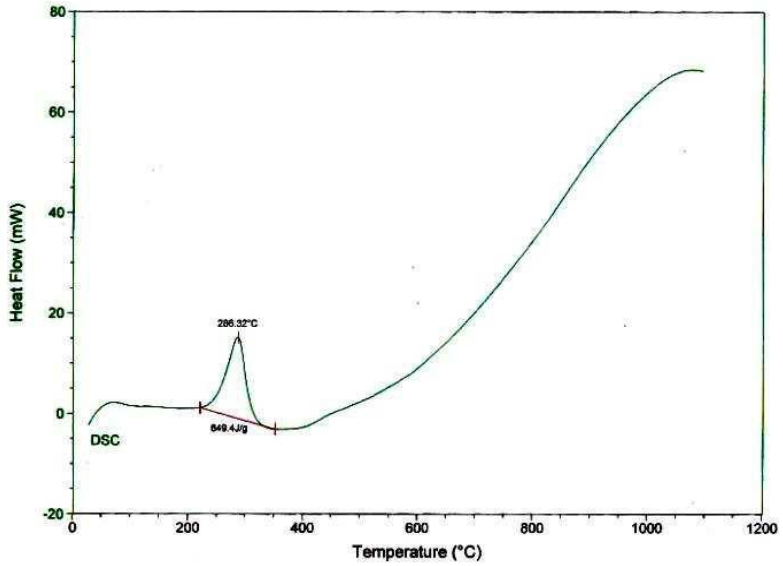

Fig. 6: DSC curve of LPZA

3.6. Vickers hardness measurement

Micro indentation is made on the surface of a specimen with the help of a diamond indenter. The Vickers pyramid indenter where opposite faces contain an angle ($\alpha = 136°$) is most widely accepted pyramid indenter. Indentations were carried out at different loads in the range 25 - 100 g. The Vickers hardness (H_V) was calculated from the relation [13],

$$H_V = \frac{1.854P}{d^2} kg/mm^2$$

The hardness values increase with the increase of the applied load. Usually a decrease in apparent micro hardness with increasing applied load which may be arised due to work hardening, initiate plastic deformation, size of dislocation loops etc,. At small loads, the indenter penetrates only the surface layers and therefore, the effect is shown sharply at the early stages. When the applied load increases, the penetration depth also increases and the overall effect must be due to the surface and inner layers. Consequently in this stage, indentation depth increases proportionally with applied pressure.

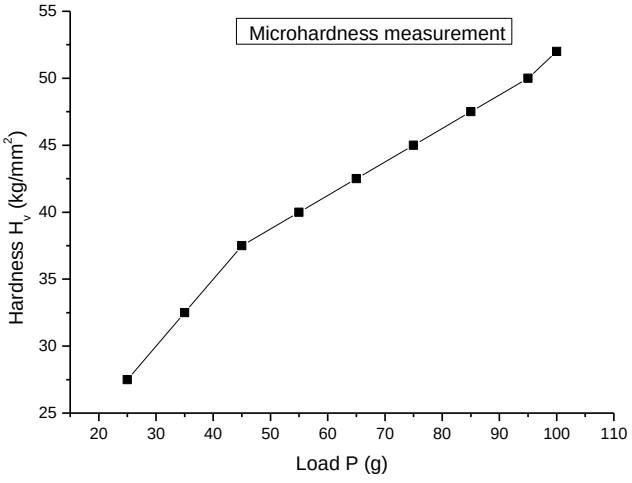

Fig. 7: Variation of Vickers constant as a function of load

3.7. Dielectric studies of the grown crystal

A graph was drawn between the calculated values of dielectric constant (ε') and log frequency. Fig. 8 shows the variation of dielectric values with various frequencies for the grown crystal LPZA at different temperatures. The dielectric constant decreases with increase in frequency for all temperatures and this is termed as anomalous dielectric dispersion [14]. This is a normal dielectric behaviour and can be understood on the basis of internal polarization process [15]. The dielectric constant value depends on the degree of polarization charge displacement in crystal. The dielectric constant of material is due to the contribution of electronic, ionic, dipolar and space- charge polarizations which depend on the frequencies. All these polarizations are active at low frequencies (below 10 KHz). The space charge polarization is generally active at lower frequencies and at higher temperatures [16].

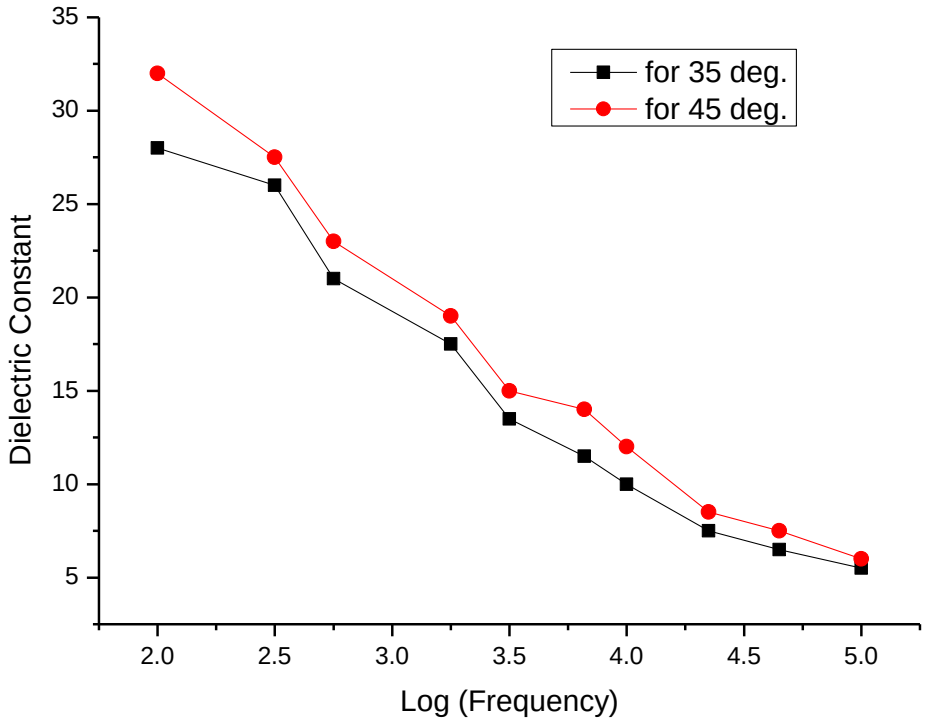

Fig. 8: Dielectric constant of LPZA as a function of frequency at 35°C & 45°C

A material must have low dissipation factor for device fabrication. Dielectric loss values were calculated from the experimental observations and the graph is drawn between the dielectric loss and frequency values. Fig. 9 shows the variation of dielectric loss with applied frequency of the field for the grown crystal LPZA. Fig. show the low dielectric loss at high frequencies suggests that the samples have lesser defects. Also at lower frequencies and at high temperatures, the dissipation factor is due to space charge polarization owing to charged lattice defects [17]. The charge carriers can migrate some distance under the influence of applied fields. Due to blocking of charge carriers at the cathode, space charge region is developed and there will be substantial increase of dielectric loss at lower frequencies. Also the hopping of charge carriers on the lattice surface is thermally activated by an increase in the temperature. Thus the gradual decrease of loss at higher frequency clearly shows defect free optical quality crystals.

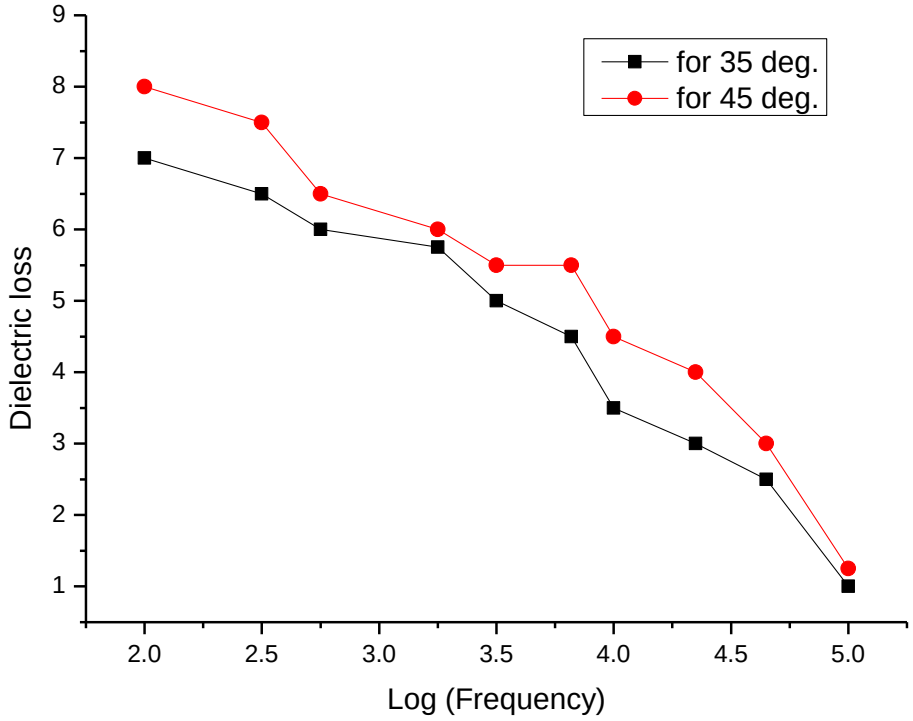

Fig. 9: Dielectric loss of LPZA as a function of frequency at 35°C & 45°C

3.8. Optical transmission study

The fig. 10 shows the optical transmission spectra of LPZA crystal. The thickness of the sample used for this study was 2 mm. It is found that LPZA crystal has transmittance of 66 %. The lower cut off for LVP is 470 nm. Semi organic complex LPZA show their wide transparency in the visible region due to amino acid combination with inorganic metal salts.

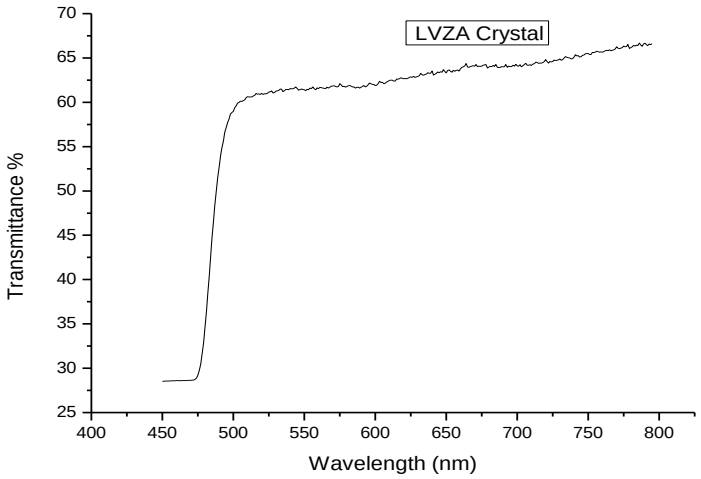

Fig. 10: Optical transmission for LPZA crystal

3.9. SHG efficiency of the grown crystal

In the present work, the SHG efficiency of the powdered samples LPZA was found relatively with KDP. The measured values are presented in Table 3. In semi organic crystals, delocalization of electrons are promoted due to metal ions. Hence LPZA have good relative SHG efficiencies than other organic crystals. Since the second order non linear efficiency will vary with the particle size of powder sample [18], the care has been taken to maintain uniform particle size of source and the reference material.

Table 3: Relative SHG efficiency of the grown crystals

Sample	Laser power (mJ/p)	SHG efficiency of sample (mV)	SHG efficiency of KDP (mV)	Relative SHG efficiency
LPZA	2.4	48	35	1.37

4. Conclusions

Metal organic LPZA material was synthesized, purified and used for solubility studies to find the suitable solvent and temperature to grow good quality single crystals. Good optical quality bulk single crystals were grown with synthesized recrystallized salts from aqueous solution by slow evaporation technique. The structural characterization of the grown crystals was done by single crystal and powder X-ray diffraction studies. From these studies it was found that the LPZA was crystallized in monoclinic system. The indexed powder X-ray diffraction pattern of the grown crystal show the well defined sharp peaks which imply the good crystalline nature of the compound. FTIR spectral studies of the grown crystal confirmed the presence of functional groups in the compound. Elemental analysis gave the details of percentage of element present in the newly formed crystal sample. The experimental value obtained was in good agreement with the calculated values and the analysis confirmed the formation of the new crystal compound.

Thermal analysis of the grown crystals showed the thermal stability of the compounds. TGA of LPZA showed 70% weight loss between 208-279°C and the specific heat capacity was found to be 649 J/g/°C at 286°C. Microhardness of the crystal was performed by Vickers micro hardness test and the hardness increases with the increase of load. From the dielectric measurements, dielectric parameters such as dielectric constant and dielectric loss were calculated. The variation of dielectric constant in metal complex LPZA revealed that, the inclusion of metal ion into amino acid decreases the dielectric constant value. Low dielectric loss at higher frequencies suggests that the sample crystals have lesser defects. UV-vis-NIR spectral study was employed to understand the linear optical properties of the grown crystals. The SHG efficiency of the powdered samples of all the grown crystals was found relatively with KDP by modified Kurtz- Perry technique. LPZA have good relative SHG efficiency.

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A New Generalization of Lindley-Quasi Xgamma Distribution with Properties and Applications

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ABSTRACT

We obtained a new generalization of Lindley-Quasi Xgamma distribution by adding weight parameter to it through weighted technique and have shown the flexibility of proposed model. Expression for reliability measures, order statistics, Bonferroni curves & indices, Renyi entropy along with some other important properties are derived. Maximum likelihood estimation method is put to use for estimation of unknown parameters of proposed model. Simulation study for checking the performance of maximum likelihood estimates and for model comparison is carried out. Proposed model and its related models are fitted to real life data sets and goodness of fit measure Kolmogorov statistic & p-value, loss of information criteria's AIC, BIC, AICC & HQIC are computed through R software to check the applicability of proposed model in real life. The significance of weight parameter is also tested by using likelihood ratio test for both randomly generated data as well as real life data..

Keywords: Weighted Technique, Structural Properties, Simulation Study, Weight Parameter, Bonferroni curves & indices, Renyi entropy, Maximum Likelihood Estimation, Application.

1. Introduction

Probability models are and have been generalized for providing more flexibility in terms of hazard rate, reliability, prediction and moments. Because of presence of extra parameter generalized probability models find greater applicability in real life. Probability models can be generalized by using various methods. One of the method employed for generalizing probability models by adding weight parameter is weighted technique. Weighted models are mostly used in those situations where observations are recorded with unequal probabilities which generally happens in encountered sampling. Weighted models find applications in many fields of real life like forestery, medical sciences, socioeconomic surveys etc. Warren [1] applied the size biased distributions in connection with sampling wood cells. Hassan, Dar and Para [2] introduced a new generalization of Ishita distribution and obtained vital mathematical properties of the distribution along with applications of the proposed model. Hassan, Wani and Para [3] formulated three parameter Quasi Lindley distribution by using weighting technique and obtained various properties of that model. Das and Roy [4] studied the length biased weighted generalized Rayleigh distribution with properties and applications. Patil and Rao [5] introduced weighted distributions and size biased sampling with applications to wild life populations and human families and obtained its properties. Hassan, Wani and Shafi [6] introduced Poisson Pranav distribution and obtained its various mathematical properties along with obtaining applications of the proposed model. Rezaeia, Nadarajah and Tahghighniac [7] worked on a new three parameter life time distribution and studied its properties & applications. Hassan, Wani, Bilal and Akhtar [8] introduced

weighted Quasi Xgamma distribution and studied its properties and applications.

Hassan, Wani, Shafi and Sheikh [9] proposed a introduced Lindley-Quasi Xgamma Distribution (LQXD). With p.d.f, c.d.f and c^{th} moment about origin $E(x^c)$ given below in (1.1), (1.2) and (1.3) respectively

$$f(x,\alpha,\theta)=\frac{\theta e^{-\theta x}}{(\alpha+\theta)^2}\left\{(\alpha+\theta)(\alpha+\frac{x^2\theta^2}{2})+\theta(\theta-1)(1+\alpha x)\right\} \qquad x>0,\theta>0,\alpha\geq 0 \qquad (1.1)$$

$$F(X)=\frac{1}{2(\theta+\alpha)^2}\left[\begin{array}{l}(\alpha+\theta)\left\{2\alpha+2-\left(2\alpha+x^2\theta^2+2\theta x+2\right)e^{-\theta x}\right\}\\+2(\theta-1)\left\{\theta+\alpha-\left(\theta+\alpha\theta x+\alpha\right)e^{-\theta x}\right\}\end{array}\right] \qquad x>0,\theta>0,\alpha\geq 0 \qquad (1.2)$$

$$E(x^c)=\frac{c!\left\{(\theta+\alpha)\left(\alpha+\frac{(c+1)(c+2)}{2}\right)+(\theta-1)(\theta+\alpha(c+1))\right\}}{\theta^c(\theta+\alpha)^2} \qquad (1.3)$$

The important statistical properties along with application in real life were studied for the model given in (1.1).

In this paper we have obtained weighted version of Lindley-Quasi Xgamma (LQXD) distribution with p.d.f given in (1.1).

2. Weighted Lindley-Quasi Xgamma Distribution

Consider X to be a non-negative random variable following Lindley Quasi Xgamma distribution with p.d.f $f(x)$. Suppose $W(x)$ is the non-negative weight function, then the probability density function of the weighted Lindley Quasi Xgamma distribution (WLQXD) is

$$f_w(x,\alpha,\theta,c)=\frac{W(x)f(x)}{E(w(x))}, \qquad x>0$$

Where $w(x)=x^c$ is a non-negative weight function and $f(x), E(x^c)$ are given in (1.1), (1.3) respectively.

$$f_w(x,\alpha,\theta,c)=\frac{x^c f(x)}{E\left[x^c\right]}$$

(2.1)

$$f_w(x)=\frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)} \qquad x>0,\theta>0,\alpha\geq 0,c\geq 0 \qquad (2.2)$$

Proof of (2.2) is a probability density function is given below

Proof: $\int_0^\infty f_w(x)=\int_0^\infty \frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}$

$$=\frac{\theta^{c+1}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\int_0^\infty x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}$$

$$= \frac{\theta^{c+1}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)} \times \frac{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}{\theta^{c+1}}$$

$$=1$$

$$\int_0^\infty f_w(x) = 1$$

So (2.2) is a probability density function

where $\int_0^\infty x^{\beta-1}e^{-\alpha x}dx = \frac{\Gamma\beta}{\alpha^\beta}$ is a gamma function

The plots of p.d.f and c.d.f for different values of parameters are given in graphs 1 & 2 below. Graph 1 indicating that proposed model is positively skewed & platykurtic as well as laptokurtic. Graph 2 Indicating curve starts with zero and ends at one and showing c.d.f is non-decreasing function.

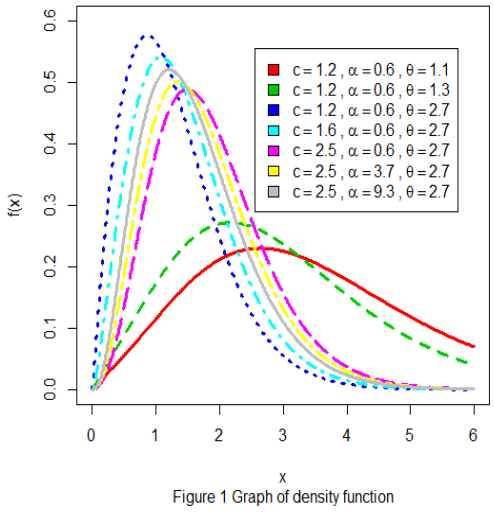

Figure 1 Graph of density function

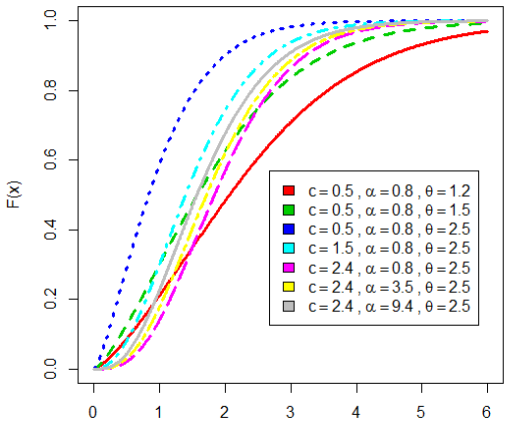

Figure 2 Graph of distribution function

The corresponding c.d.f of Weighted Lindley-Quasi Xgamma distribution is given in (2.3) & obtained as

$$F_w(x) = \int_0^x \frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}dx \qquad (2.3)$$

Put $\theta x = t$ in (2.3)

$\theta\, dx = dt$

$as\ x \to 0, t \to 0\ \ and\ \ \ x \to x, t \to \theta x$

$$F_w(x)=\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \quad (2.4)$$

where $\gamma(s,x)=\int_0^x t^{s-1}e^{-t}dt$ is a lower incomplete gamma function

3. Motivation & Need of Proposed model.

There are many situations in real life where models with less parameters don't perform better. Here in this paper we added an extra parameter known as weight parameter to two parameter Lindley-Quasi Xgamma distribution to obtain a generalized model which will find greater applicability in dealing with complex data. It can be observed from table 1 that proposed model can be used for over dispersed as well as under dispersed data. Addition of weight parameter also brings the flexibility in terms of moments as can be seen from graphs of probability density function and hazard rate. Complex data applicability and increased flexibility were two important points which motivated us to work on this model.

4. Reliability Measures

This division of paper presents survival function, hazard rate, reverse hazard rate of the proposed Weighted Lindley-Quasi Xgamma distribution for random variable X , where X represents the lifetime of a system.

4.1 Reliability function R(x)

The reliability function or survival function $R(x)$ gives the numerical value of odds of surviving of a system beyond a specified time (t) .

Mathematically

$R_w(x)=P(X>t)=1-F_w(x)$

The reliability function or the survival function of Weighted Lindley-Quasi Xgamma distribution is obtained as:

$$R_w(x)=1-\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right]$$

4.2 Hazard Function:

The hazard function which is defined as chance that a system which is surviving up to time *"t"* will fail in the small time interval after *"t"* is obtained for WLQXD as:

$$H.R=h_w(x)=\frac{f_w(x)}{R_w(x)}$$

$$=\left(\frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{\left(\begin{array}{l}c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)-\\(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)\end{array}\right)}\right)$$

The graphs of reliability function and hazard rate of WLQXD for different values of parameter are given below

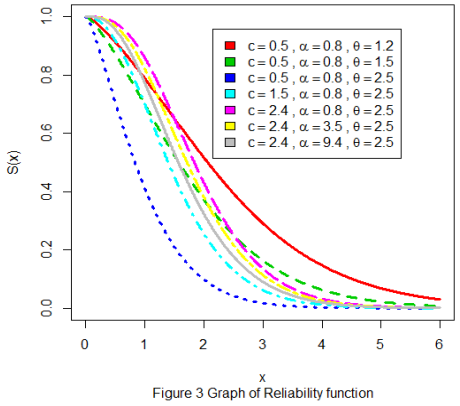

Figure 3 Graph of Reliability function

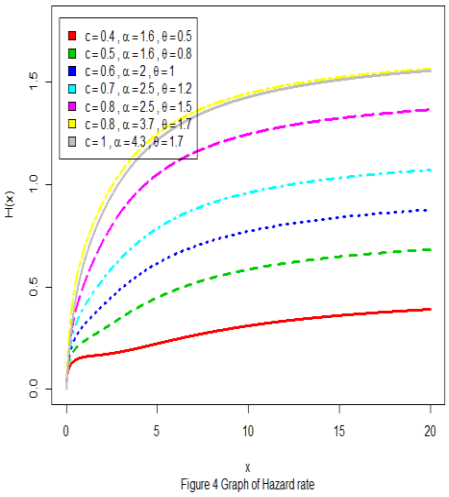

Figure 4 Graph of Hazard rate

From the above graph of hazard rate it is revealed that our proposed model possesses non-decreasing hazard rate and it can be also seen that hazard rate becomes constant as value of x increases. There are many situations in real life where hazard rate is non-decreasing, like lifetime of human beings, animals etc.

4.3 Reverse Hazard Rate

The reverse hazard rate of the Weighted Lindley-Quasi Xgamma distribution is given as:

$$R.H.R = h_{r\,w}(x) = \frac{f_w(x)}{F_w(x)}$$

$$= \frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}$$

5. Statistical properties

Moments, characteristic function, mean deviation, harmonic mean, coefficient of variation characterize probability models. Here we have obtained these statistical properties for proposed Weighted Lindley-Quasi Xgamma distribution.

5.1 Moments and related measures

Assuming X to be a random variable having Weighted Lindley-Quasi Xgamma distribution with parameters θ, c and α .Then the r^{th} moment about origin for a given probability distribution is given by

$$\mu_r' = E\left(X^r\right) = \int_0^\infty x^r f_w(x)dx \qquad r=1, 2, 3\ldots$$

$$= \int_0^{\infty} x^r \frac{\theta^{c+1} x^c \left((\alpha+\theta)\left(2\alpha + x^2\theta^2\right) + 2\theta(\theta-1)(1+\alpha x)\right) e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)}\, dx$$

$$\mu_r{}' = \left[\frac{(r+c)!\left((\alpha+\theta)(2\alpha+(r+c+1)(r+c+2)) + 2(\theta-1)(\theta+\alpha(r+c+1))\right)}{\theta^r \left(c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right] \tag{5.1.1}$$

Put r=1 in equation (5.1.1) we get

$$\mu_1{}' = \left[\frac{(c+1)\left((\alpha+\theta)(2\alpha+(c+2)(c+3)) + 2(\theta-1)(\theta+\alpha(c+2))\right)}{\theta\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right]$$

Which is mean of the WLQXD.

Put r=2 in equation (5.1.1) we get

$$\mu_2{}' = \left[\frac{(c+1)(c+2)\left((\alpha+\theta)(2\alpha+(c+4)(c+3)) + 2(\theta-1)(\theta+\alpha(c+3))\right)}{\theta^2\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right]$$

The variance of WLQXD is

$$\mu_2 = \left(\left[\frac{(c+1)(c+2)\left((\alpha+\theta)(2\alpha+(c+4)(c+3)) + 2(\theta-1)(\theta+\alpha(c+3))\right)}{\theta^2\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right] - \left[\frac{(c+1)\left((\alpha+\theta)(2\alpha+(c+2)(c+3)) + 2(\theta-1)(\theta+\alpha(c+2))\right)}{\theta\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right]^2 \right)$$

The coefficient of variation of WLQXD is

$$C.V = \frac{(\mu_2)^{\frac{1}{2}}}{\mu_1{}'}$$

$$= \frac{\left(\left[\frac{(c+1)(c+2)\left((\alpha+\theta)(2\alpha+(c+4)(c+3)) + 2(\theta-1)(\theta+\alpha(c+3))\right)}{\theta^2\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right] - \left[\frac{(c+1)\left((\alpha+\theta)(2\alpha+(c+2)(c+3)) + 2(\theta-1)(\theta+\alpha(c+2))\right)}{\theta\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right]^2 \right)^{\frac{1}{2}}}{\left[\frac{(c+1)\left((\alpha+\theta)(2\alpha+(c+2)(c+3)) + 2(\theta-1)(\theta+\alpha(c+2))\right)}{\theta\left(\left((\theta+\alpha)(2\alpha+(c+1)(c+2)) + 2(\theta-1)(\theta+\alpha(c+1))\right)\right)} \right]}$$

The index of dispersion (γ) of WLQXD is

$$\gamma = \frac{(\mu_2)}{\mu_1'}$$

$$= \frac{\left(\left[\frac{(c+1)(c+2)\left((\alpha+\theta)(2\alpha+(c+4)(c+3))+2(\theta-1)(\theta+\alpha(c+3))\right)}{\theta^2\left(((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right]-\left[\frac{(c+1)\left((\alpha+\theta)(2\alpha+(c+2)(c+3))+2(\theta-1)(\theta+\alpha(c+2))\right)}{\theta\left(((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right]^2\right)}{\left[\frac{(c+1)\left((\alpha+\theta)(2\alpha+(c+2)(c+3))+2(\theta-1)(\theta+\alpha(c+2))\right)}{\theta\left(((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right]}$$

Table 1: Description of WLQXD for different parameter values.

α	θ	c	Mean	Variance	Index of dispersion	Coefficient of variation
0.5	0.5	0.3	6.353	14.54	2.289	0.600
2.5	0.5	0.5	4.704	14.00	2.976	0.795
2.5	5.5	1.5	0.619	0.136	0.220	0.596
0.5	5.5	2.0	0.748	0.165	0.221	0.543

It can be observed from above table that WLQXD is over dispersed as well as under dispersed for different parameter values.

5.2 Harmonic mean of Weighted Lindley-Quasi Xgamma Distribution (WLQXD).

The harmonic mean *H* of the WLQXD is determined as

$$\frac{1}{H} = E\left[\frac{1}{X}\right] = \int_0^\infty \frac{1}{x} f_w(x;c,\alpha,\theta)dx$$

$$= \int_0^\infty \frac{1}{x} \frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}dx$$

$$H = \frac{c\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}{\theta\left((\alpha+\theta)(2\alpha+c(c+1))+2(\theta-1)(\theta+\alpha c)\right)}$$

5.3 Mean deviation about mean and median of Weighted Lindley-Quasi Xgamma distribution (WLQXD)

We have derived the expressions for mean deviation about mean and median of WLQXD in this section.

Theorem 1: If *X* has the WLQXD (θ,α,c), then the mean deviation about mean $(\delta_1(X))$ and mean deviation about median $(\delta_2(X))$ are given as:

$$\delta_1(X) = \left[\begin{array}{l} 2\mu\left\{\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta\mu)+\gamma(c+3,\theta\mu)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta\mu)+\alpha\gamma(c+2,\theta\mu)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\} \\ -2\left\{\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta\mu)+\gamma(c+4,\theta\mu)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta\mu)+\alpha\gamma(c+3,\theta\mu)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\} \end{array}\right]$$

And

$$\delta_2(X)=\left[\mu-2\left\{\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta M)+\gamma(c+4,\theta M)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta M)+\alpha\gamma(c+3,\theta M)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\right]$$

respectively.

Proof: Mean deviation about mean and mean deviation about median are defined as

$$\delta_1(X)=\int_0^{\infty}|x-\mu|f_w(x)dx$$

And $\delta_2(X)=\int_0^{\infty}|x-M|f_w(x)dx$

respectively.

Where μ and *M* are mean and median respectively of random variable *X~WLQXD*. The measures $\delta_1(X)$ and $\delta_2(X)$ can be obtained by using the simplified relationships.

(5.3.2)

Where $f_w(x)=\dfrac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}$

Now

$$\int_0^{\mu}xf_w(x)dx=\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta\mu)+\gamma(c+4,\theta\mu)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta\mu)+\alpha\gamma(c+3,\theta\mu)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \quad (5.3.3)$$

And

$$\int_0^{M}xf_w(x)dx=\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta M)+\gamma(c+4,\theta M)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta M)+\alpha\gamma(c+3,\theta M)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \quad (5.3.4)$$

Using expressions (5.3.1), (5.3.2), (5.3.3) and (5.3.4) and expression for c.d.f (2.4) we obtain mean deviation about mean $(\delta_1(X))$ and mean deviation about median $(\delta_2(X))$

$$\delta_1(X)=\left[\begin{array}{l}2\mu\left\{\dfrac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta\mu)+\gamma(c+3,\theta\mu)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta\mu)+\alpha\gamma(c+2,\theta\mu)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\\ -2\left\{\dfrac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta\mu)+\gamma(c+4,\theta\mu)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta\mu)+\alpha\gamma(c+3,\theta\mu)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\end{array}\right]$$

$$\delta_1(X)=\int_0^{\mu}(\mu-x)f_w(x)dx+\int_{\mu}^{\infty}(x-\mu)f_w(x)dx$$

$$\delta_1(X)=2\mu F_w(\mu)-2\int_0^{\mu}xf_w(x)dx \quad (5.3.1)$$

And

$$\delta_2(X)=\int_0^{M}(M-x)f_w(x)dx+\int_M^{\infty}(x-M)f_w(x)dx \quad (5.3.2)$$

&

$$\delta_2(X)=\left[\mu-2\left\{\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta M)+\gamma(c+4,\theta M)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta M)+\alpha\gamma(c+3,\theta M)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\right]$$

5.4 Moment generating function and Characteristic function of Weighted Lindley-Quasi Xgamma Distribution (WLQXD)

We will derive moment generating function and characteristic function of WLQXD in this segment of paper.

Theorem 2: If $X\sim WLQXD(\theta,\alpha,c)$ then the moment generating function $M_X(t)$ and characteristic generating function $\phi_X(t)$ are

$$M_X(t)=\left(\frac{\theta^{c+1}}{\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\left((\alpha+\theta)\left(\frac{2\alpha}{(\theta-t)^{c+1}}+\frac{\theta^2(c+1)(c+2)}{(\theta-t)^{c+3}}\right)+2\theta(\theta-1)\left(\frac{1}{(\theta-t)^{c+1}}+\frac{(c+1)\alpha}{(\theta-t)^{c+2}}\right)\right)\right)$$

And

$$\phi_X(t)=\left(\frac{\theta^{c+1}}{\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\left((\alpha+\theta)\left(\frac{2\alpha}{(\theta-it)^{c+1}}+\frac{\theta^2(c+1)(c+2)}{(\theta-it)^{c+3}}\right)+2\theta(\theta-1)\left(\frac{1}{(\theta-it)^{c+1}}+\frac{(c+1)\alpha}{(\theta-it)^{c+2}}\right)\right)\right)$$

respectively.

Proof: We begin with the well-known definition of the moment generating function given by

$$M_X(t)=E\left(e^{tX}\right)=\int_0^\infty e^{tx}\,f_w(x)\,dx$$

$$=\int_0^\infty e^{tx}\,\frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\,dx$$

$$M_X(t)=\left(\frac{\theta^{c+1}}{\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\left((\alpha+\theta)\left(\frac{2\alpha}{(\theta-t)^{c+1}}+\frac{\theta^2(c+1)(c+2)}{(\theta-t)^{c+3}}\right)+2\theta(\theta-1)\left(\frac{1}{(\theta-t)^{c+1}}+\frac{(c+1)\alpha}{(\theta-t)^{c+2}}\right)\right)\right) \quad (5.4.1)$$

Which is the m.g.f of Weighted Lindley-Quasi Xgamma distribution.

Also we know that $\phi_X(t)=M_X(it)$

Therefore,

$$\phi_X(t)=\left(\frac{\theta^{c+1}}{\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\left((\alpha+\theta)\left(\frac{2\alpha}{(\theta-it)^{c+1}}+\frac{\theta^2(c+1)(c+2)}{(\theta-it)^{c+3}}\right)+2\theta(\theta-1)\left(\frac{1}{(\theta-it)^{c+1}}+\frac{(c+1)\alpha}{(\theta-it)^{c+2}}\right)\right)\right) \quad (5.4.2)$$

Which is the characteristic function of WLQXD distribution.

6. Order Statistics of Weighted Lindley-Quasi Xgamma Distribution

Consider $X_{(1)}, X_{(2)}, X_{(3)}\ldots,X_{(n)}$ to be the ordered statistics of the random sample $x_1, x_2, x_3,\ldots.x_n$ obtained from the Weighted Lindley-Quasi Xgamma distribution with cumulative distribution function $F_w(x)$ and probability density function $f_w(x)$, then the probability density function of v^{th} order statistics $X_{(v)}$ is given by:

$$f_{vw}(x)=\frac{n!}{(v-1)!(n-v)!}f_w(x)[F_w(x)]^{v-1}[1-F_w(x)]^{n-v}$$

v=1, 2, 3… n

Using the equations (2.2) and (2.3), the probability density function of v^{th} order statistics of Weighted Lindley-Quasi Xgamma distribution is given by:

$$f_{(v)w}(x)=\left[\frac{n!}{(v-1)!(n-v)!}\left\{\frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\right.$$
$$\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right]^{v-1}$$
$$\left.\left[1-\left(\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right)\right]^{n-v}\right].$$

Then, the p.d.f of first order statistic $X_{(1)}$ of Weighted Lindley-Quasi Xgamma distribution is given by:

$$f_{(1)w}(x)=\left[n\left\{\frac{\theta^{c+1}x^{c}\left((\alpha+\theta)\left(2\alpha+x^{2}\theta^{2}\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\left[1-\left(\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right)\right]^{n-1}\right].$$

and the pdf of n^{th} order statistic $X_{(n)}$ of Weighted Lindley-Quasi Xgamma distribution is given as:

$$f_{(n)w}(x)=\left[n\left\{\frac{\theta^{c+1}x^{c}\left((\alpha+\theta)\left(2\alpha+x^{2}\theta^{2}\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right\}\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+1,\theta x)+\gamma(c+3,\theta x)\right)+2(\theta-1)\left(\theta\gamma(c+1,\theta x)+\alpha\gamma(c+2,\theta x)\right)}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right]^{n-1}\right].$$

7. Bonferroni and Lorenz Curves and Indices of WLQXD

The Bonferroni curve $(B(p))$, Lorenz curve $(L(p))$, Bonferroni index (B) and Gini index (G) have find applicability in fields of economics, demography, reliability, life testing and medical sciences. The Bonferroni and Lorenz curves are defined as

$$B(p)=\frac{1}{p\mu}\int_{0}^{q}xf_{w}(x)dx$$

(7.1)

$$L(p)=\frac{1}{\mu}\int_{0}^{q}xf_{w}(x)dx$$

(7.2)

Where $\mu=E(x)$ is the mean of WLQXD and $q=F^{-1}(p)$.

The Bonferroni and Gini indices are defined as

$$B=1-\int_{0}^{1}B(p)dp$$

(7.3)

$$G=1-2\int_{0}^{1}L(p)dp$$

(7.4)

Using the p.d.f (2.2) of WLQXD we get

$$\int_{0}^{q}xf_{w}(x)dx=\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta q)+\gamma(c+4,\theta q)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta q)+\alpha\gamma(c+3,\theta q)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \quad (7.5)$$

Using equation (7.5) in (7.1) & (7.2) we get

$$B(p)=\frac{1}{p\mu}\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta q)+\gamma(c+4,\theta q)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta q)+\alpha\gamma(c+3,\theta q)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \quad (7.6)$$

And

$$L(p)=\frac{1}{\mu}\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta q)+\gamma(c+4,\theta q)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta q)+\alpha\gamma(c+3,\theta q)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \quad (7.7)$$

Using (7.6) & (7.7) in (7.3) & (7.4) we get

$$B = 1 - \frac{1}{\mu}\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta q)+\gamma(c+4,\theta q)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta q)+\alpha\gamma(c+3,\theta q)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \tag{7.8}$$

$$L = 1 - \frac{2}{\mu}\left[\frac{(\alpha+\theta)\left(2\alpha\gamma(c+2,\theta q)+\gamma(c+4,\theta q)\right)+2(\theta-1)\left(\theta\gamma(c+2,\theta q)+\alpha\gamma(c+3,\theta q)\right)}{\theta c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right] \tag{7.9}$$

8. Renyi Entropy

The information associated with various values of random variable following a particular distribution is called entropy. Renyi entropy $T_R(\delta)$ of random variable X following Weighted Lindley-Quasi Xgamma distribution is obtained as

$$T_R(\gamma) = \frac{1}{1-\delta}\log\left(\int_0^\infty {f_w}^\delta(x)dx\right)$$

Where $\delta > 0$ and $\delta \neq 1$

$$T_R(\delta) = \frac{1}{1-\delta}\log\left(\int_0^\infty\left(\frac{\theta^{c+1}x^c\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right)^\delta dx\right)$$

$$T_R(\delta) = \frac{1}{1-\delta}\log\left(\int_0^\infty \frac{\theta^{\delta(c+1)}x^{\delta c}\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)^\delta e^{-\delta\theta x}}{\left(c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)\right)^\delta}dx\right) \tag{8.1}$$

Using the binomial expansion

$$\left((\alpha+\theta)\left(2\alpha+x^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x)\right)^\delta$$

$$= \sum_{k=0}^{\delta}\binom{\delta}{k}2^k\theta^k(\theta-1)^k(1+\alpha x)^k(\alpha+\theta)^{\delta-k}\left(2\alpha+x^2\theta^2\right)^{\delta-k}$$

$$= \sum_{k=0}^{\delta}\binom{\delta}{k}2^k\theta^k(\theta-1)^k(\alpha+\theta)^{\delta-k}\sum_{p=0}^{k}\binom{k}{p}\alpha^p x^p\sum_{l=0}^{\delta-k}\binom{\delta-k}{l}x^{2l}\theta^{2l}2^{\delta-k-l}\alpha^{\delta-k-l} \tag{8.2}$$

Using (8.2) in (8.1) we get

$$T_R(\delta)=\frac{1}{1-\delta}\log\left\{\frac{\left(\sum_{k=0}^{\delta}\binom{\delta}{k}(\theta-1)^k(\alpha+\theta)^{\delta-k}\sum_{p=0}^{k}\binom{k}{p}\sum_{l=0}^{\delta-k}\binom{\delta-k}{l}\theta^{c\delta+\delta+k+2l}2^{\delta-l}\alpha^{p+\delta-k-l}\int_0^{\infty}x^{c\delta+p+2l}e^{-\delta\theta x}dx\right)}{\left(c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)\right)^{\delta}}\right\}$$

$$T_R(\delta)=\frac{1}{1-\delta}\log\left\{\frac{\left(\sum_{k=0}^{\delta}\binom{\delta}{k}(\theta-1)^k(\alpha+\theta)^{\delta-k}\sum_{p=0}^{k}\binom{k}{p}\sum_{l=0}^{\delta-k}\binom{\delta-k}{l}\theta^{\delta+k-p-1}2^{\delta-l}\alpha^{p+\delta-k-l}(c\delta+p+2l)!\right)}{\left(c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)\right)^{\delta}\delta^{c\delta+p+2l+1}}\right\}$$

9. Estimation of Parameters of Weighted Lindley-Quasi-Xgamma distribution.

Parameters are estimated by using method of maximum likelihood estimation. Considering $x_1, x_2, \ldots x_n$ to be the random sample of size n drawn from Weighted Lindley-Quasi Xgamma distribution having density function given by (2.2), then the likelihood function of WLQXD is given as:

$$L(x\mid\theta,\alpha)=\prod_{i=1}^{n}\left(\frac{\theta^{c+1}x_i{}^c\left((\alpha+\theta)\left(2\alpha+x_i{}^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x_i)\right)e^{-\theta x_i}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}\right)$$

Taking log on both sides of likelihood function we get log likelihood function as:

$$\log L=\begin{pmatrix}n(c+1)\log\theta+c\sum_{i=1}^{n}\log x_i-\theta\sum_{i=1}^{n}x_i+\sum_{i=1}^{n}\log\left((\alpha+\theta)\left(2\alpha+x_i{}^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x_i)\right)\\ n\log c!-n\log\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)\end{pmatrix} \quad (9.1)$$

Differentiating the log-likelihood function with respect to θ,α,c .This is done by partially differentiate (9.1) with respect to θ,α,c and equating the result to zero, we obtain the following normal equations,

$$\frac{\partial\log L}{\partial\theta}$$

$$=\begin{bmatrix}\frac{(c+1)n}{\theta}-\frac{n(2\alpha+(c+1)(c+2)+4\theta+2\alpha(c+1)-2}{\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}+\\ \sum_{i=1}^{n}\left(\frac{2\alpha\theta x_i{}^2+2\alpha+3x_i{}^2\theta^2+2(1+\alpha x_i)(2\theta-1)}{\left((\alpha+\theta)\left(2\alpha+x_i{}^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x_i)\right)}\right)-\sum_{i=1}^{n}x_i\end{bmatrix}=0 \quad (9.2)$$

$$\frac{\partial \log L}{\partial \alpha} = \left[-\frac{n(2\theta+(c+1)(c+2)+4\alpha+2\theta(c+1)-2(c+1)}{((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1)))} + \sum_{i=1}^{n}\left(\frac{4\alpha+{x_i}^2\theta^2+2\theta+2\theta(\theta-1)x_i}{\left((\alpha+\theta)\left(2\alpha+{x_i}^2\theta^2\right)+2\theta(\theta-1)(1+\alpha x_i)\right)} \right) \right] = 0 \quad (9.3)$$

$$\frac{\partial \log L}{\partial c} = \left[n\log\theta - \frac{n((\theta+\alpha)(2c+3)+(2\alpha\theta-2\alpha))}{((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1)))} - n\left(\log(c+1)-\frac{1}{2(c+1)}\right)+\sum_{i=1}^{n}\log x_i \right] = 0 \quad (9.4)$$

MLEs of θ, α, c cannot be obtained by solving above complex equations as these equations are not in closed form. So we solve above equations by using iteration method through R software.

10. Simulation study

In this part of paper we have carried out the simulation study for checking the performance of maximum likelihood (ML) estimates by taking different sample sizes (n=30, 50, 70, 110). We have used the inverse CDF technique for data simulation for WLQXD using R software. The process was repeated 1000 times for calculation of bias, variance & mean square error (MSE) as are given values in table 2. For two parameter combinations of WLQXD, decreasing trend is being observed in average bias, variance and MSE as we increase the sample size. Hence, the performance of ML estimators is quite good and consistent in case of Weighted Lindley-Quasi Xgamma Distribution.

Table 2: Simulation Study of ML estimators for WLQXD

Parameter	**n (sample size)**	$\alpha=0.8, \theta=0.7, c=0.8$			$\alpha=0.5, \theta=1.7, c=0.6$		
		Bias	**Variance**	**MSE**	**Bias**	**Variance**	**MSE**
α	30	0.4862598	0.4406534	0.677102	0.40865	0.540489	0.7074845
θ		1.625651	2.056811	4.699553	0.6685304	1.925161	2.372094
c		0.4383506	0.5523539	0.7445051	0.5508202	0.5480579	0.8514608
α	50	0.478908	0.438007	0.6673606	0.36540	0.454492	0.5880101
θ		1.434994	0.9519631	3.011171	0.4003302	1.001894	1.162159
c		0.3290241	0.2367339	0.3449908	0.4239412	0.2483344	0.4280606

α	70	0.467299	0.4364103	0.6547787	0.30907	0.447506	0.5430311
θ		1.261992	0.6351194	2.227743	0.338809	0.6839647	0.7987562
c		0.2534664	0.1573207	0.2215659	0.3918621	0.1738424	0.3273983
α	110	0.459871	0.4333168	0.6447982	0.26780	0.398899	0.4706166
θ		1.17978	0.3789148	1.770795	0.2331814	0.4179511	0.4723247
c		0.2156018	0.09346848	0.1399526	0.3397029	0.1026403	0.2180383

11. Testing significance of Weight parameter on basis of simulated data from WLQXD

For comparing proposed model with base model and for testing the significance of weighted parameter we generated random samples of sizes (50, 100, 200, 500) from WLQXD using inverse CDF technique. It is evident from the table 3 that weighted parameter plays a highly significant role for large samples. Even though in small samples, the AIC, AICC, BIC and Negative Loglikelihood values are also minimum in case of Weighted model as compared to base model. LR statistic for testing H_0 versus H_1 is $\psi = 2(L(\hat{\Theta}) - L(\hat{\Theta}_0))$, where $\hat{\Theta}$ and $\hat{\Theta}_0$ are the MLEs under H_1 and H_0. The statistic ψ is asymptotically $(as\, n \to \infty)$ distributed as χ^2_k, with k degrees of freedom which is equal to the difference in dimensionality of $\hat{\Theta}$ and $\hat{\Theta}_0$. H_0 will be rejected if the LR-test p-value is <0.01 (or LR Statistic value >3.841) at 95% confidence level

Table 3: Model Comparison Based On Simulated Data From WLQXD.

$\hat{c} = 0.6, \hat{\alpha} = 0.9, \hat{\theta} = 1.5$				Parameter Estimates		Likelihood Ratio Statistic
Criterion	WLQXD	LQXD	Sample Size (n)	WLQXD	LQXD	
-logL	13.02580	17.33376	50		$\hat{\alpha} = 1.317147$ (1.466524) $\hat{\theta} = 3.107664$ (0.352400)	8.615
AIC	32.05161	38.66752				
AICC	24.05161	32.66752				
	37.78767	42.49157				

BIC				$\hat{c} = 0.7756921$ (0.3682644) $\hat{\alpha} = 0.7541315$ (3.0450987) $\hat{\theta} = 4.8614277$ (0.9328238)		
-*logL*	19.48443	31.00223	100	$\hat{c} = 0.9303426$ (0.2523067) $\hat{\alpha} = 1.9131216$ (3.0526314) $\hat{\theta} = 5.3480262$ (0.6873024)	$\hat{\alpha} = 1.6114539$ (1.1262244) $\hat{\theta} = 3.1965086$ (0.2635093)	23.035
AIC	44.96885	66.00447				
AICC	36.96885	60.00447				
BIC	52.78436	71.21481				
-*logL*	33.61176	61.80406	200	$\hat{c} = 1.1748909$ (0.2734827). $\hat{\alpha} = 0.4499443$ (1.9152323) $\hat{\theta} = 5.9318359$ (0.6560791)	$\hat{\alpha} = 1.5711807$ (0.7844924) $\hat{\theta} = 3.2011676$ (0.1854941)	56.384
AIC	73.22353	127.60812				
AICC	65.22353	121.6081				
BIC	83.11848	134.2048				
-*logL*	106.5939	134.1149	500	$\hat{c} = 0.54764349$ (0.0891730 4) $\hat{\alpha} = 1.50125869$ (1.0533225 3) $\hat{\theta} = 4.64187400$ (0.2643538 8)	$\hat{\alpha} = 1.5740119$ (0.5568915) $\hat{\theta} = 3.2970302$ (0.1221850)	55.042
AIC	219.1878	272.2297				
AICC	211.1878	266.2297				
BIC	231.8316	280.6589				

12. Applications of Weighted Lindley-Quasi Xgamma Distribution

Proposed model, its base model and some other lifetime models are fitted to two real life data sets for testing how fine proposed model fits to real life data sets as compared to other mentioned models.

Data set 1: The data set given in table 4 represents the tensile strength measures in GPa of 69 carbon fibres tested under tension at gauge lengths of 20mm and has been taken from Bader and Priest [10].

Table 4: Tensile strength measures in GPa of 69 carbon fibres

1.312	1.314	1.479	1.552	1.700	1.803	1.861	1.865
1.944	1.958	1.966	1.997	2.006	2.021	2.027	2.055
2.063	2.098	2.140	2.179	2.224	2.240	2.253	2.270
2.272	2.274	2.301	2.301	2.359	2.382	2.382	2.426
2.434	2.435	2.478	2.490	2.511	2.514	2.535	2.554
2.566	2.570	2.586	2.629	2.633	2.642	2.648	2.684
2.697	2.726	2.770	2.773	2.800	2.809	2.818	2.821
2.848	2.880	2.954	3.012	3.067	3.084	3.090	3.096
3.128	3.233	3.433	3.585	3.585			

Data set 2: This data set given in table 5 is due to Smith and Naylor [11] consists of 63 observations of the strengths of 1.5 cm glass fibres, originally

obtained by workers at the UK National Physical Laboratory.

Table 5: The strengths of 1.5 cm glass fibres of 63 observations

0.55	0.74	0.77	0.81	0.84	0.93	1.04	1.11
1.13	1.24	1.25	1.27	1.28	1.29	1.30	1.36
1.39	1.42	1.48	1.48	1.49	1.49	1.50	1.50
1.51	1.52	1.53	1.54	1.55	1.55	1.58	1.59
1.60	1.61	1.61	1.61	1.61	1.62	1.62	1.63
1.64	1.66	1.66	1.66	1.67	1.68	1.68	1.69
1.70	1.70	1.73	1.76	1.76	1.77	1.78	1.81
1.82	1.84	1.84	1.89	2.00	2.01	2.24	

For the analysis of both the data sets we used R Software version 3.5.3.

Table 6: Summary Statistic of data set 1 and 2.

Data set	**Number of observations**	**Min.**	**Mean**	**First Quartile**	**Median**	**Third Quartile**	**Max.**
1	69	1.3	2.4	2.09	2.4	2.7	3.58
2	63	0.5	1.5	1.37	1.5	1.6	2.24

Table 7: Model function of fitted models

Distribution	**Model function**
Weighted Lindley Quasi Xgamma Distribution (WLQXD)	$\frac{\theta^{c+1}x^{c}\left((\alpha+\theta)\left(2\alpha+x^{2}\theta^{2}\right)+2\theta(\theta-1)(1+\alpha x)\right)e^{-\theta x}}{c!\left((\theta+\alpha)(2\alpha+(c+1)(c+2))+2(\theta-1)(\theta+\alpha(c+1))\right)}$
Lindley Quasi Xgamma Distribution (LQXD)	$\frac{\theta e^{-\theta x}}{(\alpha+\theta)^{2}}\left\{(\alpha+\theta)(\alpha+\frac{x^{2}\theta^{2}}{2})+\theta(\theta-1)(1+\alpha x)\right\}$
Quasi Lindley Distribution (QLD)	$\frac{\theta(\alpha+\theta x)}{\alpha+1}e^{-\theta x}$
Exponential Distribution (ED)	$\frac{1}{\theta}e^{-\frac{x}{\theta}}$
Quasi Akash Distribution (QAD)	$\frac{\theta^{2}}{(\alpha\theta+2)}\left(\alpha+\theta x^{2}\right)e^{-\theta x}$

Table 8: ML estimates, -logL, AIC, AICC, BIC, HQIC, KS-distance, for fitted WLQXD and other mentioned models for data set 1.

Distribution	**WLQXD**	**LQXD**	**QLD**	**ED**	**QAD**
-logL	49.9985	96.20767	105.7322	130.8676	92.28544
AIC	105.997	196.4153	215.4644	263.7352	188.5709
AICC	106.3662	196.5972	215.6462	263.7949	188.7527
BIC	112.6993	200.8836	219.9326	265.9693	193.0391
HQIC	108.656	198.188	217.2371	264.6216	190.3436

KS-Distance (D)	0.057772	0.355	0.36154	0.44828	0.31119
Likelihood ratio statistic	92.418				
ML Estimates	$\hat{c} = 21.760292$ (5.169830) $\hat{\alpha} = 125.672241$ (958.21578 5) $\hat{\theta} = 9.793707$ (1.716879)	$\hat{\alpha} = 0.001000$ $\hat{\theta} = 0.98255426$ (0.0583184 1)	$\hat{\alpha} = 0.001000$ $\hat{\theta} = 0.8156695$ (0.0635997 5)	$\hat{\theta} = 2.4513330$ (0.2951056)	$\hat{\alpha} = 0.001000$ $\hat{\theta} = 1.22351031$ (0.0677973 2)

Table 9: ML estimates, -logL, AIC, AICC, BIC, HQIC, KS-distance, for fitted WLQXD and other mentioned models for data set 2.

Distribution	**WLQXD**	**LQXD**	**QLD**	**ED**	**QAD**
-logL	23.75059	73.63075	66.34654	88.83032	54.55285
AIC	53.50119	151.2615	136.6931	179.6606	113.1057
AICC	53.90797	151.4615	136.8931	179.7262	113.3057
BIC	59.93059	155.5478	140.9793	181.8038	117.392
HQIC	56.0299	152.9473	138.3789	180.5035	114.7915
KS-Distance (D)	0.2156	0.30991	0.34707	0.418	0.30549
Likelihood ratio statistic	99.760				
ML Estimates	$\hat{c} = 14.829858$ $\hat{\alpha} = 0.001000$ $\hat{\theta} = 11.732504$ (1.464477)	$\hat{\alpha} = 0.001000$ $\hat{\theta} = 1.4647349$ (0.1004913)	$\hat{\alpha} = 0.001000$ $\hat{\theta} = 1.3269391$ (0.1075059)	$\hat{\theta} = 1.506826$ (0.189842)	$\hat{\alpha} = 0.001000$ $\hat{\theta} = 1.9900949$ (0.1132172)

Different criteria's of goodness of fit like AIC, BIC, AICC, HQIC and K-S distance have been computed by using R software for both the data sets and it has been observed from tables 8 and 9 that proposed model possesses lesser AIC, BIC, AICC, HQIC & K-S distance values as compared to Lindley Quasi Xgamma distribution, Quasi Lindley distribution, Exponential distribution and Quasi Akash distribution for both the data sets. Hence proposed model provides well fit to both the mentioned data sets.

$\text{AIC} = 2\text{k-}2\log L$ $\quad \text{AICC} = \text{AIC} + \frac{2k(k+1)}{n-k-1}$

$\text{BIC} = \text{k}\log n - 2\log L$ $\quad \text{HQIC} = 2\text{k}\log(\log(\text{n})) + 2\log L$

Where k= number of parameters in model

n= size of the sample (number of observations in data set)

logL= value of likelihood function of model

Likelihood ratio statistic is used for testing the significance of weight parameter in both the data sets. For testing $H_0 : c = 0$ versus $H_1 : c \neq 0$ the LR statistic for testing H_0 is $\omega_1 = 2\{L(\hat{\Theta}) - L(\hat{\Theta}_0)\} = 92.418$ for data set 1, $\omega_2 = 2\{L(\hat{\Theta}) - L(\hat{\Theta}_0)\} = 99.760$ for data set 2 where $\hat{\Theta}$ and $\hat{\Theta}_0$ are MLEs under H_1 and H_0. LR statistic $\omega \sim (\chi_{(1)}{}^2(\alpha = 0.05) = 3.841)$ as $n \to \infty$, where 1= degrees of freedom is the difference in dimensionality. From table 8 $\omega_1 = 92.418 > 3.841$ & from table 9 $\omega_2 = 99.760 > 3.841$ at 5% level of significance for both the data sets, so we reject H_0 and conclude that weight parameter c plays statistically a significant role.

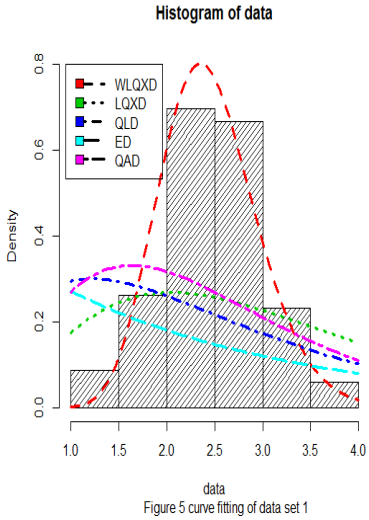

Figure 5 curve fitting of data set 1

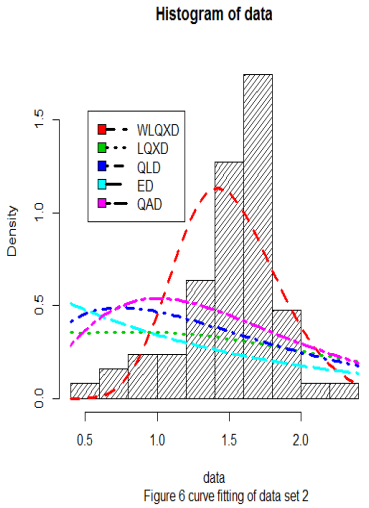

Figure 6 curve fitting of data set 2

13. Conclusion

Generalized version of Lindley-Quasi Xgamma distribution by using weighted technique has been proposed in this paper. We obtained the important statistical properties like moments, reliability, moment generating function, order statistics, Bonferroni and Gini indices of formulated model. Expression for Renyi entropy has been derived. For obtaining the estimates of unknown parameters maximum likelihood estimation method is used. For testing the suitability of ML estimates simulation study has been carried which showed that ML estimation method performs well for proposed model. For testing the goodness of fit of proposed model and for investigating the application of proposed model in real life we fitted our proposed model and its related models to two real life data sets and computed log-likelihood values, AIC, AICC, HQIC, BIC and Kolmogorov statistic (D). We observed that our model possesses lesser values of AIC, BIC, AICC, HQIC and D values. Hence our model finds greater applicability in modeling survival times. From generated data as well as from real life data significant role of weight parameter has been observed.

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Poisson Size Biased Exponential Distribution With its Applications

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Abstract: In this manuscript, we have proposed a new probability distribution by compounding Poisson with size biased Exponential distribution. Important mathematical and statistical properties of the distribution have been derived and discussed. Parameter estimation of the proposed model is discussed using maximum likelihood method of estimation. Finally, real data set is analyzed to investigate the suitability of the proposed distribution.

Keywords: Poisson distribution, Size biased exponential distribution, Compound distribution, Count data, Maximum likelihood estimation.

1. Introduction

Compounding of probability distributions is a sound and innovative technique to obtain new probability distributions to fit data sets not adequately fit by common parametric distributions. Compound distributions serve well to describe various phenomena in biology, epidemiology, genetics and so on. Barreto-souza and Bakouch (2013) obtained a new class of compound distribution with decreasing failure rate by compounding Zero-truncated Poisson Lindley distribution and exponential distribution. Hajebi et al. (2013) obtained a new life time model by compounding exponential distribution with negative binomial distribution. Mohmoudi and jafari (2014) introduced a new life time compound probability distribution which generalizes the linear failure rate of distribution. Ghitany et al. (2011) obtained weighted lindley distribution and has pointed that Lindley distribution valuable in exhibiting biological data from mortality studies. Asgharzadeh et al. (2014) created a new class of distribution by mixing any continuous distribution and Poisson Lindley distribution through compounding technique. Chesneau et al (2020) introduced Cosine geometric distribution for count data modeling. Bourguigon et al. (2014) obtained the Birnbaum-saunders power series distribution. The new life time distribution has decreasing, increasing or constant hazard rate. Silva and cordeiro (2015) created a new life time distribution by mixing BurrXII and power series distribution through compounding technique. Pinho et al. (2015) obtained a new distribution by assuming that simple size distribution as Harris distribution. Bardbar and Nematollahi (2016) obtained a modified exponential distribution- geometric distribution with increasing or decreasing failure rate. Flores et al (2013) obtained the complementary exponential power series distribution by considering the distribution of vectors through maximum components.

In this paper, we propose a new compounding distribution by compounding Poisson distribution with size biased exponential distribution, as there is a need to find more flexible model for analyzing statistical data.

2. Definition of proposed model (Poisson size biased exponential distribution)

If $Z|\nu \sim \mathrm{P}(\nu)$, where ν is itself a random variable following size biased exponential distribution with parameter(μ), then determining the distribution that results from marginalizing over ν will be known as a compound of Poisson distribution with that of size biased exponential distribution, which is denoted by $PSBED(Z;\alpha)$. It may be noted that proposed model will be a discrete since the parent distribution is discrete.

Theorem 2.1: The probability mass function of a Poisson weighted exponential distribution i.e., $PSBED(Z;\mu)$ is given by

$$P(Z=z)=\alpha^2\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+3}}\right];z=0,1,2,3,\ldots;\mu>0$$

Proof: Using the definition (2), the pmf of a PSBED $(Z;\alpha)$ can be obtained as

$$g(z\,|\,\nu)=\frac{e^{-\nu}\nu^z}{(z)!}\quad;\ z=0,1,2,3,\ldots;\nu>0$$

When its parameter ν follows weighted exponential distribution (SBED) with pdf

$$h(\nu;\alpha)=\frac{\mu^2}{\mu+1}(1+\nu)e^{-\mu\nu}\,;\nu>0,\mu>0$$

We have

$$P(Z=z)=\int_0^\infty g(z\,|\,\nu).h(\nu;\alpha)d\nu$$

$$P(Z=z)=\alpha^2\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+3}}\right];z=0,1,2,3,\ldots,;\alpha>0 \qquad (2.1)$$

which is the p.m.f. of PSBED

The corresponding c.d.f of PSBED is obtained as:

$$F_Z(z)=\sum_{n=0}^{z}\left[\frac{\alpha^2}{\alpha+1}\left[\frac{(1+\alpha)+(n+1)}{(1+\alpha)^{n+2}}\right]\right]$$

$$1-\frac{\alpha^2+1+3\alpha+\alpha z}{(1+\alpha)^{z+3}}\ ;\ z=0,1,2\ldots,\alpha>0 \qquad (2.2)$$

Fig. 1 : The below figures shows the pmf plot for different values of α

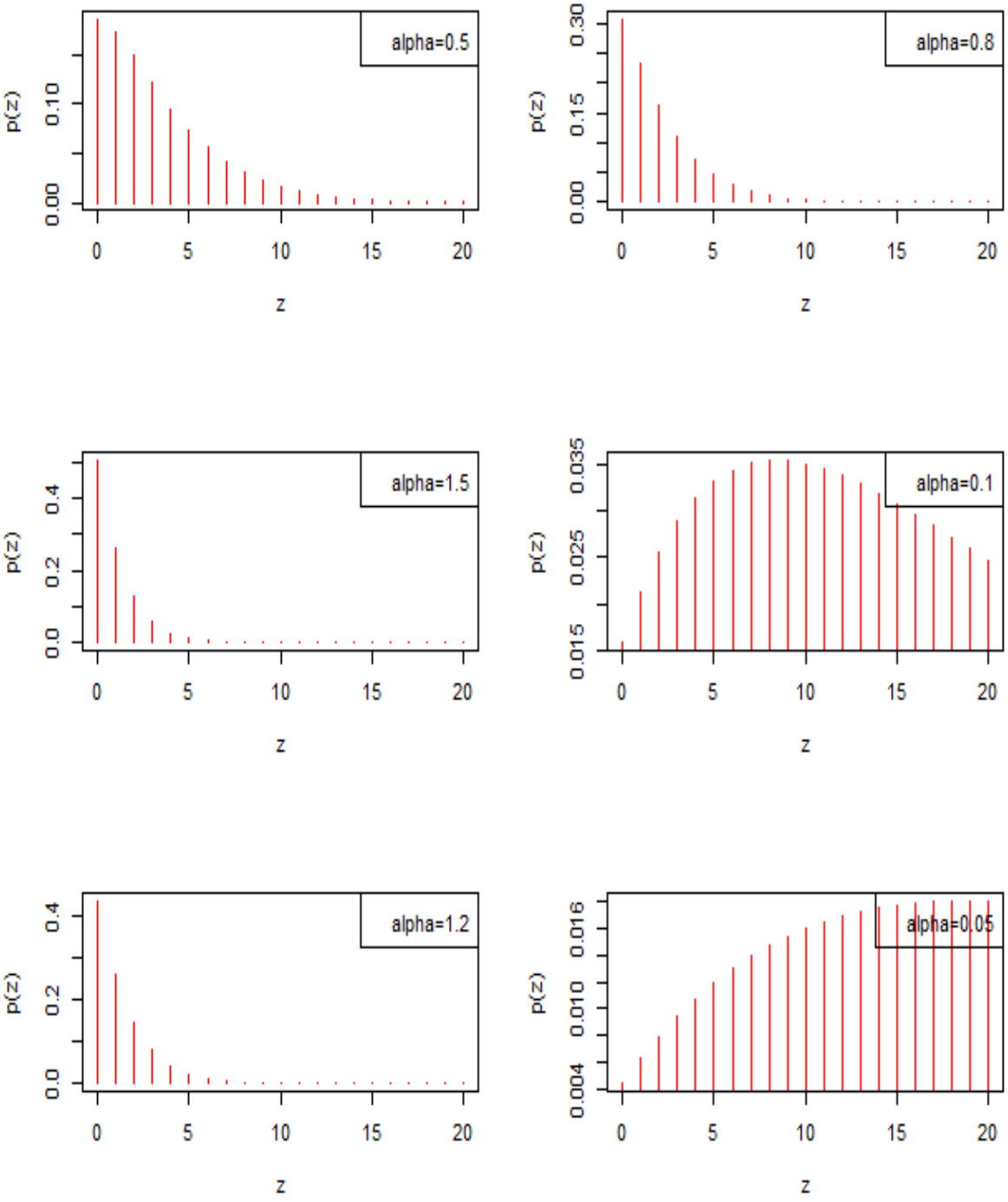
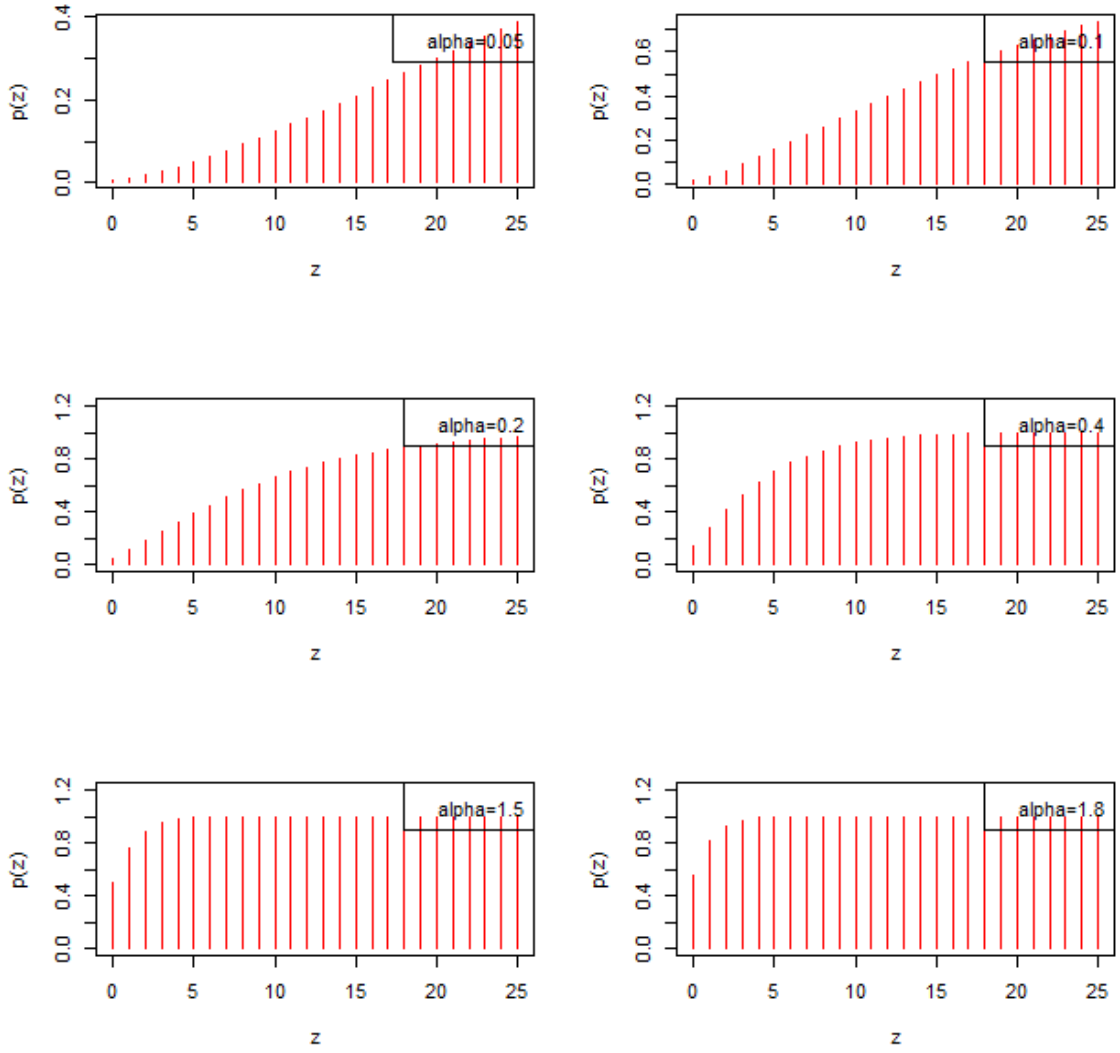


Fig. 2 : The below figures shows the cdf plot for different values of α



5 Reliability Analysis

5.1 Reliability Function R(z): The reliability function is defined as the probability that a system survives beyond a certain time. The reliability function or the survival function of PSBED is given as

$$R(z,\alpha)=\left(\frac{\alpha^2+1+3\alpha+\mu\alpha z}{(\alpha+1)^{z+3}}\right)$$

5.2 Hazard Function: The hazard function is also known as hazard rate is given as:

$$\text{H.R}=\frac{\alpha^2[(1+\alpha)+(z+1)]}{\alpha^2+1+3\alpha+\alpha z}$$

5.3 Reverse Hazard Rate and Mills Ratio: The reverse hazard rate and the mills ratio of PSBED are respectively given as:

$$\text{R.H.R}=\frac{\alpha^2[(1+\alpha)+(z+1)]}{(\alpha+1)^{z+3}-(\alpha^2+1+3\alpha+\alpha z)}$$

$$\text{Mills ratio}=\frac{(\mu+1)^{z+3}-(\mu^2+1+3\mu+\mu z)}{\mu^2[(1+\mu)+(z+1)]}$$

6. Statistical properties

In this section, structural properties of the PSBE model have been evaluated.

6.1 Moments

6.1.1 Factorial Moments

Using (2.1), the rth factorial moment about origin of the PSBED (2.1) can be obtained

$\mu_{(r)}{}' = E[E(Z^{(r)} \mid \nu)],\ where\ Z^{(r)} = Z(Z-1)(Z-2)\ldots(Z-r+1)$

$$\mu_{(r)}{}' = \frac{\alpha^2}{\alpha+1}\int_0^\infty\left[\nu^r\left(\sum_{z=r}^{\infty}\frac{e^{-\nu}\nu^{z-r}}{(z-r)!}\right)\right](1+\nu)e^{-\alpha\nu}d\nu$$

$Taking u = z-r, we\ get$

$$\mu_{(r)}{}' = \frac{\alpha^2}{\alpha+1}\int_0^\infty\left[\nu^r\left(\sum_{u=0}^{\infty}\frac{e^{-\nu}\lambda^u}{u!}\right)\right](1+\nu)e^{-\alpha\nu}d\nu$$

$$\mu_{(r)}{}' = \frac{\alpha^2 r!}{\alpha+1}\left[\frac{\alpha+(r+1)}{\alpha^{r+2}}\right] \qquad 6.1$$

Taking r=1,2,3,4 in (5.1), the first four factorial moments about origin of PSBED can be obtained as

can be obtained as

$$\mu_{(1)}{}' = \frac{1}{\alpha+1}\left[\frac{\alpha+2}{\alpha}\right]$$

$$\mu_{(2)}{}' = \frac{2}{\alpha+1}\left[\frac{\alpha+3}{\alpha^2}\right]$$

$$\mu_{(3)}{}' = \frac{6}{\alpha+1}\left[\frac{\alpha+4}{\alpha^3}\right]$$

$$\mu_{(4)}{}' = \frac{24}{\alpha+1}\left[\frac{\alpha+5}{\alpha^4}\right]$$

6.1.2 Moments about origin (Raw moments)

The first four moments about origin, using the relationship between factorial moments about origin and the moments about origin, of PSBED (2.1)can be obtained as

$$\mu_1' = \frac{1}{\alpha+1}\left[\frac{\alpha+21}{\alpha}\right]$$

$$\mu_2' = \frac{\alpha(\alpha+2)+2(\alpha+3)}{\alpha^2(\alpha+1)}$$

$$\mu_3' = \frac{6(\alpha+4)+6\alpha(\alpha+3)+\alpha^2(\alpha+2)}{\alpha^3(\alpha+1)}$$

$$\mu_4' = \frac{24(\alpha+5)+36\alpha(\alpha+4)+14\alpha^2(\alpha+3)+\alpha^3(\alpha+2)}{\alpha^4(\alpha+1)}$$

6.1.3 Moments about the Mean (Central moments)

Using the relationship $\mu_r = E(Y-\mu_1')^r = \sum_{H=0}^{r}\binom{r}{h}\mu_h'(-\mu_1')^{r-h}$ between moments about the mean and the moments about origin, the moments about the mean of the PSBED (2.1) can be obtained as $\mu_2 = \frac{\mu(\mu+2)+2(\mu+3)}{\mu^2(\mu+1)} - \left[\frac{1}{\mu+1}\left[\frac{\mu+2}{\mu}\right]\right]^2$

$$\mu_3 = \frac{6(\alpha+4)+6\alpha(\alpha+3)+\alpha^2(\alpha+2)}{\alpha^3(\alpha+1)} - 3\frac{(\alpha(\alpha+2)+2(\alpha+3))}{\alpha^2(\alpha+1)}\frac{1}{\alpha+1}\left[\frac{\alpha+2}{\alpha}\right]$$

$$\mu_4 = \frac{24(\alpha+5)+36\alpha(\alpha+4)+14\alpha^2(\alpha+3)+\alpha^3(\alpha+2)}{\alpha^4(\alpha+1)} - 4\frac{6(\alpha+4)+6\alpha(\alpha+3)+\alpha^2(\alpha+2)}{\alpha^3(\alpha+1)}\frac{1}{\alpha+1}\left[\frac{\alpha+2}{\alpha}\right]$$
$$+6\frac{\alpha(\alpha+2)+2(\alpha+3)}{\alpha^2(\alpha+1)}\left[\frac{1}{\alpha+1}\left[\frac{\alpha+2}{\alpha}\right]\right]^2 - 3\left[\frac{1}{\alpha+1}\left[\frac{\alpha+2}{\alpha}\right]\right]^4$$

6.2 Coefficient of variation (c.v) , skewness $(\sqrt{\beta_1})$, kurtosis (β_2) and Index of Dispersion (γ)

$$C.V = \frac{\sqrt{(\alpha(\alpha+2)+2(\alpha+3))(\alpha+1)-(\alpha+2)^2}}{(\alpha+2)}$$

$$\sqrt{\beta_1} = \frac{(\alpha+1)(6(\alpha+4)+6\alpha(\alpha+3)+\alpha^2(\alpha+2))-3(\alpha(\alpha+2)+2(\alpha+3)(\alpha+2))(\alpha+2)}{((\alpha+1)(\alpha(\alpha+2)+2(\alpha+3))-(\alpha+2)^2)^{3/2}}$$

$$\beta_2 = \frac{((24(\alpha+5)+36\alpha(\alpha+4)+14\alpha^2(\alpha+3)+\alpha^3(\alpha+2))-4(6(\alpha+4)+6\alpha(\alpha+3)+\alpha^2(\alpha+2))(\alpha+2)}{-6(\alpha(\alpha+2)+2(\alpha+3))(\alpha+2)^2-3(\alpha+1)(\alpha+2))(\alpha+1)^2}$$
$$\frac{}{(\alpha(\alpha+2)+2(\alpha+3))^2(\alpha+1)(\alpha+2)^4}$$

$$\gamma = \frac{(\alpha(\alpha+2)+2(\alpha+3))(\alpha+2)-(\alpha+2)}{\alpha(\alpha+1)(a+2)}$$

6.3 Moment generating function and Probability generating function of Poisson size biased Exponential Distribution

Theorem 6.3.1: If Z has the PSBED (α), then the Probability generating function $P_z(t)$ has the following form

$$P_X(t) = \frac{\alpha^2}{(\alpha+1)^2}\left[\frac{(\alpha+1-t)((1+\alpha)+1)+t}{(\alpha+1-t)^2}\right]$$

Proof: We begin with the well known definition of the probability generating function given by

$$P_Z(t) = \sum_{z=0}^{\infty} t^z \left[\alpha^2\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+3}}\right]\right]$$

$$P_Z(t) = \frac{\alpha^2}{(\alpha+1)^2}\left[\frac{(\alpha+1-t)((1+\alpha)+1)+t}{(\alpha+1-t)^2}\right]$$

Theorem 6.3.2: If X has the PSBED (α), then the moment generating function $M_Z(t)$ has the following form

$$M_Z(t) = \frac{\alpha^2}{(\alpha+1)^2}\left[\frac{(\alpha+1-e^t)((1+\alpha)+1)+e^t}{(\alpha+1-e^t)^2}\right]$$

Proof: We begin with the well known definition of the moment generating function given by

$$M_Z(t) = \sum_{z=0}^{\infty} e^{tz}\left[\alpha^2\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+3}}\right]\right]$$

$$M_Z(t) = \frac{\alpha^2}{(\alpha+1)^2}\left[\frac{(\alpha+1-e^t)((1+\alpha)+1)+e^t}{(\alpha+1-e^t)^2}\right]$$

Similarry Laplace and Fourier transforms as calculated as

$$L_Z(t) = \frac{\alpha^2}{(\alpha+1)^2}\left[\frac{(\alpha+1+e^t)((1+\alpha)+1)+e^t}{(\alpha+1+e^t)^2}\right]$$

$$F_Z(t) = \frac{\alpha^2}{(1+\alpha)^2}\left[\frac{(\alpha+1+t)((1+\alpha)+1)+t}{(\alpha+1+t)^2}\right]$$

6.4 ***Recurrence Relation Between Probabilities***

The PSBED can be written as

$$P(Z=z) = \alpha^2\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+3}}\right]$$

$$P(Z=z+1)=\alpha^2\left[\frac{(1+\alpha)+(z+2)}{(1+\alpha)^{z+4}}\right]$$

Dividing P(Z=z+1) by P(Z=z), we find the recurrence relation between probabilities

$$P(Z=z+1)=\frac{(1+\alpha)+(z+2)}{(1+\alpha)}P(Z=z)$$

7. Order statistics

Let $Z_{(1)},Z_{(2)},Z_{(3)}....,Z_{(n)}$ be the ordered statistics of the random sample $Z_1,Z_2,Z_3,....Z_n$ drawn from the discrete distribution with cdf $F_Z(z)$ and pmf $P_Z(z)$, then the pmf of rth order statistics $Z_{(r)}$ is given by: $f_{z(r)}(z,\mu,\sigma)=\frac{n!}{(r-1)!(n-r)!}P(z)[F(z)]^{r-1}[1-F(z)]^{n-r}.r=1, 2, 3,\ldots,n$

Using the equations (2.1) and (2.2), the probability density function of rth order statistics of Poisson size biased exponential distribution is given by

$$f_{(r)}(z,\mu)=\frac{n!}{(r-1)!(n-r)!}\alpha^2\left[\frac{(1+\alpha)+(z+1)}{(1+\mu)^{z+3}}\right]\left[1-\frac{\alpha^2+1+3\alpha+\alpha z}{(\alpha+1)^{z+3}}\right]^{r-1}\left[\frac{\alpha^2+1+3\alpha+\alpha z}{(\alpha+1)^{z+3}}\right]^{n-r}$$

Then, the pmf of first order $Z_{(1)}$ Poisson size biased exponential distribution is given by:

$$f_1(Z;\mu,\sigma)=n\left[\frac{(1+\alpha)+(z+1)}{(1+a)^{z+2}}\right]\left[\frac{\alpha^2+1+3\alpha+\alpha z}{(\alpha+1)^{z+3}}\right]^{n-1}.$$

And the pmf of nth order $Z_{(n)}$ Poisson weighted exponential model is given as:

$$f_{(n)}(z,\mu)=n\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+2}}\right]\left[1-\frac{\alpha^2+1+3\alpha+\alpha z}{(\alpha+1)^{z+3}}\right]^{n-1}$$

8. Estimation of Parameters

In this section, we estimate the parameters of the Poisson size biased exponential distribution by method of maximum likelihood estimation.

8.2 Method of Maximum Likelihood Estimation

This is one of the most useful method for estimating the different parameters of the distribution. Let $Z_1,Z_2,Z_3,...,Z_n$ be the random sample of size n draw from PSBED, then the likelihood function of PSBED is given as

$$L(z\mid\alpha)=\alpha^{2n}\prod_{i=1}^{n}\left(\left[\frac{(1+\alpha)+(z+1)}{(1+\alpha)^{z+3}}\right]\right)$$

$$\log L = 2n\log\alpha - n\log(\alpha+1) + \sum_{i=1}^{n}\log((1+\alpha)+(z+1)) - (\sum_{i=1}^{n} z_i + 2n)\log(1+\alpha)$$

$$\frac{\delta}{\delta\alpha}\log L = \frac{2n}{\alpha} - \frac{n}{\alpha} + \sum_{i=1}^{n}\frac{1}{((1+\alpha)+(z+1)} - \frac{\sum_{i=1}^{n} z_i + 2n}{(1+\alpha)} = 0$$

The above equations can be solved numerically by using R software (3.5.2).

9. Applications of Poisson size biased exponential distribution

We fitted our proposed model on two data sets and showed that it gives better results as compared to other fitted models.

Data set (1): The data representing distribution of mistakes in copying groups of random digits used by and due to Kemp and Kemp (1965) as below.

No. of Errors per Group	**0**	**1**	**2**	**3**	**4**
Observed Frequency	**35**	**11**	**8**	**4**	**2**

Now we analyzed the data set 1 by computing AIC, BIC, chi-square value, p value by fitting our proposed model and compared our proposed model with other fitted models.

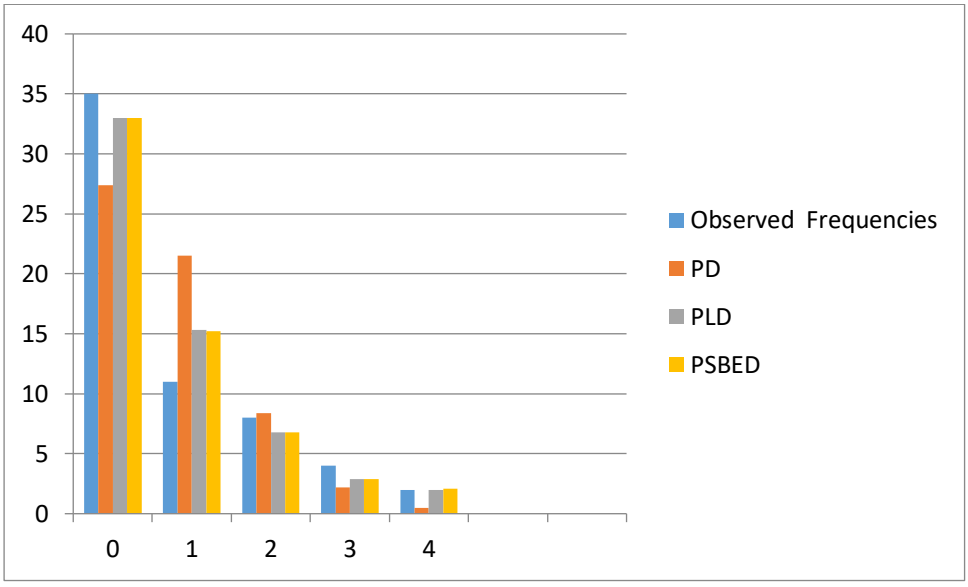
Table 1: In this table we reveals that our newly formulated Poisson-size biased exponential distribution possesses least value of AIC and BIC as compared to Poisson distribution and Poisson Lindley distribution for the data set (1).

Criterion	**PD**	**PLD**	**PSBED**
-logL	77.95	73.35	73.2
AIC	157.9	148.70	148.40
BIC	156.6	147.4	147.1

Table 2: In this table we reveals that p-value is maximum and chi-square value is minimum for our proposed model as compared to Poisson distribution and Poisson Lindley distribution which shows that our proposed model fits well to data set (1) as compared to other mentioned related models.

Number of Errors(Z)	Observed Frequencies	PD	PLD	PSBED
0	35	27.4	33	33
1	11	21.5	15.3	15.2
2	8	8.4	6.8	6.8
3	4	2.2	2.9	2.9
4	2	0.5	2.0	2.1
Total	60			
ML estimates (Standard error)		θ =0.78 (0.11)	θ =1.74 (0.28)	θ =1.7 (0.27)
Chi-squared		7.98	2.20	1.69
d.f		1	1	1
p-value		0.0047	0.13	0.19

Fig 3: Number of Mistakes in Copying Group of Random Digits Fitted by using Some Models



Data set (2): The data set second regarding distribution of Pyrausta Nublilalis is due to Beall (1940) and is given as below:

No. of Insects	**0**	**1**	**2**	**3**	**4**	**5**
Observed Frequency	**33**	**12**	**6**	**3**	**1**	**1**

Now we analyzed the data set 2 by computing AIC, BIC, chi-square value, p value by fitting our proposed model and compare this model with other related models.

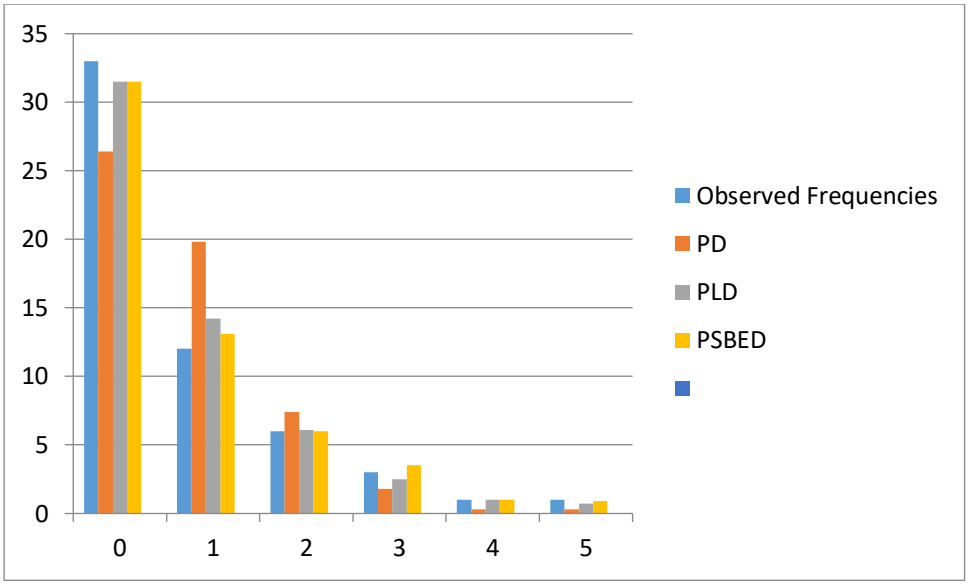
Table 3: The above table reveals that our newly formulated Poisson -Pranav model possesses least value of AIC and BIC as compared to Poisson distribution and Poisson Lindley distribution for the data set (2). This means that loss of information by fitting Poisson-Pranav model to data set (2) is less as compared to other mentioned related models.

Criterion	**PD**	**PLD**	**PSBED**
-logl	71.58	67	66.6
AIC	145.1	136	135.2
BIC	143.9	134.7	134.3

Table 4: In this table we reveals that p-value is maximum and chi-square value is minimum for our formulated Poisson size biased exponential distribution as compared to Poisson model and Poisson Lindley model which shows that our proposed model fits well to data set (2) as compared to other competing models.

Number of insects (X)	**Observed Frequencies**	**PD**	**PLD**	**PSBED**
0	33	26.4	31.5	31.5
1	12	19.8	14.2	13.1
2	6	7.4	6.1	6
3	3	1.8	2.5	3.5
4	1	0.3	1.0	1
5	1	0.3	0.7	0.9
Total	56			
ML estimates (Standard error)		θ =0.75 (0.11)	θ =1.81 (0.30)	θ =1.8 (0.3)
Chi-squared		4.87	0.53	0.17
d.f		1	1	1
p-value		0.0273	0.4666	0.67

Fig 4: Distribution of Pyrausta Nublilalis in 1937



9. CONCLUSION

We constructed a new probability model known as Poisson-size biased exponential distribution for count data by mechanism of compounding. Then we obtained its vital statistical properties and fitted our model to count data sets and compared with related models and showed our proposed model gives better fit to count data as compared to Poisson distribution and Poisson Lindley distribution.

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REVIEW ON VALUE ADDED PRODUCT FROM LIGNIN AND ITS POTENTIAL

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ABSTRACT:

Lignin is a complex organic polymer that is present in the vascular tissue of plant. The biological objective of the lignin is to provide mechanical support to the plants. It protects the plants from various stresses. Lignin is used as the renewable source of energy. Lignin is of three groups. The first group consists of aromatic lignin such as phenols, xylene etc., which has very low potential, second group consists of lignin macromolecule, which has very high potential and the third group consists of lignin containing carbon materials.

Lignin is used in the production of jet fuels alternative to the petroleum. Cellulosic ethanol production along with the lignin as raw material is used for the production of jet fuels that increases the economic viability and sustainable fuel. Lignin is also used for the production of wood pellets. Kraft black liquor and Indulin AT(IAT) are the two types of lignin used in the production of wood pellets. The wood pellets produced by using IAT has better quality pellets and has higher fuel values than with kraft black liquor as kraft black liquor pellets are soft and spongy. Lignin produced from kraft process and Organosolv- like lignin production can be used as the alternative of fossil fuel because of their low molecular weight and free from Sulphur. After the ultrafiltration of black liquor, kraft lignin of high purity is separated using lignoboost technique. Lignin depolymerization in supercritical fluid containing carbon dioxide/ water/acetone are used for the production of aromatic chemicals. The aromatic chemicals such as vanillin, acetovanillin and vanillin acid are obtained by depolymerization of lignin.

KEY WORDS: Lignin, renewable source, jet fuel, wood pellet, Kraft black liquor, Indulin AT, Organosolv, Lignoboost technique, Depolymerization.

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LIGNIN SEPARATION AND PURIFICATION FROM LIGNOCELLULOSIC BIOMASS – REVIEW

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ABSTRACT

Lignin is an amorphous cross linked polymer. Lignin is the second most abundant biopolymer in nature. The position of lignin within lignocellulosic matrix is middle lamella. Lignin is a three dimensional polymer built up of phenyl propanoid units, which are Coniferyl alcohol, Sinapyl alcohol, p-Coumaryl alcohol. Guaiacyl lignin is typical of softwood species and it is formed mostly of trans-coniferyl alcohol. Guaiacyl-syringyl lignins found in hardwood species, are mainly composed of trans-coniferyl alcohol and trans-sinapyl alcohol. In softwood lignin, Phenolic hydroxyl, Aliphatic hydroxyl, Methoxyl, Carbonyl are present. Lignin is most abundant in softwood species. Kraft lignin derived from kraft pulping of wood is the principle available lignin type. Kraft lignin is obtained by precipitation with acid. In the first step carbon dioxide is used to reduce the PH of the liquor. The refined lignin is treated with sulphuric acid minimizing the PH. Electrophilic Substitution reaction happens due to the neutralization of black liquor by acid. The precipitated kraft lignin is difficult to dissolve in water and it can be recycled, regenerated as well reuse. To determine the lignin content FTIR spectrophotometric method is the effective method to obtain relatively high yields of lignin. Isolation of lignin from lignocellulosic biomass by acidification is more efficient comparing other isolation methods.

KEY WORDS: Lignin, Kraft lignin, Soft wood, Acidification, FTIR

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LUTEIN – THE HIDDEN MEDICINE OF THE HUMAN HEALTH – REVIEW

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ABSTRACT:

Present investigation is focused on reviewing about lutein and its prospects of human health care. Lutein – a most prominent oxy-carotenoid form, usually fond of its presence in the muscular regions is a fundamental muscular pigment. Lutein is the most advisably asked for the consciousness of health to a number of defects such as risk reduction of many age related mascular degeneration (AMD) , cancer and cardiovascular diseases. It is also recommended bioproduct for the anti-mutagenic changes involved. The main source of its origin is by a cultivable MARIGOLD flower's pollen. Along with this source of production lutein can also be produced by the cellular level organisms such as microalgae *Scenedesmus sp* , *Escherichia vulneris.* The other thing that makes lutein more special is that it is identified as a new line of cure for more than one age related eye problem , when treated lutein along with "ZEAXANTHIN" . Lutein supplementation is a modern solution to the very modern digital problematic life that's been going on at the moment , it has come to knowledge that lutein can maintain visual function by filtering blue light and also in this process it can protect the photosensitive cells in our eyes. Another very successful form of lutein intake is the economically suited dietary products whose result show that the dietary lutein increased tumour latency which is ultimately suppressing mammary tumour growth at the very large scale of excellence. Dietary lutein keeps adding its usefulness by providing both cell mediated and humoral immune responses in the domestic canine and cats as well as protecting the skin from UV radiations with its carotenoid and antioxidant properties.

KEY WORDS :

Lutein , Dietary , Mariegold flower, microalgae

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PRODUCTION, PURIFICATION AND CHARACTERIZATION OF LACTASE - A REVIEW

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ABSTRACT

This work reviews the production of lactase by bacterium *Bacillus subtilis.* Wheat bran solid medium and broth media is used. The analyzer used here is 16SArDNA. Zymogram method is used for testing an enzyme. The major parameter involved in this process is temperature [30 to 70°C],pH [5 to 8] and incubate at 48 hrs. Another strain used for identification is Kluyveromyceslactis. Interaction between lactase molecule are studied using atomic force microscopy. MgSO4, yeast extract are the major components used in fermentation process. Methodology used for optimization is "Response surface methodology" and the techniques performed here is ion exchange and gel filtration chromatography. Lactase catalyse the hydrolysis of the glycosidic bond in the disaccharide lactose, as a result it releases galactose and glucose.

KEYWORDS : Lactase production, Bacillus subtilis, Kluyveromyceslactis, galactose

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Topic-Electrochemistry and Corrosion

Porous 3D Cu@Cu_2O Aerogels Anchored N-Doped Graphene sheets for Electrochemical sensing and Supercapacitor Applications

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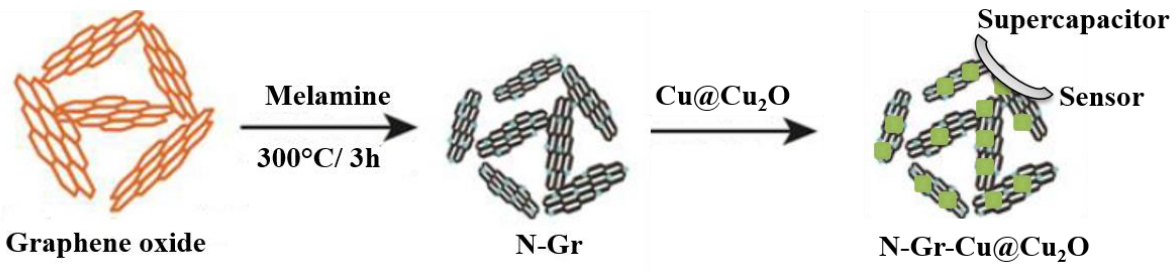
ABSTRACT: Herein, we report synthesis of a porous three-dimensional Cu@Cu_2O aerogels anchored on N-Doped graphene (N-Gr-Cu@Cu_2O) by using a facile strategy method. The as-synthesized N-Gr-Cu@Cu_2O composites were characterized by a variety of physicochemical characterization techniques. The N-Gr-Cu@Cu_2O modified electrode material is employed in two different applications such as electrochemical sensing and supercapacitor applications. Remarkably, the fabricated electrode materials towards glucose sensor is exhibited a low detection limit, high sensitivity and long-term durability. The N-Gr-Cu@Cu_2O modified electrode possesses an appreciable specific capacitance and remarkable long-term cycling stability. Moreover, as synthesized N-Gr-Cu@Cu_2O is suitable for the both sensing and supercapacitor applications.



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A chromogenic and fluorescence turn-on sensor for the selective and sensitive recognition of Al^{3+} ions - a new approach Schiff base derivative as probe

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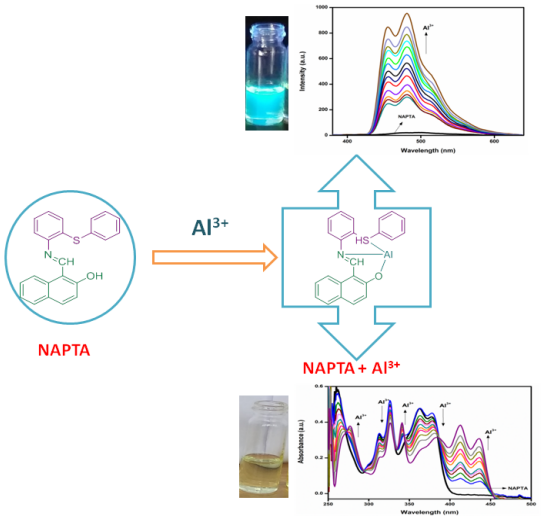
Abstract

In this present study, A newly designed and synthesized probe specifically (E)-1-(((2-(phenylthio)phenyl)imino)methyl)naphthalen-2-ol (NAPTA) as efficient chemosensor was portrayed through the utilization of various spectroscopic techniques like ^{1}H, ^{13}C NMR and ESI-MS. The probe exhibits fantastically specific and sensitive towards Al^{3+} ions than the other contending cationic metal ions. This designed probe indicates chromogenic and turn-on fluorescence behavior which may be noticeable through naked-eye and UV light individually. The 1:1 binding interaction of NAPTA with Al^{3+} ions was revealed from the Job's plot investigation. The limit of detection was determined as 13x 10^{-7} M which is very lower level than the permitted level. The DFT figuring and calculations have furthermore upheld to the proposed mechanism as CHEF and ICT from the acquired spectroscopic outcomes.

Keywords: Chemosensor, interaction, selective, sensitive.



Use of N-Heterocyclic Compounds as CPCs on Mild steel: An Overview

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Abstract

Corrosion of metals and its alloys are unavoidable but can be a controllable process. Combating this process is a greater economic challenge for several developing as well developed countries. Corrosion prevention compounds are the substances added directly into the corrosive medium to suppress the corrosion happening in the metals. For the past two decades various substances like organic compounds containing heteroatoms, inorganic compounds, polymeric compounds, natural polysaccharides, natural product extracts were attempted to inhibit the corrosion process. These substances are called to be corrosion prevention compounds (CPCs). Also the best way to control the impact of corrosion of metals is using CPCs specifically contains hetero atoms in it. These heterocyclic compounds have drawn huge attention due to its simple synthesis methodology and utmost corrosion inhibition activity in various metals towards the corrosive environment. Nitrogen based heterocyclic compounds such as benzimidazole, imidazoline, amides, imidazoline amino amides, Piperidines, Pyrroles, Substituted purines and their derivatives have been successfully used as inhibitor in many oil industries. These heretocyclic compounds would act like a base materials and which serve as electron donor to the metal steel surface and this creates huge electrostatic interaction between the added inhibitor and the metal surface. Thus, the metal becomes passive and hence corrosion is prevented. Therefore, the aim of the present review is to highlight the works carried out using heterocyclic compounds and its derivatives for metal protection.

Keywords: Corrosion inhibitors, Heterocyclic compounds, Mild steel

Highly selective CN^- ion sensing through Diphenyl Amine based dyes in Aqueous medium

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Developed a simple triphenyl amine based fluorophores (HK &MK) for selective sensing of CN^- ion in aqueous medium. We have synthesized hexyl and methyl substituted fluorophores. They showed a remarkable selectivity towards CN^- ions in aqueous medium even in presence of high concentration of various interfering ions. Both of them have weak emission in aqueous medium. The addition of cyanide ion to the receptors causes 'turn on' strong yellow fluorescence. Among them the limit of detection for hexyl substituted fluorophore (1.4×10^{-9} M) is comparatively higher than the methyl substituted fluorophore (12×10^{-8} M). Job's plot analysis suggested that both fluorophores have 1:1 binding stoichiometry with CN^- ion. Thus, the fluorophores (HK &MK) can be employed for fluorescent live cell imaging of Hela cells.

Key words: Triphenyl amine, cyanide ion, turn on, Fluorescence, Cell imaging.

A novel triazine based organic fluorophore for selective detection of picric acid in aqueous medium

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Abstract

A simple D-A containing triazine derivatives such as **TZNET TZSET**, **TZOME** were synthesized via a simple cross coupling reactions. Especially, **TZNET** has excellent opto-electronic properties. Generally, **TZNET** exhibits enhanced emission induced through aggregation and mechanochromic behavior. Moreover, AIEE fluorescent **TZNET** has turn-off fluorescence sensor for picric acid and its limit of detection is 40 x 10^{-6} M. To the best of our knowledge, this is the first sensor for picric acid in aqueous medium via AIEE fluorophore.

Key words: Triazine, AIEE, fluorescence, picric acid, turn off.

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Water Quality Status of Monomictic Lake of Kashmir Himalaya, India

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Abstract

In fresh water ecosystems, water quality plays an important role in determining the status and condition of that fresh water ecosystem. During the present study, an attempt was made to assess the water quality and conservation status of Manasbal Lake of Kashmir Himalaya. The Manasbal Lake, a marl lake, is located district Ganderbal in the UT of Jammu and Kashmir, India. The actual location of the Manasbal catchment is defined by latitudes $34^0$14' - $34^0$16' N and longitude $74^0$40' - $74^0$43' E, and has altitude position of about 1551m a.s.l. The lake catchment covers an area of about 22 km^2located in district Ganderbal at a distance of 30 km north from the Srinagar city of Jammu and Kashmir.

The Manasbal Lake a semi urban lake is getting modified as a result of cultural eutrophication due to anthropogenic pressure, siltation and the waste water released from the nearby kilns and residential areas. From the present study, it can be concluded that the higher values of Phosphates (PO4), Alkalinity, Hardness, Electric Conductivity, Free carbon dioxide and lower values of dissolved oxygen and transparency clearly depicted higher trophic status of Manasbal Lake. It can also be concluded that climatic factors, untreated sewage and solid garbage from surrounding population, fertilizers containing Nitrates and Phosphates and slit load were the main causes for degradation of water quality of the studied lake.

Hence, periodic monitoring of Manasbal Lake is necessary for assessing the quality of water for human and animal consumption as well as for aquatic life. Besides,immediate remedial measures should be taken up for protection and conservation of this monomictic lake in order to save it from further pollution and deterioration.

Keywords: Manasbal Lake, Anthropogenic, Cultural eutrophication, Conservation.

Studies on removal of Copper using Graphene from wastewater

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ABSTRACT

This paper focuses mainly on removing of heavy metal ion Copper (II) from wastewater using Graphene as an adsorbent. The batch experiments were conducted to study the adsorption kinetics of copper removal for the concentration of 10 mg/L (10 ppm) copper solution. The equilibrium was achieved around 90 min for the above concentration. Batch mode experiments were carried out as a function of adsorbent dosage, metal ion concentration and contact time. FT-IR spectra of the adsorbent were recorded to explore the number and position of functional groups available for the binding of Cu (II) ion. The removal of copper was dependent on the physicochemical characteristics of the amount of adsorbent and adsorbate concentration. Maximum 85 % metal removal of Cu (II) was observed at 5 gms of adsorbent. The applicability of Langmuir and Freundlich isotherms was also tested. The results revealed that the divalent copper fits considerably with Langmuir isotherm than Freundlich isotherm. It can be concluded that adsorption could be an economical method for the removal of divalent copper from aqueous systems.

Keywords: Adsorption, Graphene, Copper

Biosynthesis of Ag/ ZnO nanoparticles using *Ficus benghalensis* leaf extract and their Photo catalytic properties

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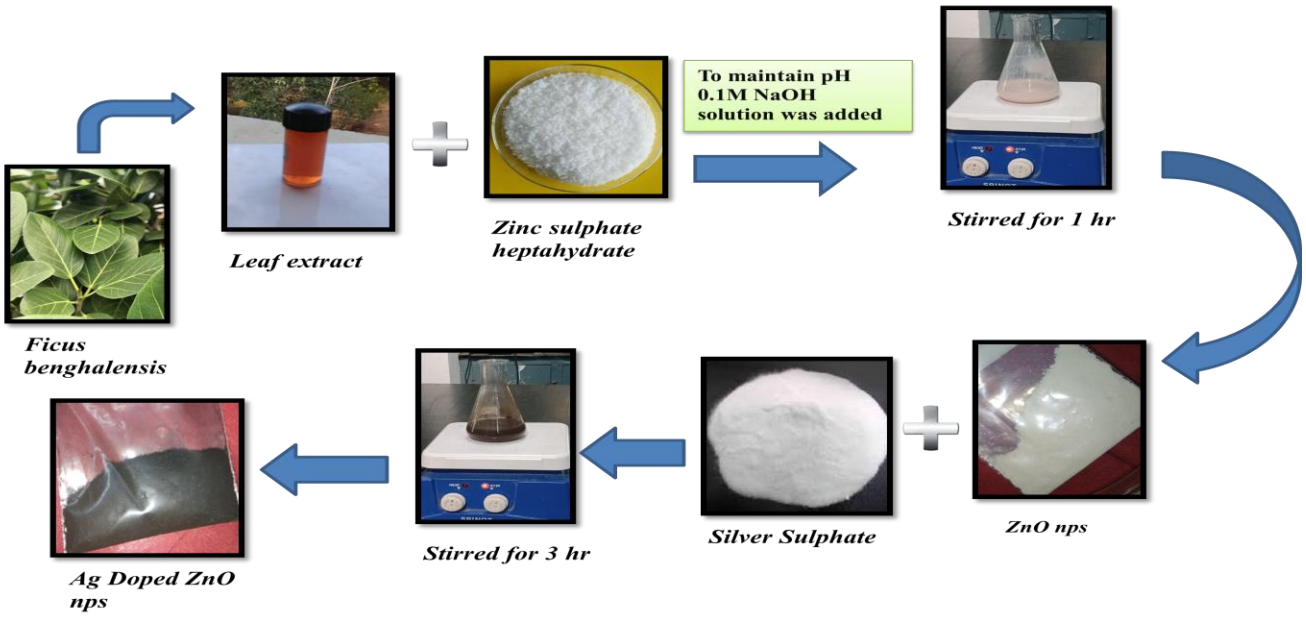
Recent research implies that the nanoparticles find applications in many areas such as drug delivery, sensors and photo catalytic activity. In specific, metal doped or polymer based nanocomposites act as catalyst for degradation of organic pollutants from the industries. Keeping this as our aim, in this work the study of photo catalytic activity of nanoparticle for degradation of the dye crystal violet under visible light irradiation was carried out. Crystal violet is harmful[1] to our health and it must be removed from the water sources.

In this work zinc oxide nanoparticles are synthesized by green route method using the extract of *Ficus benghalensis*[2]. Phytochemical studies reveal that biomolecules in the *Ficus benghalensis* could act as the template for reduction and stabilization of green modified ZnO nps[3]. And an attempt was made to synthesise Ag doped ZnO nanoparticles to increase the efficiency of the catalyst.

The ZnO Ag doped ZnO nanoparticles are characterized by X-ray diffraction, UV-visible, FT-IR, EDAX and SEM analysis. The designed nanocatalyst material was found to possess heterogeneous photo catalytic potential against the oxidative degradation of Crystal Violet (CV) dye taken as model pollutant. The minimum energy of ZnO semiconductor has wide band gap of ~3.19eV with a large exciton binding energy (60 meV). Doping with silver makes it a more active photo catalyst because of the photo generated electron–hole pairs. The maximum energy is~3.26 eV for ZnO–Ag.

The photo degradation of the dye was studied by UV-Visible spectrophotometer using a photo catalytic reactor. The concentration of the dye was taken as 15 µm, 20 µm and 25 µm. The amount of nanocatalyst was varied as 25 mg, 50 mg and 75 mg to fix the suitable system. To conclude, the silver doped zinc oxide nanoparticles degrade the dye to maximum 83%. Thus the modified Ag doped ZnO nanocatalyst can promote enhanced photo catalytic activity.



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High Selective Asymmetric Michael Addition Reaction: Enantiopure Binuclear Ni(II) Helicates as Catalyst for Synthesis of *S*-Warfarin Drug

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Abstract: The enantiopure Ni(II) helicates **[Ni L ^{RR}.Cl$_2$], [Ni L ^{SS}.Cl$_2$], [Ni L ^{RR}.Cl$_2$], [Ni L ^{SS}.Cl$_2$]** were successfully synthesized by one-pot self-assembly technique from R-(+)- or S-(-)-1,1'-binaphthyl-2,2'-diamine, 4-methyl-2,6-diformyl phenol or 4-*tert*-butyl-2,6-diformyl phenol and nickel salts . This binuclear double stranded Ni(II) helicate were characterized by ESI-MS, FT-IR and their extensive chiroptical properties were studied by using CD spectroscopy. The chiroptical CD spectra suggest that the complexes are enantiopure in nature. The chirality transfer from ligand **L ^{RR}** & **L ^{RR}** to Ni(II) metal centre produced ΔΔ geometrical chirality while in the **L ^{SS}** & **L ^{SS}** is produced ΛΛ chirality. These enantiopure helicates were further applied as catalyst in asymmetric Michael addition of 1,3-dicorabonyl compound with β-nitrostyrene to produce nitroalkanes in good yield (≈96-98%) and ee (≈78-90%).

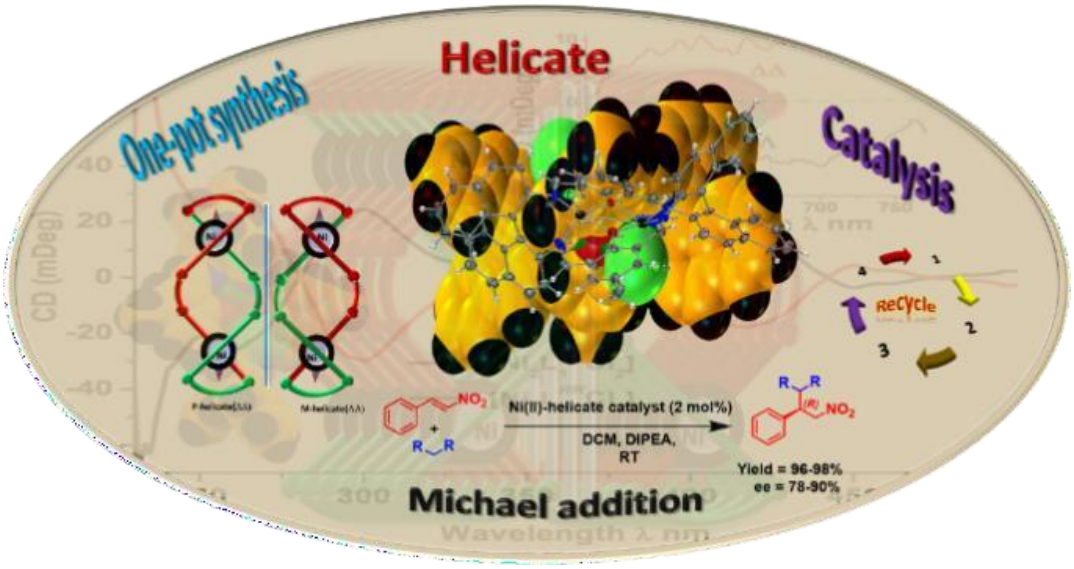

Figure1. Schematic representation of P(ΔΔ) and M(ΛΛ)-helicates and Asymmetric Michael addition reaction.

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Study on removal of Mercury (II) from its aqueous solution using Cephalandra indica as an acid activated carbon

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Abstract

In this current research work, batch adsorption experiments were done to examine the appropriateness of prepared acid activated carbon in extracting heavy metal ion such as mercury (II). Acid activated carbon is acquired from Cephalandra indica using Conc. Sulphuric acid and it is labelled as sulphonated cephalandra indica carbon (SCIC). The adsorption equilibrium information for mercury (II) was obtained from adsorption by the prepared activated carbon. Langmuir and Freundlich models agree the data well. Prepared activated carbon demonstrated higher adsorption capacity for mercury (II). The removal of mercury (II) was studied by the prepared acid activated carbon at different pH, contact time, metal ion initial concentration adsorbent dose, agitation rate, intraparticle diffusion rate, grain size and temperature. The isotherms studies exposed that the prepared activated carbon for the removal of mercury (II) from aqueous solution correlated well with Langmuir isotherm by high R^2 value. Kinetic studies implied that the adsorption of Hg (II) on the activated carbon followed Pseudo second order kinetic model.

Keywords:

Cephalandra indica; mercury (II); Characterization; heavy metals removal; Regeneration.

Catalystic Hydrosilylation of Imines by Iron-*NHC* Complexes

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Abstract

In recent years the NHC ligands become alternatives for classical π electron donor ligands such as amines, ethers, and phosphines. The strong σ-donating and less-π acceptor nature of NHCs reveals an eminent support to stabilize various oxidation states of the complex. Several Ir, Rh, Ru, and Ag complexes have been reported and owing to the toxicity issues, less abundance, and expensive criteria offer a new avenue to search for suitable alternatives. Thus, one rational approach is to use naturally gifted metal like iron as it capable of adopting variable oxidation states and tuneable redox potentials. Here we are reporting *N*-heterocyclic carbenes (NHCs) as a ligand for precious iron metal complex catalysts for imine hydrosilylation. The novel Fe^{II}-NHC-carbene complexes [Fe(L1)Cp(CO)] **1** (*m/z*, 430.05) [L1 = 1-((4-methoxy-3,5-dimethylpyridin-2-yl)methyl)-3-methyl-1H-benzo[d]imidazol-3-ium iodide], **2** (*m/z*, 506.03) [L2 = 3-benzyl-1-((4-methoxy-3,5-dimethylpyridin-2-yl)methyl)-1H-benzo[d]imidazol-3-ium bromide], **3** (*m/z*, 371.98) [L3 = (3-methyl-1-(pyridin-2-ylmethyl)-1H-benzo[d]imidazol-3-iumiodide] and [Fe(L4)Cp(CO)], **4** (*m/z*, 447.95) [L4 = (3-benzyl-1-(pyridin-2-ylmethyl)-1H-benzo[d]imidazol-3-ium bromide] have been synthesized and are characterized by the NMR and ESI-MS. The disappearance of ^{1}HNMR signals at 10.20 –11.78 ppm of NHC ligand confirms the complex formation via Fe-C coordination and it is further supported by two asymmetric protons of the methylene group gives two distinct doublets. The IR spectra shows ν_{str}, 1933- 1959 cm^{-1} for the coordinated –C≡O, which are virtually independent of the wingtip substituents on **1** - **4** and possibly this limits the influence of those groups on the electronic properties of iron(II) center. The Tolman's electronic parameters (TEP) also calculated as 2062 -2068 cm^{-1} for **1** - **4**. The molecular structure of the complexes reveals that the coordination of ligand, Cp and the C≡O to low spin Fe^{II} center (S = 0). The bonds Fe-$C_{carbene}$, (3, 1.919; 4, 1.934 Å), Fe-N_{Py} (3, 1.995; 4, 2.019 Å), Fe-CO (3, 1.743 Å; 4, 1.762 Å) and Fe-Cp (3, 2.053 Å; 4, 2.097 Å) are almost identical. The bite angles CO-Fe-$C_{carbene}$ (3, 93.2°; 4, 92.9°) are higher than the Cp-Fe-$C_{carbene}$ (3, 97.2°; 4, 113.8°) but the bite angle of pyridyl nitrogen metal atom and CO are merely same in all complexes CO-Fe-N_{py} 89.7°. The complexes **1** - **4** shows two redox couples at 0.61 - 064 V and 1.05 – 1.08 V corresponds to Fe^{II}/Fe^{III} and $[Fe(L)Cp(CO)]/[Fe(L)Cp(CO)]^+$ couples respectively. The Lever's electrochemical parameter E_L values (LEP) of the ligands were obtained at the range of 0.17 – 0.26. The complexes exhibited the inspiring hydrosilylation of imine and afforded amine at shorter reaction time with 99% yield and the highest TON up to 10000 at mild reaction condition.

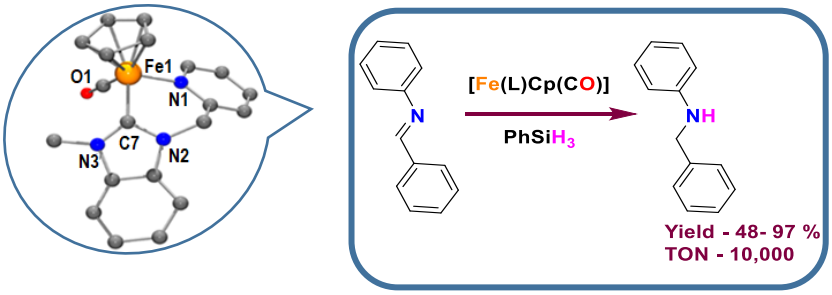

Figure 1. The X-ray structure of **3** (left) and catalytic Hydrosilylation of Imines (right).

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Keywords: *Iron NHC Carbene complexes, Hydrosilylation of Imine to amine, TON up to 10,000.*

APPLICATION OF NB_2O_5 AS PHOTOCATALYST FOR DEGRADATION OF RHODAMINE-B UNDER VISIBLE-LIGHT IRRADIATION

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Abstract

Rhodamine-B (RB) dye photo-catalytic degradation in aqueous solution was carried out with niobium pentaoxide (Nb_2O_5) as photocatalyst and the performance of the Nb_2O_5 was evaluated in the solution under visible-light irradiation. The effect of the catalyst (Nb_2O_5) dosage, initial concentration of RB, and the pH of the solution as various process parameters on photocatalytic degradation of RB is studied. The results showed that maximum degradation of RB was observed at optimal condition i.e. 10 mg/L, catalyst (Nb_2O_5) dosage is 1 mg/l and the pH is 3.

Key Words: *Photo-catalytic, Rhodamine-B, Nb_2O_5, Visible-light irradiation*

VIRTUAL PORTABLE BANKING AND E-SERVICE QUALITY IN 21St CENTURY

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Abstract

With the advent of internet technology, most of the services went digital and seamlessly integrated with the advancements in the portability of digital devices. The internet penetration and easy access to affordable smartphones led to the biggest innovation in financial sector ever, the start of virtual banking. Initially, the process was cumbersome and less secure but with the improvement in the processing capacities, the virtual banking has shifted from PC's onto handheld mobile devices. Latest entrants in the space of digital finance are the e-wallets. This research is an attempt to identify problems and issues which customers face while using mobile banking. The research was aimed at identifying the problems that were universal and not related to the service of a particular bank or financial institution. An online questionnaire was distributed to customers from 7 countries across 3 continents in an attempt to find out common problems from a diverse population. Cochran's sampling technique was used to determine the number of respondents. Cronbach's alpha technique was employed to crosscheck the reliability of the questionnaire. The questionnaire used 5 point Likert scale. The Sampling technique used was non-probability random sampling. The data was analyzed using SPSS. The findings indicated that privacy, security, integration across applications, and instant responsiveness were the common problems identified among the surveyed population.

Keywords: mobile banking, e-service, issues and challenges, banks, e-banking.

Implementing TBLT (Task Based Language Teaching): The Need for a Standardized Framework in the Vernacular Medium Schools of Assam.

Abstract:

In today's world English has become the 'language of survival'. The present system of teaching in the government and non-government vernacular medium schools of Assam focuses mainly on the reading and writing skills; where the other two skills of listening and speaking are seemed to be utterly neglected. Therefore, this paper will try to study how English is taught in these vernacular medium schools. The paper assumes that there is no proper framework in these schools to enhance students' communicative skills for which students feel anxiety while it comes to communicate in English language and also face lots of difficulty to cope up with the higher education, which is imparted in English language only.

The current research is going to throw insight on how TBLT can be useful and can help learners to achieve a certain competency level to be able to communicate efficiently. The research will also try to identify the challenges and possibilities in TBLT implementation. The researcher is also going to attempt to suggest some effective measures as there is an urgent need to design a standardized framework to enhance student's communicative skills. As Dave and Willis put it " the aim of language teaching is to enable learners to use the language they have learned in school or college to communicate confidently with other users of English in the world outside." Therefore this research will be helpful to design a more 'just' education system. However this paper also see anxiety as an obstacle to reach that fluency and competency level.

Keywords: TBLT, Task-Based, Language Teaching, English Teaching, Vernacular medium, Standard Framework, Anxiety, Fluency.

EXPLORATION OF VARIOUS TYPES OF SOFT SKILLS TRAINING WITH EXAMPLES , OVER LIST OF HARDSKILLS, FOR STUDENT DEVELOPMENT.

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ABSTRACT

The major criticism against present day education system is that the needs of the Industry requirements are not met. The industry requirements related to hard skills is not met in most of the institutions. Despite hardskills even various types of soft skills is not fulfilled by the education institutions. NASSCOM opines that most of the graduates in India are unemployable due to lack of relevant hard and soft skills. This write up explores various types of soft skills training required with examples, over list of hardskills, for student development.

Sample research questions include:

1) What are the educational background of students : Engineering or non-Engineering ?
2) In which year of under-graduation, are students trained in Softskills ?
3) Is Softskills part of the syllabus ?
4) Is soft skills training provided by college faculty or external faculty?
5) Is Soft skills training essential to succeed in campus recruitment exam?
6) Is Soft skills a lifetime skill or a time bound skill ?
7) Are students aware of Soft skills course in SWAYAM?
8) Are students exposed to Softskills in their under graduation classes?
9) Which year is ideal for Soft skills training?
10) Which skill predominates in campus recruitment exam : Softskills or Hard skills?

Exploratory methodology of research is adopted to analyze the research questions. The findings reveal that irrespective of the educational background, students are not trained in softskills in a systematic manner by including in the syllabus. In most cases the training is provided by external or adhoc faculty who are not available to students after the training.

KEYWORDS: Softskills, Hard skills, Training ,Development.

Common fixed point theorems for non compatible mappings in G- metric space

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Abstract: In this paper common fixed point theorems are established in G-Metric space. To prove the results, it is assumed that the mappings are non compatible and faintly compatible.

Keywords: common fixed point, non compatible mappings, faintly compatibility, G- metric space.

Genetic variability, association and diversity study among the sunflower genotypes at seedling stage based on different morpho-physiological parameters under polyethylene glycol induced stress

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Presenter: Ms. Uzma Ayaz

Subject Area: Plant breeding & Genetics

Abstract

Drought stress directly affects growth along with productivity of plants by altering plant water status. Sunflower (*Helianthus annuus* L.) an oilseed crop, is adversely affected by abiotic stresses. The present study was carried out to study the genetic variability and diversity among the sunflower genotypes at seedling stage based on different morpho-physiological parameters under Polyethylene Glycol (PEG) induced stress. A total of twenty seven genotypes including two hybrids, eight advanced lines and seventeen accessions of sunflower (*Helianthus annuus* L.) were tested at germination and seedling stages in Polyethylene Glycol. Correlation and principle component analysis confirmed that germination percentage, root length, proline content, shoot length, chlorophyll content, stomatal frequency and survival percentage are positively correlated with each other hence; these traits were responsible for most of variation among genotypes. The cluster analysis results showed that genotypes Ausun, line-2, line-8, 17559, 17578, Hysun-33, 17555, and 17587 as more diverse among all the genotypes. These most divergent genotypes could be utilized in the development of inbreed which could be subsequently used in the heterosis breeding.

Key words: Sunflower, drought, stress, polyethylene glycol

STAGGERING SECURITY STRUCTURE FOR WOMEN

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Abstract

Ladies nowadays are under danger. They have numerous difficulties to confront particularly in worry of their security. Although there are many systems that exist to serve women security purpose the need for advanced smart security system is increasing this paper clarifies about themade sure about electronic framework for ladies which includes an Arduino controller and sensors,for example, temperature, beat, sound sensors and innovation such GSM,GPS are utilized. At the point when a ladies is under danger, the gadget detects the adjustment in temperature, heartbeat and sound with the assistance of different sensors.At the point when any of the boundaries crosses as far as possible the gadget gets actuated and finds the area of the casualty utilizing the GPS module.By utilizing the GSM module the casualty's area alongside scope and longitude is sent to the particular contact number enlisted. A chemical spray is added to make the victim escape the situation by spraying it on the attacker which produces an irritation on the skin.

KEYWORDS : Arduino controller, GSM, GPS

HOME SECURITY SYSTEM USING RASPBERRY PI AND IOT

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ABSTRACT

Now-a-days security is the most important issue as rate of the theft and cheating cases are increasing. It is equally important to catch the thief to prevent theft. Most of the time, thief escapes due to delay in action taken by concerned authorities at that time. In this project we present the design of a security system which solves this issue. The proposed system is for home/office/room security with raspberry pi using IoT and is done by integrating webcam and motion sensor with e-mail.Raspberry pi operates and controls motion sensor and webcam for sensing and surveillance. For instance, whenever any motion is detected, the webcam clicks a picture and raspberry pi sends an email with the current photo taken by the webcam attached to the owner's registered email-id. The webcam captures the intruder's image and sends it over e-mail for real time action to be taken by the owner to prevent theft. A python script, then directs the raspberry Pi to send email notifications every time a motion is detected. With these components Raspberry Pi, PIR Sensor and a webcam accost effective and efficient security camera system is made. It provides security to the user. Here real-time tracking and time to time alerts are available. It is powerful and run on least power backup. One will know about raspberry pi and raspbian Os.One will learnt how to implement IoT practically via gmail ,telegram etc. Psuedo python is used here.

Keywords: SSMTP, Multipurpose Internet Mail Extensions (MIME), Attaching Image, Raspbian Os.

Investigations on structural, morphological and electrical properties of Nickel Oxide nanoparticles

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Abstract

NiO nanoparticles (NiO NPs) is a good ferroelectric p-type semiconductor. Stoichiometric NiO is an insulator with a resistivity of the order of 10^{13} Ω cm at room temperature; its resistivity can be lowered by an increase of Ni^{3+} ions resulting from an addition of monovalent atoms such as lithium or by the appearance of nickel vacancies and/or interstitial oxygen in NiO crystallites. High-permittivity dielectric materials with good thermal stability have played a significant role in microelectronics. In the present work, Nickel oxide (NiO NPs) nanoparticles have been prepared by Sol-gel method. The synthesized nanoparticles were investigated by X-ray diffraction analysis (XRD), Atomic Force Microscopy (AFM) and AC impedance studies. Formation of Face Centered Cubic (FCC) structure of NiO nanoparticles was confirmed by XRD at room temperature. Particle size and dislocation density were estimated by Modified Williamson-Hall Method. The particle size and dislocation densities of NiO nano particle found (2.83 ± 0.2) $\times 10^{-9}$m and (2.1 ±0.16) $\times 10^{17} m^{-2}$ respectively. Smooth surface of the sample was observed by AFM (R_{rms}~5 nm). Electrical and dielectric properties of NiO NPs were studied in the frequency range of 2 Hz–5 MHz at different temperatures (RT-150˚C). The AC conductivity of the NiO NPs increases with increase in temperature and frequency. The increase of conductivity with frequency in the semiconducting regime follows Jonscher power law. DC conductivity found at room temperature is 1.04 X 10^{-9} S/cm. The conductivity in semiconductor regime has been understood by hopping mechanism of localized charge carriers. The impedance data was fitted using CPE equation with two components. The impedance data can be fitted with two semicircles. The semicircles intercepted Z' axis at the low frequency side and higher frequency side provided grain boundary resistance (R_{gb}) and grain resistance (R_g),

respectively. The corresponding resistivity of the samples (ρ_{gb} and ρ_g) at different temperatures was calculated by incorporating the dimension of the samples. The dielectric constant and dielectric loss of the NiO nanoparticles decreases with increase in frequency.

Keywords: NiO nanoparticles, Sol-gel, Face centered Cubic, AFM microscopy, Semiconductor.

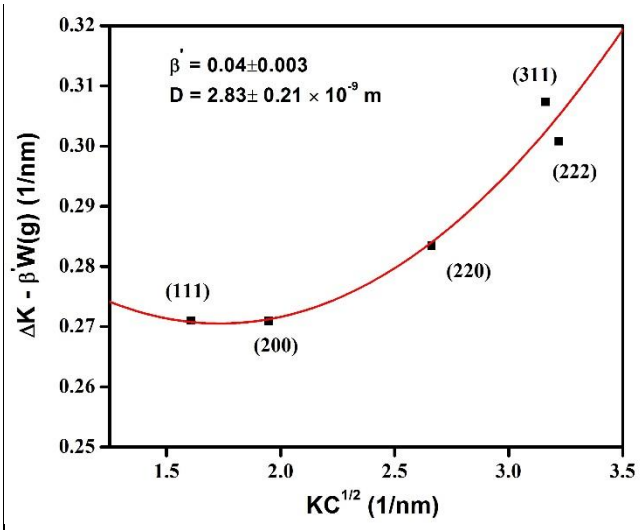

Fig. The FWHM of NiO NPs in the modified Williamson-Hall plot with planar fault.

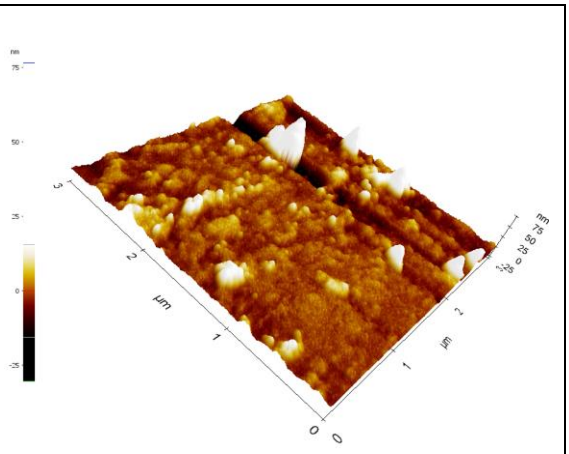

Fig. 3D AFM image of NiO NPs.

Synthesis of SnO_2 thin films by the spin-coating method and its characterization

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[2]Department of Electronics Science, Mohamed Sathak College of Arts & Science, Chennai

ABSTRACT:

The SnO_2 thin films were synthesized by the spin-coating method. The influence of annealing temperature on the structural, morphological, and optical properties of SnO_2 thin films were studied. Spin coated films were thermally annealed at 673 K and 773 K for 2 hour. The XRD patterns of the thin films annealed in the 673 and 773 K show less intense and broad diffraction peaks. The size of the grains increased with raising the annealing temperature. The size of the grains is enhanced due to increasing annealing temperature up to 773 K. For films annealed at the higher temperature of 773 K, the grains are well agglomerated. The transmission spectra of SnO_2 thin films annealed at various temperatures of 673 and 773 K was analyzed. The percentage of transmittance increases from 56 to 91% with an increase in the annealing temperature from room temperature to 773 K, and also band gap energy value (Eg) increases from3.25 to 3.35 eV at increase in annealing temperatures.

Keywords: Spin coating, annealing temperature, XRD, transmission spectra, band gap energy.

Intermolecular interaction in binary liquid mixture of methyl methacrylate and 1-propanol at 303 K by using ultrasonic technique.

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Abstract: Density (ρ), viscosity (η) and ultrasonic velocity (U) have been measured for a binary mixture of methyl methacrylate and 1-propanol at 303K. From the experimental values, adiabatic compressibility (β), free length (L_f), free volume (V_f), viscous relaxation time (τ) and Gibbs free energy (ΔG) have been determined. The excess values of various parameters (β^E, L_f^E , V^E_f , τ^E and ΔG^E) have also been deduced and interpreted in terms of molecular interactions. The deviations in the sign and values of these excess parameters from the ideal mixing reveal that intermolecular interactions decreased with increasing in 1-propanol concentrations.

Keywords : Methyl methacrylate; 1-propanol; ultrasonic velocity; hydrogen bonding.

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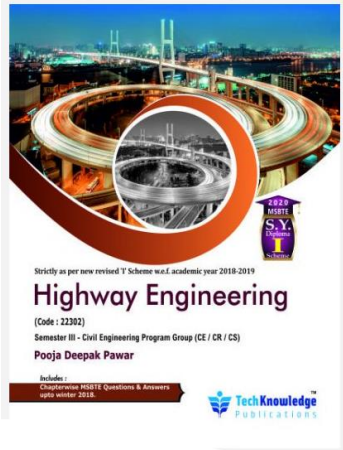

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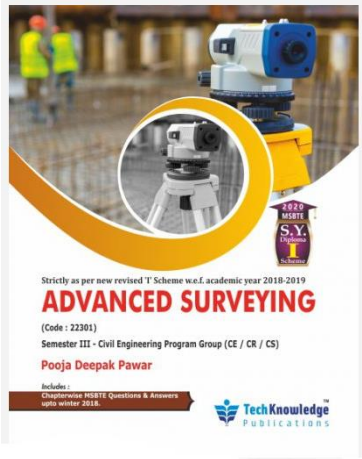

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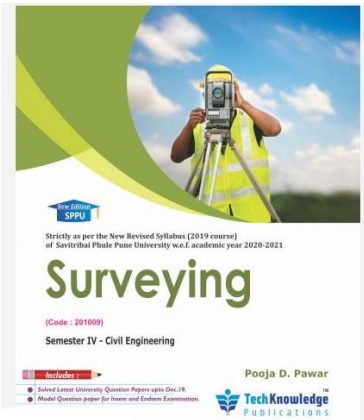

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Chapter
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Abstract

The Internet of Things (IoT) has been evolving in tandem with centralized cloud computing to fog computing, edge computing, Semantic computing, etc. Pervasive IoT applications like Healthcare applications generate a huge amount of sensor data and imaging data that needs to be handled rightly for further processing. In traditional IoT ecosystem, Cloud computing ensures solution for efficient management of huge data with its ability to access shared resources and provide common infrastructure in a ubiquitous manner. Majority of the IoT applications are highly sensitive to time and necessities latency bounded execution. There is time delay introduced when the data transmission occurs between the cloud and the application which is unacceptable. This chapter will disclose the various facets and trends in the integration/coupling of evolving computing platforms and disruptive technologies like Fog/Edge Computing, Big Data, blockchain with IoT that overcomes challenges existing in the traditional deployment of IoT environment. Further, there are several issues with IoT and Cloud Computing framework like each individual part of the IoT architecture could act as a point of failure that can interrupt the whole network and secondly, the centralized cloud model is vulnerable to loss of integrity of data. This chapter will review and reveal the trends in bracing computing approaches, managing the huge data using datacenters in Internet of Things ecosystem. The review is advocated with a case study on waste management system applied with the fog/edge computing and cloud computing. Further, various trends in applicability of block chain in the IoT ecosystem is also reviewed. This chapter discusses the fundamental facets of various computing paradigms and approaches that may help to address issues of big data through creating IoT ecosystems.

Keywords

Internet of Things (IoT) Cloud computing Block chain Big data Machine learning Coupling

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Notes

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Deep Ensemble Approach for Question Answer System

K. P. Moholkar and S. H. Patil

Abstract Researches on question answering systems has been attracting significant research attention in recent years with the explosive data growth and breakthroughs in machine learning paradigm. Answer selection in question answering segment is always considered as a challenging task in natural language processing domain. The major difficulty detected here is that it not only needs the consideration of semantic matching between question answer pairs but also requires a serious modeling of contextual factors. The system aims to use deep learning technique to generate the expected answer. Sequential ensemble approach is deployed in the proposed model, where it categorically boosts the prediction of LSTM and memory network to increase the system accuracy. The proposed model shows a 50% increase in accuracy when compared to individual systems with a few number of epochs. The proposed system reduces the training time and boosts the system-level accuracy.

Keywords Question answer system · Deep neural network · LSTM · Memory · Network ensemble · CatBoost

1 Introduction

In general, people tend to seek information through conversation, Internet, books, etc. Due to information overload, the process of extracting the required answers using machine learning techniques has become a challenging task. The task become more complicated when the users have started to post different types of questions like Wh, short question, factoid, reasoning questions, counting, etc. A system is always expected to learn facts and apply reasoning to discover new facts that can assist in answering the given question. Extraction and identification of suitable answer

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depends on understanding the main intent of a question. This makes the task of building an appropriate model as a challenging task. The conventional method of question system will have data retrieval and handcrafted rules. The performance of traditional systems is restricted as they heavily depend on manually extracted rule. The task becomes difficult because of imbalanced dataset. The QA process can be broken into two parts: information retrieval and reading comprehension. The process of finding the document containing the answer for the raised question is known as information retrieval. Reading comprehension deals with identifying answer from a given the passage. However, the recent schemes on deep learning have shown their potential in improving the performance of QA system. Deep learning models require a substantial amount of training. GRU, LSTM, and bidirectional LSTM help to handle longer text sequences unrolled during time. Enhancements like attention mechanism and memory networks help the model to identify important features. Dialog systems [8] like chat bots [9], Alexa, and IBM Watson [10] which simulate human conversation are derived from question answer systems. With the increase in digital awareness and reach in rural area, the need of multilingual question answer system has started arising. Availability of multilingual QA corpus is a challenging task. Until recently, multilingual QA system was dependent on machine translation. Identifying appropriate answers and framing syntactically and semantically correct sentence require consideration of language-specific grammar, which is also difficult task. This would further affect the accuracy of system. Therefore, advancements in QA system are the need of the hour. Ensemble models help to combine the strengths of individual models to enhance the accuracy of system. The major contribution of the paper is an ensemble model which categorically boosts the combined predictions of LSTM model and memory model. The ensemble model is designed to boost the accuracy of question answering system capable of handling different question categories. The proposed research work has been arranged as follows: Section 2 provides a brief review of literature. Section 3 explains the overview of the proposed question answering system. Section 4 presents experimental setup. Section 5 illustrates the results and discussion, and Sect. 6 presents the conclusion.

2 Literature Review

Abishek et al. [1] proposed a CNN—LSTM model for identifying duplicate questions using Quora dataset. The author proved that identifying duplicate questions before the classification enhances the performance of model tremendously. Bae et al. [2] employed word weighting method for question classification. The author proposed mechanism to identifying positive and negative words, and positive words having negative sentiments, and vice versa for query processing. Razzaghnoori et al. [3] experimented with recurrent neural network (RNN) for extracting feature vector mechanism and employed classical support vector machine (SVM) for query classification. Hong et al. [4] have proposed a model that constructs a binary tree structure to take care of composite reasoning implied in the language. The recursive

grounding tree (RVG-TREE) parses the language and then performs a visual reasoning along the tree in a bottom-up fashion. Liu [5] proposed a Siamese architecture that compromises of multilayer long short-term memory (LSTM) network and convolutional neural networks (CNN). The author uses concept interaction graph for matching long text. The graph vertex acts as a concepts, and interaction level act as edges. The model aggregates the matching signals through a graph convolutional network which checks similarity relationship between two articles. Ullah et al. [6] proposed an attention model that emphasizes on the importance of context and time that helps to provide contextual information regarding the question while generating the answer representations. In 2017, Yue et al. [7] developed a dynamic memory networks to carry out "textual QA." The model takes the inputs that are processed to take out hierarchical and global salient features simultaneously. Consequently, they were deployed to formulate numerous feature sets at every interpretation phases. Experimentation was performed on a public textual Q&A dataset using without and with supervision approach from labels of constructive details. Finally, when distinguished with preceding works, the developed technique demonstrates improved stability and accuracy.

3 Proposed System

3.1 Long Short Term Memory

LSTM helps to defend the error that is backpropogated through time. LSTM is the memory element in the model. A LSTM cell consists of neural network with three different activation functions. LSTM cell has three basic gates which are neural networks with sigmoid activation function known as input gate '*i*', forget gate '*f*', and output gate '*o*'. Neural net with Tanh activation is known as candidate layer '*c*'. Output is a current hidden state id denoted by vector '*h*', and memory state denoted by vector '*c*'. Forget layer '*F*' decides which information to discard. Inputs to the LSTM cell at each step are X the current input and H the previous hidden state, and C is the previous memory state. Outputs from the LSTM cell are H the current hidden state and C the current memory state. The following equations demonstrate the working of LSTM layers.

$$f_t = \sigma(W_f.[h(t-1), x_t] + b_f) \tag{1}$$

$$i_t = \sigma(W_f.[h(t-1), x_t] + b_i) \tag{2}$$

$$\tilde{C} = \tanh(W_C.[h(t-1), x_t] + b_C) \tag{3}$$

$$C_t = f_t * C(t-1) + i_t * \tilde{C}) \tag{4}$$

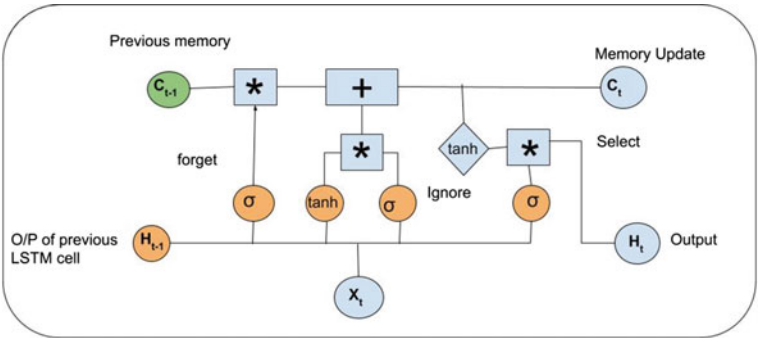

Fig. 1 LSTM cell

$$o_t = \sigma(W_o.[h(t-1), x_t] + b_o) \tag{5}$$

$$h_t = o_t * \tanh(C_t) \tag{6}$$

Figure 1 demonstrates the working of LSTM cell. The cell compares its memory with previous output of LSTM cell to identify the importance and reads a current word considering previous.

3.2 Encoder–Decoder Model

For a QA system to be efficient, inference mechanism and memory elements are required to memorize long sequences with context. These long sequences serve as knowledge for effective prediction of answers. This model decodes the context and question in fixed length vector and produces the expected answer. This model is also known as encoder–decoder model. Consider a network with $M = \mu_1, \mu_2, \ldots, \mu_n$ memory elements, I input feature of vector of size e, u update parameter for updating old memory with present input, O the output feature map, and R the expected response. The encoder processes the input feature and produces a two-dimensional output matrix. The model takes input as sentence and stores in available memory μ. The input length depends on the number of memory cells in the layer. A new memory is stored in u module without changing the old memory μ. LSTM layer acting as a decoder takes input vector, the time steps, and features to produce a decoded sequence, i.e., answer (Fig. 2).

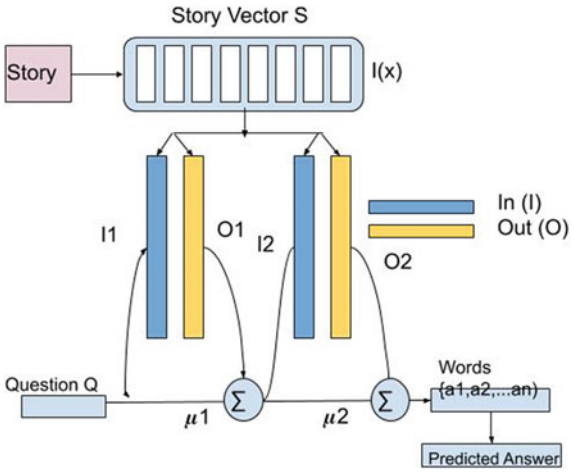

Fig. 2 Memory network

Algorithm 1: Memory Cell

Data: input text character/word/sentence
Result: Memory Network Algorithm
initialization;
while *not at end of sentence* **do**
  Encode x → I(x);
  while *not at end of X* **do**
    Update Memory
    $\mu_i = u(\mu_i, I(x), \mu), \exists i$
    Compute $O = O(I(x), \mu)$
    end of X
    Decode $o : r = R(o)n$;
  end
end

3.3 CatBoost

CatBoost is an implementation of gradient boosting, which uses binary decision trees as base predictors [12]. Existing gradient boosting algorithms like random forest, Adaboost, and Xgboost suffer from prediction shift problem. Boosting algorithm relies on target of all training examples which causes prediction shift. Traditional approach [14] converts categorical features to statistical model leading to target leakage. CatBoost algorithm provides solution to both the said issues by employing principle of ordering. CatBoost is based on gradient boosted decision trees. Decision

trees are built repetitively during training phase. Each successive tree is built with reduced loss compared to the previous trees. When the algorithm identifies over fitting, it stops construction of new tress.

Algorithm 2: Categorical Boosting

```
Data: input text character/word/sentence
Result: tree
Preliminary calculation of splits.;
Choosing the tree structure.;
while not over-fitting do
    Divide objects into disjoint ranges;
    Split data into bucket;
    Select tree structure;
    Calculating values in leaves.;
    while not over-fitting do
        Calculate penalty function;
        min(penalty)
        Select split
    end
    Calculate Score
end
```

The CatBoost algorithm is good in handling categorical values and performs best when used with default parameters, and parameters can be tuned for optimized results. Though the algorithm is robust and easy to use, it requires considerable time to train and optimize the results. CatBoost takes more time to train a system with numerical features. It does not support sparse matrices.

3.4 Ensemble Model

A deep neural network (DNN) learns complex nonlinear relationship in data. Bias, variance, and noise are prediction errors. While noise cannot be handled by algorithmic approach, bias and variance can be reduced by proper choice of model. Every time a DNN is trained, different version of mapping function is learnt. This stochastic nature affects the performance of model. The DNN suffers from low bias and high variance. The proposed model uses ensemble approach to reduce the problem of high bias. Sequential ensemble approach is used in the proposed system to reduce bias error. This approach combines predictions from base learners and applies categorical boosting to enhance the accuracy of system. Several instances of the same base model are trained sequentially to train the LSTM learner with previous weak learners. Figure 3 shows the working of the model. Long short-term recurrent neural network and memory networks are used as base learners. Categorical boosting is done by CatBoost algorithm which is used as meta learners to enhance the accuracy of ensemble model. The proposed model works in two phases. The learning

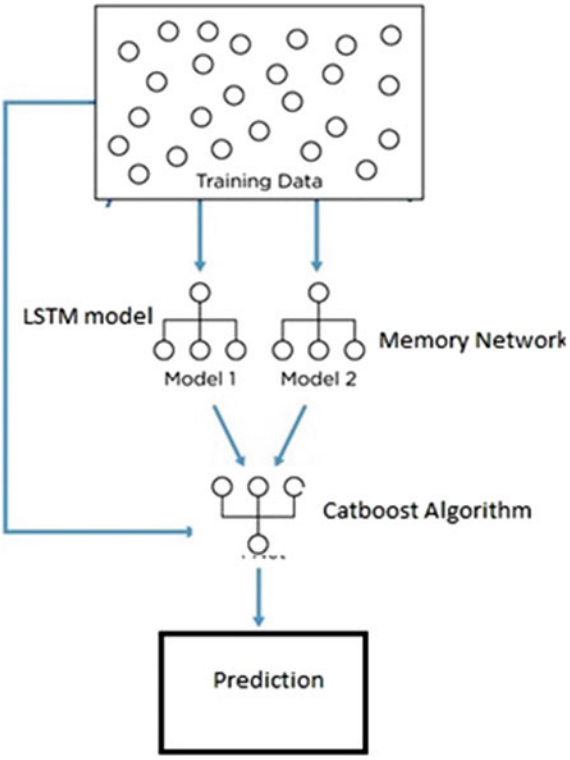

Fig. 3 Proposed model

algorithms for LSTM are based on minimizing the error rate. The first phase uses data subsets to produce results. The results generated by first phase are combined together, and performance boost is achieved by categorical boosting (Fig. 3).

4 Experimental Setup

LSTM and memory networks are trained in full supervision by providing context, question, and expected answers to the system. Each model is tested in isolation for accuracy and loss parameters. Evaluation of the proposed system is done on babi question answering dataset. The dataset consists of 20 different question answering tasks. The models are trained with 40 epochs and batch size of 32. The model is trained on 1000 samples. A dropout of 0.3 is applied to avoid over fitting. The efficiency of a QA system is judged by the correctness of answer predicted. Precision and recall are traditional factors for judging a classification problem. Apart from these, mean reciprocal rank (MRR) is the ability of a QA system to select appropriate answer for

a given question from the ranked list of answers. If suitable answer is not found, then rank becomes zero. The proposed model was evaluated on precision, recall, and f1 measure.

$$\text{Precision (Micro)} = \frac{\text{No. of correctanswers for Question } q}{\text{answers retrieved for Question } q} \tag{7}$$

$$\text{Recall (Micro)} = \frac{\text{Correct answers retrieved for Question } q}{\text{gold standard answers retrieved for } q} \tag{8}$$

$$\text{Precision} = \text{Average of Precision for all questions} \tag{9}$$

$$\text{Recall} = \text{Average of Recall for all questions} \tag{10}$$

$$\text{F1 Score (Micro)} = \text{Harmonic mean of Precision (Micro) and Recall (Micro)} \tag{11}$$

$$\text{F1 Score} = \text{Harmonic Mean of Precision and Recall} \tag{12}$$

$$\text{MRR} = \frac{1}{Q}\sum_{i=1}^{Q}\frac{1}{\text{answerrank}_i} \tag{13}$$

5 Results and Discussion

From experiments, it was observed that each classifier requires different settings of hyperparameters for producing best model. With fixed hyperparameter setting, individual performance of classifier varies a lot. The proposed ensemble boosting helps to overcome this bottleneck. Considerable amount of time needs to be invested to identify optimal hyperparameters. In cases where single classifier is not sufficient to correctly predict the result, the proposed approach provides a better alternative. Metric classification report indicates that proposed ensemble model performs better than individual models. The accuracy of LSTM model is obtained around 60% and memory network model around 60% for 40 epochs. The accuracy of proposed ensemble model obtained is 95.45%. The f1 score of proposed model is 93%. A considerable boost in accuracy is observed in the result (Table 1).

Table 1 Comparing different models on precision, recall, and f1 score

Model	Precision	Recall	F1 score
LSTM	51	50	50
Memory network	37	38	37
Proposed model	91	95	93

The ROC curve is plotted with true positive rate on *y*-axis and false positive rate on *x*-axis. The ROC curve demonstrates the probability distribution of system. Classifiers that produce curves closer to the top-left corner indicate a better performance. The ROC curve and FPR FNR curve indicate that the performance of proposed model is stable. FNR indicates the miss rate for given data (Figs. 4 and 5).

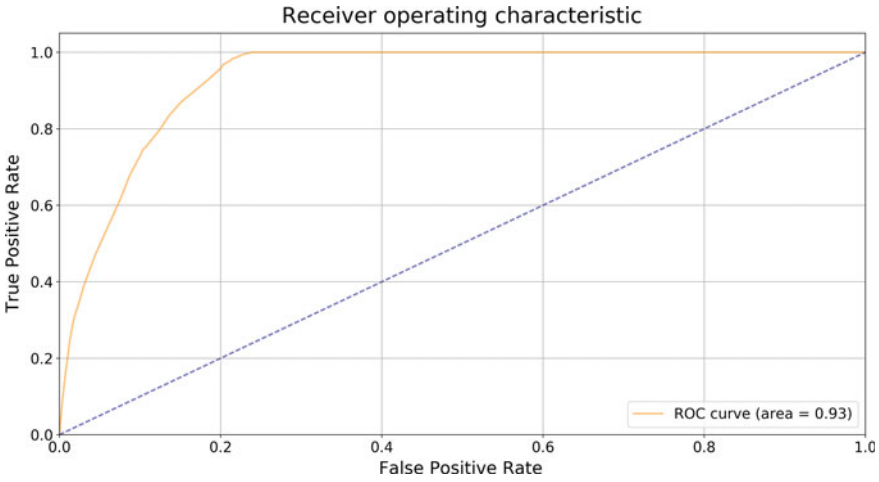

Fig. 4 ROC curve

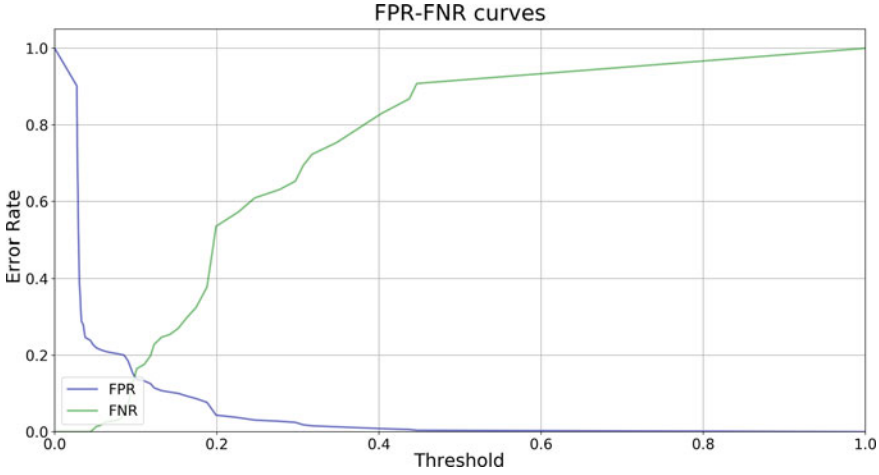

Fig. 5 FPR/FNR curve

6 Conclusion

Experiments explore proposed model for question answering (QA) task. The experiments show that using LSTM and memory network as base learners and boosting the results with CatBoost algorithm shows considerable improvement in prediction accuracy. Evaluation of proposed system is done on babi dataset which contains 1000 question answer tasks. Overcoming the problem of bias was handled successfully in the system. There are many future enhancements for the said system. Choice of base learners and combining traditional machine learning algorithm would make it computationally efficient. Testing system with multilingual data would be a challenging task.

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We are honored to dedicate the proceedings of ICCBI 2020 to all the participants and editors of ICCBI 2020.

Foreword

It is with deep satisfaction that I write this Foreword to the proceedings of ICCBI 2020 held in Vaigai College of Engineering, Madurai, Tamil Nadu, on December 15–16, 2020.

This conference was bringing together researchers, academics and professionals from all over the world, and experts in computer networks, big data and Internet of things.

This conference particularly encouraged the interaction of research students and developing academics with the more established academic community in an informal setting to present and to discuss new and current work. The papers contributed the most recent scientific knowledge known in the field of computer networks, big data and Internet of things. Their contributions helped to make the conference as outstanding as it has been. The local organizing committee members and their helpers put much effort into ensuring the success of the day-to-day operation of the meeting.

We hope that this program will further stimulate research in data communication and computer networks, Internet of things, wireless communication, big data and cloud computing and also provide practitioners with better techniques, algorithms, and tools for deployment. We feel honored and privileged to serve the best recent developments to you through this exciting program.

We thank all the guest editors, authors and participants for their contributions.

Dr. P. Sugumaran
Conference Chair, ICCBI 2020

Preface

This conference proceedings volume contains the written versions of most of the contributions presented during the conference of ICCBI 2020. The conference provided a setting for discussing recent developments in a wide variety of topics including computer networks, big data and Internet of things. The conference has been a good opportunity for participants coming from various destinations to present and discuss topics in their respective research areas.

This conference tends to collect the latest research results and applications on computer networks, big data and Internet of things. It includes a selection of 74 papers from 248 papers submitted to the conference from universities and industries all over the world. All of accepted papers were subjected to strict peer-reviewing by 2–4 expert referees. The papers have been selected for this volume because of quality and the relevance to the conference.

We would like to express our sincere appreciation to all the authors for their contributions to this book. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would like to thank the organizing committee for their hard work. Finally, we would like to thank the Springer publications for producing this volume.

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Toronto, Canada — Dr. Xavier Fernando
Joondalup, Australia — Dr. Syed Mohammed Shamsul Islam

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On behalf of the editors, organizers, authors and readers of this conference, we wish to thank the keynote speakers and the reviewers for their time, hard work and dedication to this conference. The organizers wish to acknowledge Dr. R. Saravanan, Dr. R. Thiruchenthuran, Thiru. S. Kamalakannan, Thiru. S. Balasubramanian and Thiru. S. Singaravelan, for the discussion, suggestion and cooperation to organize the keynote speakers of this conference. The organizers also wish to acknowledge speakers and participants who attend this conference. Many thanks are given to all persons who help and support this conference. ICCBI 2020 would like to acknowledge the contribution made to the organization by its many volunteers. Members contribute their time, energy and knowledge at a local, regional and international level.

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Maximizing Network Lifetime in WSN Using Ant Colony Algorıthm

M. D. Saranya, G. Pradeepkumar, J. L. Mazher Iqbal, B. Maruthi Shankar, and K. S. Tamilselvan

Abstract A wireless network is a cluster of specific transducers with statement transportation intend to study it frequently operate in an unpredictable wireless background with vigour constriction. Several types of research are mainly interest in vigour consciousness and statement dependability of a wireless sensor network to maximize network lifetime. In this article, a greedy algorithm and ACO algorithm aims at obtaining the best clarification that satisfies the given set of Greedy algorithm. The aim of the Greedy algorithm obtains a most favorable explanation that satisfies the given set of constraints and also maximizes the given objective function. Ant colony algorithm has been practical to the traveling salesman problem to find the optimal solution in a short time. However, the performance of the ACO algorithm is considered for both high energy efficiency and good power balancing, and maximal energy utilization throughout the network. ACO algorithm it is understandable that the network time increases and extends the life cycle of the wireless sensor network since it manages the energy and power management. The Greedy Algorithm creates the problem of selecting a communication path using the traveling salesman and cracks the logic by using this algorithm. The algorithm uses the single source to all destination technique to find through path for optimum network connectivity. The simulation results were demonstrated with the help of the algorithm and it outperforms the shortest path length concerning the network lifetime.

Keywords Wireless network · Maximizing network lifetime · Greedy algorithm · ACO · Communication reliability · Connectivity · Coverage · Traveling salesman problem

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1 Introduction

The wireless group is the way of contact along with sensors and observers. A Sensor network is a collection of dedicated transducers among a transportation infrastructure intended to monitor as well as record conditions at the varied location. WSN naturally encompasses numerous integer of spatially detached array-operated, an embedded option that is a network to accumulate the data to the users, and it has the restricted computing and processing capabilities. Full coverage with connectivity suggests that every location in the field is enclosed by at least one node and the information on this position can be running scared to the fusion center. The complexity of data routing and processing also depends on topology. In a WSN the sensors are work in a longer lifetime. Each communication task has an implementation time, relative deadline, and a time. The duration of a WSN is increased by scheduling the vigorous interval of devices. It could affect the performance of the network for connectivity Rc/Rs ratio has to be considered. At each node in the system should form a linked envelop to attain sensing coverage and system connectivity.

2 Review of Related Work

General optimization carried at improved force effectiveness and improved network lifetime in wireless sensor network; two critical factors are information packet size and broadcast control level. Conversely, the effect of slighter package size is disintegration into additional information packets and thereby indulgence of increased force [1, 2]. Wireless Sensor Network Lifetime (NL) is a critical metric since the antenna nodes frequently rely on the limited power supply. Cross layer network lifetime maximization consider the joint best possible proposal of the substantial, Medium Access Control (MAC), and system layers to exploit the NL of the power-constrained WSN [4]. The problem of NL maximization can be formulated as a nonlinear optimization problem encompassing the routing stream, link scheduling, contact rate, and control allocation operations for all energetic Time Slots (TSs) [5]. The complexity of NL Maximization (NLM) can be formulated as a mixed integer-convex optimization difficulty with the implementation of the Time Division Multiple Access (TDMA) technique [3, 6]. The wireless sensor system topology, the convenience of resources, and the energy consumption of nodes in different paths of the data collection tree may vary largely, thus affecting the general network lifetime [8, 7]. Cross-layer protocol, which incorporates a multipath routing protocol and an information interleaving practice based on Reed–Solomon code. Formulate the trouble of selecting sensor announcement paths as knapsack trouble and resolve it by a greedy algorithm [10, 9]. The multipath routing protocol then enables all sensors to select multiple statement paths using the proposed optimization algorithm [11, 12]. On the basis of numerous communication paths, the method of data interleaving is working by using a Reed–Solomon code to provide reliable data transmission. Simulation results

can display the available multipath routing protocols to the system lifetime since it balances energy utilization and promotes communication reliability [13, 14].

2.1 Routing Protocol

Routing is the method of selecting a path for traffic in several networks. Direction finding is performed for many types of networks, such as the path switched networks, public switched telephone network such as the Internet, as well as in networks used in society and covert transportation, such as the organization of streets, roads, and highways in universal communications. In packet switching networks, routing is the higher-level judgment construction that directs network packets from their source toward their destination through middle network nodes by exact packet forwarding mechanisms.

2.2 Traveling Salesman Problem

Traveling Salesman Problem belongs to a set of troubles in computational complexity analysis called NP-complete problem. If could find a way to declare an NP-complete problem and can employ the algorithm to explain all NP problems rapidly. TSP has a number of applications silent in its purest formulation preparation, logistic, and creates of microchips. The challenge of the complexity is that the traveling salesman needs to reduce the total length of the trip. The goal of the Traveling Salesman Problem (TSP) is to find the majority competent way to tour a choose number of "cities". Traveling Salesman Problem conserve be modeled as an undirected weighted graph, such that cities are the graph's vertices. Figure 1 shows the TSP crisis to find the minimum length of the path using the ACO algorithm. The shortest path = a–d–e, Net weight = 22.

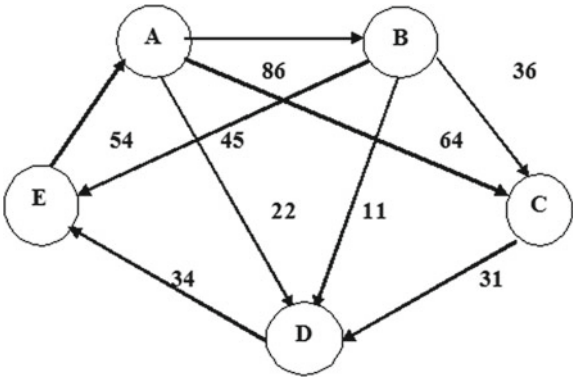

Fig. 1 Example of TSP problem

3 Proposed Scheme

3.1 Greedy Algorithm

In this article, the greedy algorithm aims at obtaining the finest solution that satisfies the given set of constraints and also maximizes the given objective function. A greedy algorithm is a traffic initiator that generates data at the maximum rate feasible and at the earliest chance possible. Each source forever has data to transmit and is not at all in an idle state due to or another local host. Greedy algorithm preserve is characterized as human life from tiny sight and in addition to non-recoverable. A greedy session is a time-limited packet flow or data flow at the maximum possible rate. A greedy source transfer creation simulation model, or a greedy transfer generator, is useful when simulating and analyzing or measuring the lifetime and throughput of a network. These locally optimal solutions will lastly include a globally best resolution. Greedy algorithm is to resolve the problem, it must be that the best explanation to the big difficulty contains the best possible solution to sub-problems.

3.2 Ant Colony Algorithm for TSP

1. ACO is an inhabitants-based Meta-heuristic to facilitate can exist used to locate estimated solutions to the complicated optimization problem.
2. In ACO, a location of a software agent called synthetic ants investigates excellent solutions to a known optimization difficulty. To apply ACO, the optimization trouble is transformed and addicted to the problem of finding the finest path on a weighted diagram.
3. ACO is a probabilistic technique searching for the finest pathway in the graph based on the performance of ants seeking a path connecting their colony and based on food. Ants steer from shell to food source; ants are blind.

Ant Colony Optimization (ACO) studies reproduction systems that obtain stimulation from the performance of authentic ant colonies and which are used to establish discrete optimization problems. The method that ants discover their grub in the straight path is interesting; ants are secreting pheromones to memorize their path. These pheromones disappear with time; whenever an ant finds food, it marks its entrance journey with pheromones.

Pheromones disappear faster on longer paths. Shorter paths make obtainable as the way to food for most of the other ants. The shorter path will be unbreakable by the pheromones further. Finally, the ants revolve up at the shortest path. Ants leave pheromone trail when they make an adaptation trails that are used in prioritizing evolution. The communication along with individuals, or stuck between individuals and the atmosphere, is based on the employ of chemicals produced by the ants. These chemicals are called pheromones.

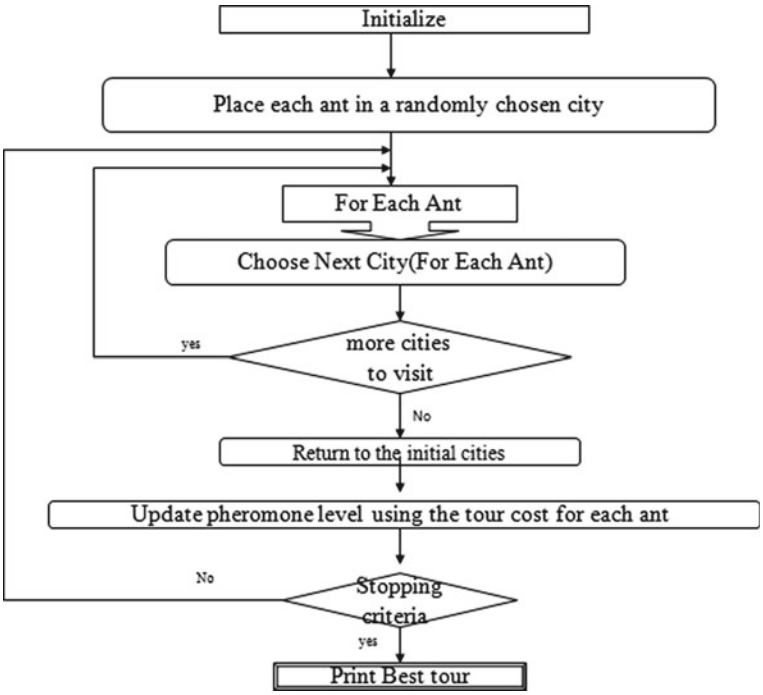

Fig. 2 Flowchart of traveling salesman predicament

ACO is proficient in solving the Traveling Salesman Problem (TSP). TSP is an NP-hard problem. Figure 2 shows the Flowchart traveling salesman problem given a set of n cities, the Traveling Salesman Problem requires a salesman to discover the shortest way between the given cities and go back to the starting city, while keeping in mind that each metropolitan preserve to be visited only once. The most primitive ACO algorithms used the Traveling Salesman Problem (TSP) as an instance application. The TSP is characteristically represented by a graph $G = (V, E)$, V is the set of integers of vertices, representing the cities, and E being the position of edges that completely connects the vertices. To every edge (i, j) a distance dij is associated. The ACO algorithm, called Ant System (AS), has been applied to the Traveling Salesman Problem (TSP). TSP is also called the Hamiltonian circuit.

3.3 Procedure of ACO

Step 1: In the TSP, each ant finds paths in a network and every work is a node. Moreover, no one has to return to the start node and the path is completed when each node is visited.

Step 2: Initially, arbitrary levels of pheromone are spread resting on the edges.

Step 3: An ant starts at a start node (so the first connection it chooses defines the first task to plan on the machine) as earlier than it uses a conversion regulation to get one step at a time, prejudiced by pheromone levels, and also a heuristic score, each instance choosing the next mechanism to agenda.

Step 4: Construct Solutions: Each ant starts at a meticulous state, and then traverse the states one by one.

Step 5: Apply Local Search: Before updating the ant's trail, a restricted search can be applied to each solution constructed.

Step 6: Update Trails: after the solutions are constructed and calculated, pheromone levels increase and reduce on paths according to favorability.

Step 7: Use d_{ij} to indicate the detachment between any two cities in the difficulty. As such $d_{ij} = [(x_i - x_j)^2 + (y_i - y_j)^2]^{1/2}$.

Step 8: Let $\tau_{ij}(t)$ indicate the strength of the track on edge (i, j) at time t, at which time every ant will have completed an expedition.

3.4 Shortest Path Problem

Figure 3 shows the shortest path identification to find the minimum length of the path using the ACO algorithm.

The ACO algorithm has been applied to the shortest path problem, and each ant finds paths in a network where each node is referred to as a node. Upon completion of every node, there is no intention to reach the start node once again. Therefore, a total number of available paths in the network and the corresponding path weight get calculated.

(a) **Available Path**

1. Path1—A–B–E–F–I–J
2. Path2—A–B–E–F–G–H–I

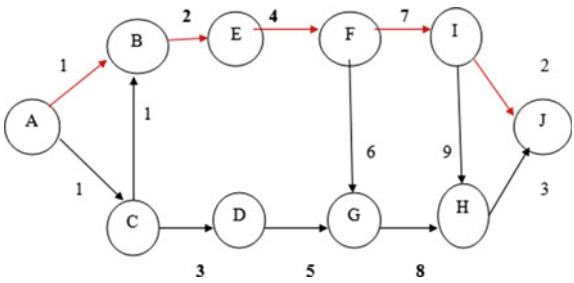

Fig. 3 Shortest path problem

Table 1 Number of connected covers

Number of test case	Number of nodes	Number of connected covers
Test case 1	5	4
Test case 2	7	6
Test case 3	10	9

3. Path3—A–C–B–E–F–I–J
4. Path4—A–C–B–E–F–G–H–J
5. Path5—A–C–D–C–H–J
6. Path6—A–B–E–F–I–H–J
7. Path7—A–C–B–E–F–I–H–J

(b) **Calculate the Path Net Weight**

1. Path1-Netweight-16
2. Path2-Netweight-24
3. Path3-Netweight-26
4. Path4-Netweight-17
5. Path5-Netweight-27
6. Path6-Netweight-25
7. Path7-Netweight-20

(c) **Optimal Shortest Path**

Path1-A-B-E-F-I-J
Netweight-16
No. of. Connected covers-7.

The number of Connected Covers in Shortest Path Identification by Greedy Algorithm is scheduled in Table 1.

4 Software Description

4.1 Proteus

Proteus mechanism to test, debug, and regulate a program is problematic. In distinction, greedy simulation allows non-intrusive monitoring and debugging, and also makes it simple to repeat executions. Proteus provides users with unparalleled edibility in choosing or customizing the period of accuracy in the wireless sensor network and memory simulations. Proteus was initially designed for evaluating language, compiler, and runtime system mechanisms to carry portability. Several CAD users release schematics detain as essential immorality in the procedure of creating printed circuit board (PCB) arrangement encloses the disputed in the peak

of investigation. With PCB layout now offering automation of equally section assignment and path routing, getting invent hooked on the computer can frequently be the main occasion overriding constituent of expending even more time working on the schematic. Proteus provides repeatability, non-instructive monitoring and debugging, and incorporated graphical output. The power of its structural design has allowed us to combine first conventional graph-based imitation and now with Proteus VSM—interactive circuit reproduction keen on the invent WSN environment. For the first time eternally, it is sufficient to explain a total circuit for a TSP based Ant Colony Optimization and then test it interactively. It provides in general control of drawing emergence in turns of line widths, fills styles, colours and fonts.

4.1.1 Features of Proteus

1. Regular wire steering and mark post/removal.
2. Powerful equipment for selecting substances and passing on their property.
3. Entire maintenance for buses including element pins, inter-sheet terminal, module ports, and wires.
4. Schedule of equipment and Electrical Rules ensure report.
5. Netlist output is to furnish all fashionable PCB layout tools.

5 Results and Discussion

5.1 Schematic Diagram

The power of its construction has allowed us to assimilate primary conventional chart based imitation and now with Proteus VSM—interactive circuit replication keen on the plan surroundings. Figure 4 shows the schematic diagram of shortest path identification using greedy in Proteus simulation.

5.2 Simulation Output

Figure 5 the simulation yield of shortest path identification using a greedy algorithm for Proteus simulation. It provides the whole administer of drawing appearance in turns of row thickness, pack style, and standard in addition to fonts.

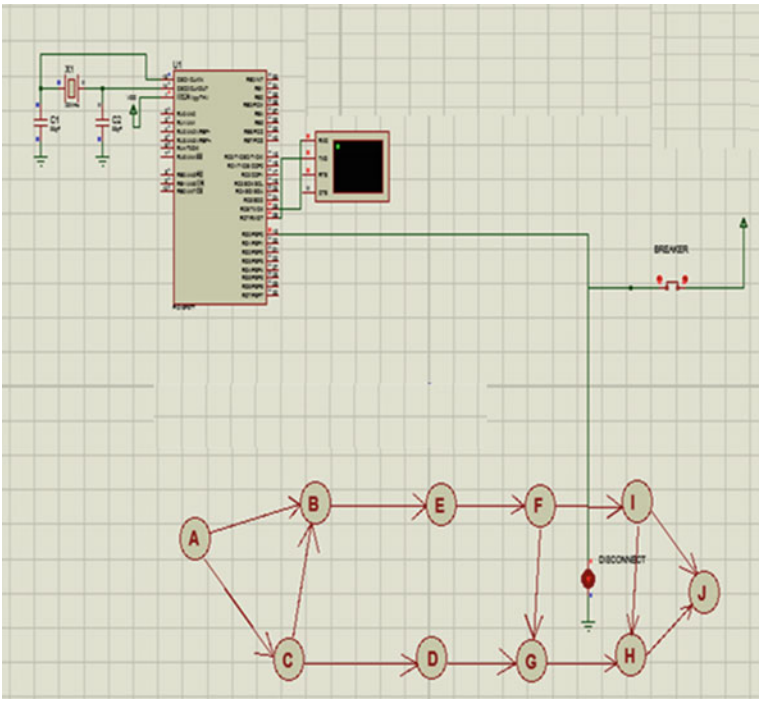

Fig. 4 Schematic figure of shortest path using greedy

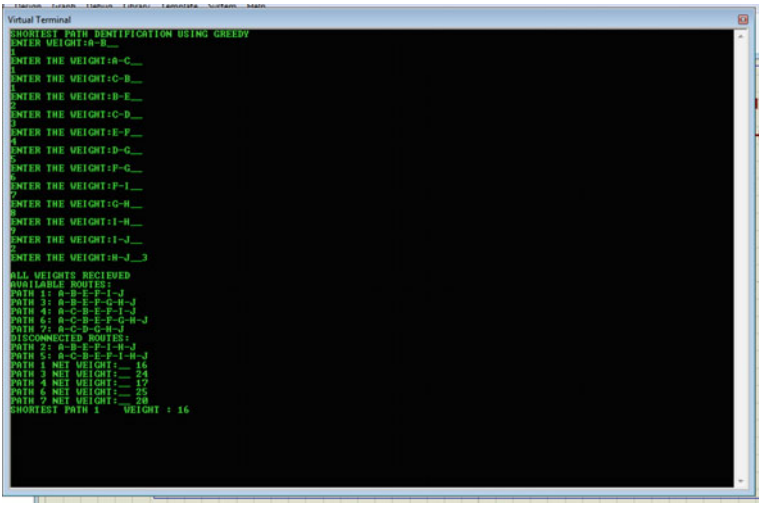

Fig. 5 Simulation output of shortest path classification using greedy algorithm

Table 2 Power consumption

Path	Weight	Power loss transmit mW	Power loss receive mW
Path1	37	55.5	74
Path2	44	66	88
Path3	42	63	84
Path4	44	66	88
Path5	51	76.5	102
Path6	49	73.5	98
Path7	30	45	60

5.3 Power Analysis of Greedy Algorithm

The amount of power utilization for communicating through dissimilar nodes inside the range is listed in Table 2.

5.4 Simulation Waveform of Greedy Algorithm

The relationships connecting the numbers of nodes and initial energy capacity using a greedy algorithm, and the results of the greedy algorithm is shown in Fig. 6 In this figure, it is obvious that the network life span increases along with the increasing initial energy capacity.

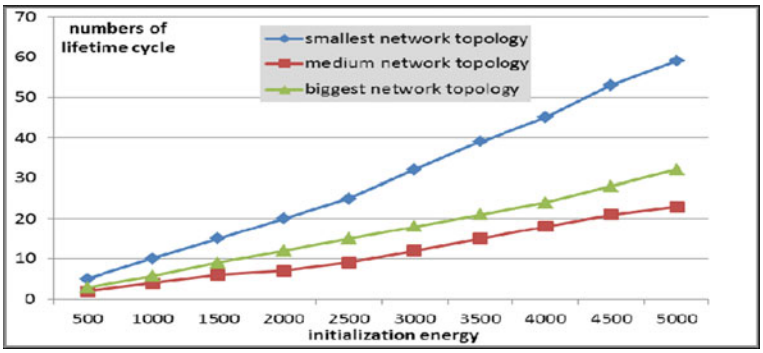

Fig. 6 Numbers of nodes and initial energy capacity using a greedy algorithm

Table 3 Power analysis of ant colony algorithm

Path	Net weight	P Power loss/transmit mW	Power loss/receive mW
Path 1	187	76.4	110
Path 2	129	63.5	87.8
Path 3	56	45.3	63
Path 4	131	64.7	83.5
Path 5	131	64.8	83.5
Path 6	86	55.9	75.2

5.5 Power Analysis of ACO

The sum of power utilization for communicating with dissimilar nodes surrounded by the variety is listed in Table 3.

5.6 Simulation Waveform of Greedy Algorithm and ACO

Figure 7 shows the relations connecting the system lifetime initial power capacities along with different algorithms; it is clear that the net lifetime increases and extends the life series of the wireless sensor network since it manages the energy and control management.

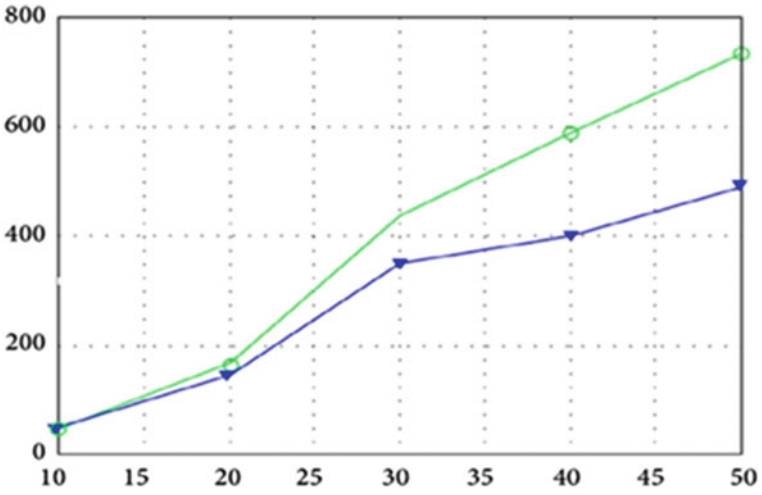

Fig. 7 Relationships between the network lifetime and Initial energy capacity along with different algorithms. Ant colony algorithm, Greedy algorithm

6 Conclusion and for Future Work

6.1 Conclusion

This article presents a greedy algorithm that aims at obtaining the best solution that satisfies the given position of constraints and also maximizes a given objective function. To create the difficulty of selecting communication paths as a Traveling salesman crisis and crack it by a greedy algorithm. The manual calculations to find the number of connected covers in shortest path identification using a greedy algorithm. Simulation results can exhibit the shortest path concerning network lifetime and communication reliability.

In this project also, using the competent ant colony algorithm has been functional to the traveling salesman problem to locate the optimal solution in a short time. However, the performance of the ACO algorithm is designed for both high energy efficiency and good power balancing, and maximal energy utilization throughout the network. The relationship between the statistics of nodes and original power capacity using ACO algorithm is evident that the network lifetime increases and extends the life cycle of the wireless sensor network since it manages the energy and power management.

6.2 Scope for Future Work

In the future, another proposed ACO algorithm will be regularly considered to recover the network lifetime and communication reliability, for example, the active adaptation of multiple routing problems that are essentially multiple paths multiple destinations of the original TSP; this is similar to vehicle routing problems. For these problems, numerous routes are considered, which makes them closer to real-world applications.

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Deep Ensemble Approach for Question Answer System

K. P. Moholkar and S. H. Patil

Abstract Researches on question answering systems has been attracting significant research attention in recent years with the explosive data growth and breakthroughs in machine learning paradigm. Answer selection in question answering segment is always considered as a challenging task in natural language processing domain. The major difficulty detected here is that it not only needs the consideration of semantic matching between question answer pairs but also requires a serious modeling of contextual factors. The system aims to use deep learning technique to generate the expected answer. Sequential ensemble approach is deployed in the proposed model, where it categorically boosts the prediction of LSTM and memory network to increase the system accuracy. The proposed model shows a 50% increase in accuracy when compared to individual systems with a few number of epochs. The proposed system reduces the training time and boosts the system-level accuracy.

Keywords Question answer system · Deep neural network · LSTM · Memory · Network ensemble · CatBoost

1 Introduction

In general, people tend to seek information through conversation, Internet, books, etc. Due to information overload, the process of extracting the required answers using machine learning techniques has become a challenging task. The task become more complicated when the users have started to post different types of questions like Wh, short question, factoid, reasoning questions, counting, etc. A system is always expected to learn facts and apply reasoning to discover new facts that can assist in answering the given question. Extraction and identification of suitable answer

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depends on understanding the main intent of a question. This makes the task of building an appropriate model as a challenging task. The conventional method of question system will have data retrieval and handcrafted rules. The performance of traditional systems is restricted as they heavily depend on manually extracted rule. The task becomes difficult because of imbalanced dataset. The QA process can be broken into two parts: information retrieval and reading comprehension. The process of finding the document containing the answer for the raised question is known as information retrieval. Reading comprehension deals with identifying answer from a given the passage. However, the recent schemes on deep learning have shown their potential in improving the performance of QA system. Deep learning models require a substantial amount of training. GRU, LSTM, and bidirectional LSTM help to handle longer text sequences unrolled during time. Enhancements like attention mechanism and memory networks help the model to identify important features. Dialog systems [8] like chat bots [9], Alexa, and IBM Watson [10] which simulate human conversation are derived from question answer systems. With the increase in digital awareness and reach in rural area, the need of multilingual question answer system has started arising. Availability of multilingual QA corpus is a challenging task. Until recently, multilingual QA system was dependent on machine translation. Identifying appropriate answers and framing syntactically and semantically correct sentence require consideration of language-specific grammar, which is also difficult task. This would further affect the accuracy of system. Therefore, advancements in QA system are the need of the hour. Ensemble models help to combine the strengths of individual models to enhance the accuracy of system. The major contribution of the paper is an ensemble model which categorically boosts the combined predictions of LSTM model and memory model. The ensemble model is designed to boost the accuracy of question answering system capable of handling different question categories. The proposed research work has been arranged as follows: Section 2 provides a brief review of literature. Section 3 explains the overview of the proposed question answering system. Section 4 presents experimental setup. Section 5 illustrates the results and discussion, and Sect. 6 presents the conclusion.

2 Literature Review

Abishek et al. [1] proposed a CNN—LSTM model for identifying duplicate questions using Quora dataset. The author proved that identifying duplicate questions before the classification enhances the performance of model tremendously. Bae et al. [2] employed word weighting method for question classification. The author proposed mechanism to identifying positive and negative words, and positive words having negative sentiments, and vice versa for query processing. Razzaghnoori et al. [3] experimented with recurrent neural network (RNN) for extracting feature vector mechanism and employed classical support vector machine (SVM) for query classification. Hong et al. [4] have proposed a model that constructs a binary tree structure to take care of composite reasoning implied in the language. The recursive

grounding tree (RVG-TREE) parses the language and then performs a visual reasoning along the tree in a bottom-up fashion. Liu [5] proposed a Siamese architecture that compromises of multilayer long short-term memory (LSTM) network and convolutional neural networks (CNN). The author uses concept interaction graph for matching long text. The graph vertex acts as a concepts, and interaction level act as edges. The model aggregates the matching signals through a graph convolutional network which checks similarity relationship between two articles. Ullah et al. [6] proposed an attention model that emphasizes on the importance of context and time that helps to provide contextual information regarding the question while generating the answer representations. In 2017, Yue et al. [7] developed a dynamic memory networks to carry out "textual QA." The model takes the inputs that are processed to take out hierarchical and global salient features simultaneously. Consequently, they were deployed to formulate numerous feature sets at every interpretation phases. Experimentation was performed on a public textual Q&A dataset using without and with supervision approach from labels of constructive details. Finally, when distinguished with preceding works, the developed technique demonstrates improved stability and accuracy.

3 Proposed System

3.1 Long Short Term Memory

LSTM helps to defend the error that is backpropogated through time. LSTM is the memory element in the model. A LSTM cell consists of neural network with three different activation functions. LSTM cell has three basic gates which are neural networks with sigmoid activation function known as input gate '*i*', forget gate '*f*', and output gate '*o*'. Neural net with Tanh activation is known as candidate layer '*c*'. Output is a current hidden state id denoted by vector '*h*', and memory state denoted by vector '*c*'. Forget layer '*F*' decides which information to discard. Inputs to the LSTM cell at each step are X the current input and H the previous hidden state, and C is the previous memory state. Outputs from the LSTM cell are H the current hidden state and C the current memory state. The following equations demonstrate the working of LSTM layers.

$$f_t = \sigma(W_f.[h(t-1), x_t] + b_f) \tag{1}$$

$$i_t = \sigma(W_f.[h(t-1), x_t] + b_i) \tag{2}$$

$$\tilde{C} = \tanh(W_C.[h(t-1), x_t] + b_C) \tag{3}$$

$$C_t = f_t * C(t-1) + i_t * \tilde{C}) \tag{4}$$

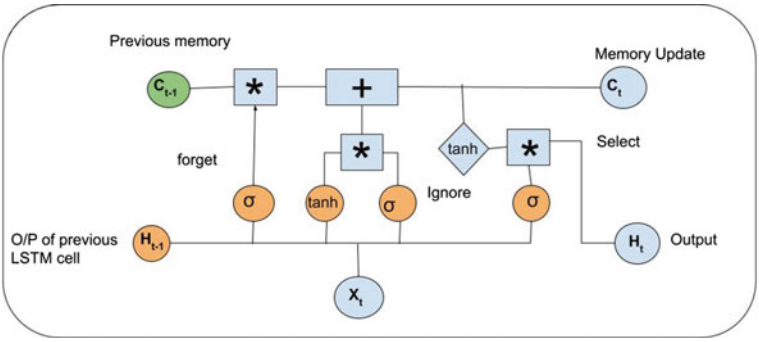

Fig. 1 LSTM cell

$$o_t = \sigma(W_o.[h(t-1), x_t] + b_o) \tag{5}$$

$$h_t = o_t * \tanh(C_t) \tag{6}$$

Figure 1 demonstrates the working of LSTM cell. The cell compares its memory with previous output of LSTM cell to identify the importance and reads a current word considering previous.

3.2 Encoder–Decoder Model

For a QA system to be efficient, inference mechanism and memory elements are required to memorize long sequences with context. These long sequences serve as knowledge for effective prediction of answers. This model decodes the context and question in fixed length vector and produces the expected answer. This model is also known as encoder–decoder model. Consider a network with $M = \mu_1, \mu_2, \ldots, \mu_n$ memory elements, I input feature of vector of size e, u update parameter for updating old memory with present input, O the output feature map, and R the expected response. The encoder processes the input feature and produces a two-dimensional output matrix. The model takes input as sentence and stores in available memory μ. The input length depends on the number of memory cells in the layer. A new memory is stored in u module without changing the old memory μ. LSTM layer acting as a decoder takes input vector, the time steps, and features to produce a decoded sequence, i.e., answer (Fig. 2).

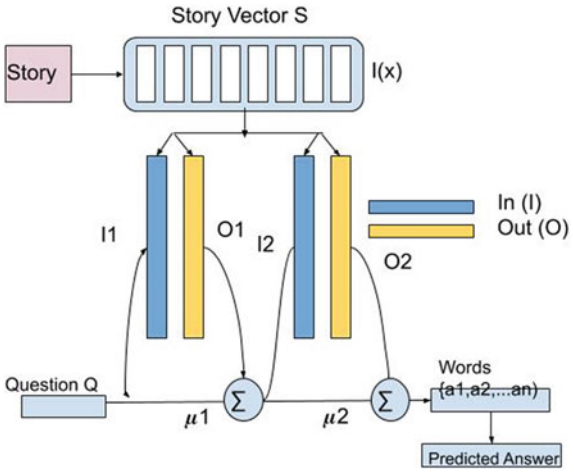

Fig. 2 Memory network

Algorithm 1: Memory Cell

Data: input text character/word/sentence
Result: Memory Network Algorithm
initialization;
while *not at end of sentence* **do**
  Encode x → I(x);
  while *not at end of X* **do**
    Update Memory
    $\mu_i = u(\mu_i, I(x), \mu), \exists i$
    Compute $O = O(I(x), \mu)$
    end of X
    Decode $o : r = R(o)n$;
  end
end

3.3 CatBoost

CatBoost is an implementation of gradient boosting, which uses binary decision trees as base predictors [12]. Existing gradient boosting algorithms like random forest, Adaboost, and Xgboost suffer from prediction shift problem. Boosting algorithm relies on target of all training examples which causes prediction shift. Traditional approach [14] converts categorical features to statistical model leading to target leakage. CatBoost algorithm provides solution to both the said issues by employing principle of ordering. CatBoost is based on gradient boosted decision trees. Decision

trees are built repetitively during training phase. Each successive tree is built with reduced loss compared to the previous trees. When the algorithm identifies over fitting, it stops construction of new tress.

Algorithm 2: Categorical Boosting

```
Data: input text character/word/sentence
Result: tree
Preliminary calculation of splits.;
Choosing the tree structure.;
while not over-fitting do
    Divide objects into disjoint ranges;
    Split data into bucket;
    Select tree structure;
    Calculating values in leaves.;
    while not over-fitting do
        Calculate penalty function;
        min(penalty)
        Select split
    end
    Calculate Score
end
```

The CatBoost algorithm is good in handling categorical values and performs best when used with default parameters, and parameters can be tuned for optimized results. Though the algorithm is robust and easy to use, it requires considerable time to train and optimize the results. CatBoost takes more time to train a system with numerical features. It does not support sparse matrices.

3.4 Ensemble Model

A deep neural network (DNN) learns complex nonlinear relationship in data. Bias, variance, and noise are prediction errors. While noise cannot be handled by algorithmic approach, bias and variance can be reduced by proper choice of model. Every time a DNN is trained, different version of mapping function is learnt. This stochastic nature affects the performance of model. The DNN suffers from low bias and high variance. The proposed model uses ensemble approach to reduce the problem of high bias. Sequential ensemble approach is used in the proposed system to reduce bias error. This approach combines predictions from base learners and applies categorical boosting to enhance the accuracy of system. Several instances of the same base model are trained sequentially to train the LSTM learner with previous weak learners. Figure 3 shows the working of the model. Long short-term recurrent neural network and memory networks are used as base learners. Categorical boosting is done by CatBoost algorithm which is used as meta learners to enhance the accuracy of ensemble model. The proposed model works in two phases. The learning

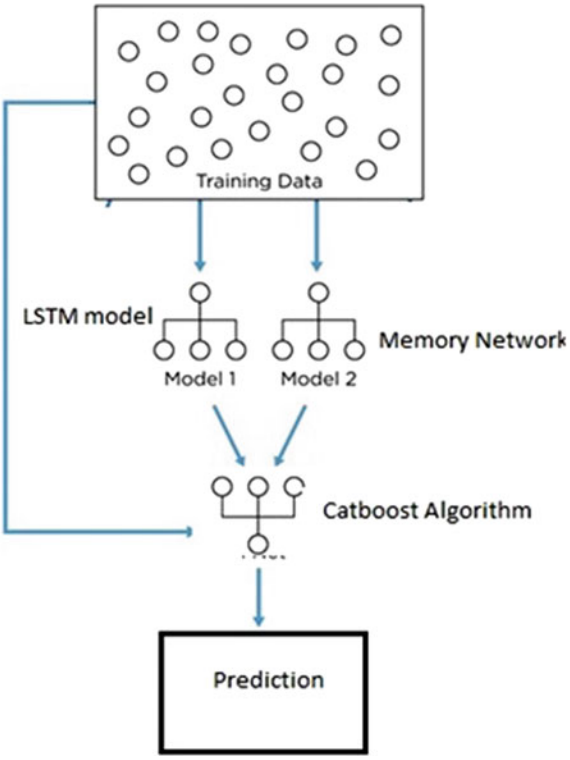

Fig. 3 Proposed model

algorithms for LSTM are based on minimizing the error rate. The first phase uses data subsets to produce results. The results generated by first phase are combined together, and performance boost is achieved by categorical boosting (Fig. 3).

4 Experimental Setup

LSTM and memory networks are trained in full supervision by providing context, question, and expected answers to the system. Each model is tested in isolation for accuracy and loss parameters. Evaluation of the proposed system is done on babi question answering dataset. The dataset consists of 20 different question answering tasks. The models are trained with 40 epochs and batch size of 32. The model is trained on 1000 samples. A dropout of 0.3 is applied to avoid over fitting. The efficiency of a QA system is judged by the correctness of answer predicted. Precision and recall are traditional factors for judging a classification problem. Apart from these, mean reciprocal rank (MRR) is the ability of a QA system to select appropriate answer for

a given question from the ranked list of answers. If suitable answer is not found, then rank becomes zero. The proposed model was evaluated on precision, recall, and f1 measure.

$$\text{Precision (Micro)} = \frac{\text{No. of correctanswers for Question } q}{\text{answers retrieved for Question } q} \tag{7}$$

$$\text{Recall (Micro)} = \frac{\text{Correct answers retrieved for Question } q}{\text{gold standard answers retrieved for } q} \tag{8}$$

$$\text{Precision} = \text{Average of Precision for all questions} \tag{9}$$

$$\text{Recall} = \text{Average of Recall for all questions} \tag{10}$$

$$\text{F1 Score (Micro)} = \text{Harmonic mean of Precision (Micro) and Recall (Micro)} \tag{11}$$

$$\text{F1 Score} = \text{Harmonic Mean of Precision and Recall} \tag{12}$$

$$\text{MRR} = \frac{1}{Q}\sum_{i=1}^{Q}\frac{1}{\text{answerrank}_i} \tag{13}$$

5 Results and Discussion

From experiments, it was observed that each classifier requires different settings of hyperparameters for producing best model. With fixed hyperparameter setting, individual performance of classifier varies a lot. The proposed ensemble boosting helps to overcome this bottleneck. Considerable amount of time needs to be invested to identify optimal hyperparameters. In cases where single classifier is not sufficient to correctly predict the result, the proposed approach provides a better alternative. Metric classification report indicates that proposed ensemble model performs better than individual models. The accuracy of LSTM model is obtained around 60% and memory network model around 60% for 40 epochs. The accuracy of proposed ensemble model obtained is 95.45%. The f1 score of proposed model is 93%. A considerable boost in accuracy is observed in the result (Table 1).

Table 1 Comparing different models on precision, recall, and f1 score

Model	Precision	Recall	F1 score
LSTM	51	50	50
Memory network	37	38	37
Proposed model	91	95	93

The ROC curve is plotted with true positive rate on *y*-axis and false positive rate on *x*-axis. The ROC curve demonstrates the probability distribution of system. Classifiers that produce curves closer to the top-left corner indicate a better performance. The ROC curve and FPR FNR curve indicate that the performance of proposed model is stable. FNR indicates the miss rate for given data (Figs. 4 and 5).

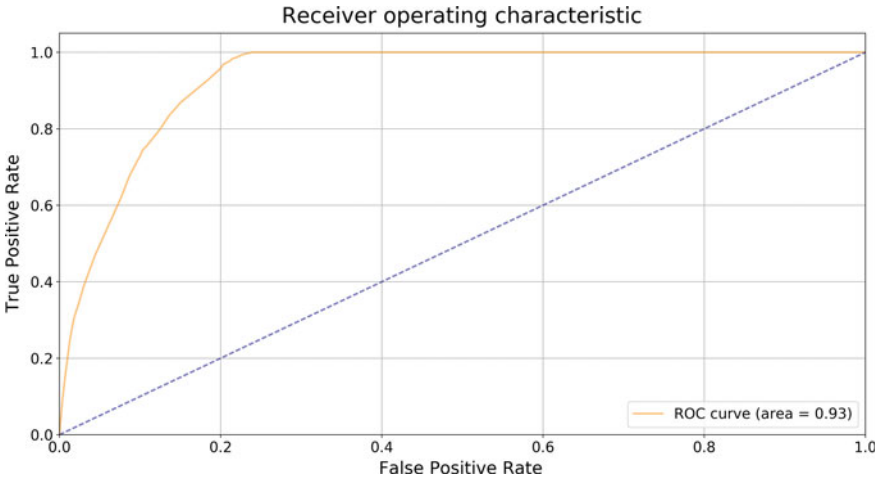

Fig. 4 ROC curve

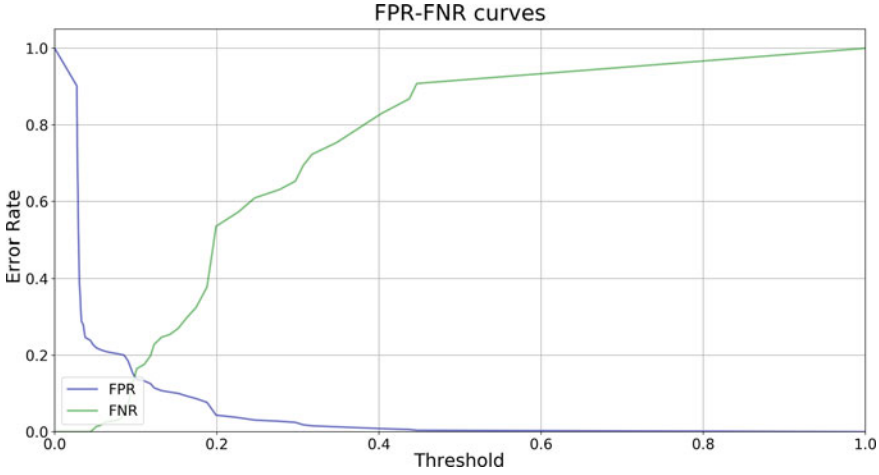

Fig. 5 FPR/FNR curve

6 Conclusion

Experiments explore proposed model for question answering (QA) task. The experiments show that using LSTM and memory network as base learners and boosting the results with CatBoost algorithm shows considerable improvement in prediction accuracy. Evaluation of proposed system is done on babi dataset which contains 1000 question answer tasks. Overcoming the problem of bias was handled successfully in the system. There are many future enhancements for the said system. Choice of base learners and combining traditional machine learning algorithm would make it computationally efficient. Testing system with multilingual data would be a challenging task.

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Information Sharing Over Social Media Analysis Using Centrality Measure

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Abstract Instagram and Twitter are popular social media in India. This exploration plans to comprehend the client's behavior and strong/weak relationship inside the social media and to find the range of interaction in the social network. UCINET is an analytic tool for social media networks which examines the client highlights and floating inspiration of these four environments. To measure the centrality three markers such as degree centrality, closeness centrality and betweenness centrality are widely used. Clients obtained the most astounding estimation of centralities are mostly used in social media by people, and the least centrality is used the least. The recurrence to utilize four web-based lives is comparable as per the results of three centralities.

Keywords Social media · Centrality · Social network analysis

1 Introduction

Immense SNA originates from social science, network analysis, and graph theory. Network analysis produces a result for the problems which are in the form of a network generally in the graph structure. There are many analytical tools to analyze this network and visualize it in the form of a graph. The main purpose of designing social network analysis is to work on groups especially on the social network rather than on individual data. SNA is used in the field of business for improving communication flow, law enforcement agencies to find forgeries network, social networks such as Facebook to find a friend of friends, and network operators such as telephone, cable, and even in mobile networks. The relationship between two nodes can be unidirectional or bidirectional. For example, Facebook is unidirectional where only one person is enough to accept the request but in the private account of Instagram, both of them need to send a follow request and accept it mutually, so Instagram is bidirectional.

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A social group can be of two types such as realist and nominalist. The social network comes under the group of nominalists and not under realist because the actors have a relationship among themselves. There are two methods for analyzing social network such as complete network and ego network-based analysis. Traditional survey is used to analyze the ego network and also involves evaluating the parameters such as average, size, min, and max of a person network. Whereas complete network analysis is used to produce the relationship between the actors such as trustworthy friends in a connected network, and it is also used to measure centrality.

UCINET is a user-friendly software system for analyzing the social network. It also provides several analytical technologies such as clustering, centrality, and statistical analysis. UCINET accepts a large number of inputs in the form of an excel file using a data editor known as DL editor. Excel can either be created in the DL editor or imported from the system. They are different features in which data can be arranged are Full matrix, Nodelist, Edgelist, Edgelist23, etc., Here, the Full matrix feature is used in which data are arranged as actor-by-actor adjacency matrix in which X_{ij} shows the strength of relation from actor i to actor j. Full matrix is mainly used for small and dense data sets.

NETDRAW enables the client to delineate and connect utilizing drawing highlights such as color, size, and shapes. Tie strength is used to differentiate the different relationships in the relation using the attribute. Thus, the result of the NETDRAW can be stored in different formats such as Windows metafile and jpeg format. It is also used for clustering and measuring centrality. UCINET produces two types of output. At first, the output log opens the text file in the notepad gets displayed default. Once the UCINET is closed, the output log file gets deleted so it is necessary to store the output log. The other way of viewing data is through UCINET which creates UCINET data file which contains results. This file will not get deleted when the UCINET is closed, so the user can view the output whenever required.

2 Related Works

In leadership development, one of the challenging tasks is evaluation of social networks. Mathematics and perception-based approach such as social network analysis (SNA) is utilized to frame the links for individuals, objectives, benefits, and different objects inside a large system [1]. SNA is utilized to expand the attention toward intensity of systems to leaders, to additional connections, associations, and finally reinforce the system limit altogether. The social organization conducted an investigation to evaluate all of its initiative improvement efforts, including the Emerging Leaders programme. The structure for administration systems supports the user by comprehending the work and help to choose and decide how and when to utilize SNA for assessment and capacity-building tool. An unpredictable system module is worked to speak the mind complex item structure, utilizing short-term esteemed intuitionist logic figure out the edge weights of the system demonstration and provides relationship qualities between measures [2]. Due to this, UCINET

is utilized for item module segment. The module is based on mutual relationship of complex products. The instrument of informal community examination utilized UCINET to exchange the co-word network into a photo of the keyword system and make an examination of it. They break down the arrangement as well as connections characteristics formed through various social entities [3].

Once the social network research organization examines to perceive the generality of its structural approach, helpful applications in an extensive variety of experimental circumstances moved toward becoming possible. SNA study is one of the few social endeavors in which individuals impact each other such that they all cooperate to assemble an aggregate assemblage of knowledge [4]. In the web condition, the hyperlink quantity checks and quantity of webpages are utilized to measure the affect factor. Self-references are supplanted without anyone else joins, i.e., connections inside the sites, and references are supplanted through in-joins, i.e., incoming links from other sites. There are several approaches to discover the effect of dairy, paper, and web locales, and so on. The proposed framework will discover the affect factor of understudies E-Dissertation through h-record and associated connections of E-Dissertation spoken to pictorially by utilizing UCINET programming [5].

The centrality of the venture administration group is very high, which implies it has the greatest power in the correspondence organization, yet that will influence the general correspondence productivity [6]. In migration estimation, social networks have denoted a significant takeoff of understanding. It is not just a component as the movement procedure is spotted. This extraordinary issue arises as migrants are implanted between individual connections and primary subjects, directions of no less than two distinct country states. In this way, their lives span crosswise over borders. The creators appear among others that migrants and non-migrants have very comparative talk networks and participation on different measurements, yet they vary in the ethnic composition of their systems [7].

SNA objective depends on scientific investigation, commonly on estimations that are defined on the 60s and the present created strategies. Estimations and relations between them will be broke down, utilizing the current programming for informal community examination, for example, UCINET and ORA. This related work is finished on numerous means, while for information, investigation is utilized DBLP dataset [8]. Utilizing a self-administrated survey, 210 individuals are requested to give a reply for the study utilizing the accommodation examining strategy [9]. Individuals spend more than 33% of their waking day expending social media. However, with the notoriety of social media sites, a few organizations are utilizing informal communication destinations to help the production of brand networks [10].

The fundamental purpose of this article was the investigation of co-initiation in a particular meeting and the connection of these co-creators with paper procedures. Research through poll study and meetings to gather data and manufacture a system of connections, utilizing a blend of subjective quantitative examination, with the guide of the UCINET social organize examination programming to break down the impact level of relationship writes and comparing system impacts, accomplish the graphical portrayal of the system topological structure [11].

In addition, exploration estimated the grade in light of informal community investigation techniques, dissects the networks into strong subcategories along with group calculation and inner circle. The point is to recognize the impact of online networking promoting on brand loyalty of the shoppers, given that the idea is accepting and expanding consideration from advertising the scholarly community and experts. Data was gathered through the organization of an organized survey with an example of 338 individuals who were online networking users [12]. One question asked whether the respondent was utilizing web-based life more than once in seven days. The respondent was utilizing web-based life more than once in seven days, and they took after no less than one brand via web-based networking media. The questionnaire was created to quantify measure brand loyalty in social media.

3 Data Analysis

The analysis is experimented with 25 active participants in social media such as Instagram and Twitter. Some of the members were interviewed and constructed the matrix of interaction. In view of the meeting, information of connection among actors has been collected. The parameters were exposed to the contiguousness network, which is a sort of connection between clients and server who are hubs of social systems. The information was investigated based on the product UCINET 6, which is the contiguousness network input parameter. The outcomes acquired and in addition to their understanding are identified with the accompanying measures such as centrality (degree, betweenness, closeness) grouping coefficient, thickness, achieve, geodesic separation, and eigenvector [13].

Social information is represented with charts called sociograms. A different sociogram is normally worked for each social connection under study. Sociologists as a rule get them through public opinion surveys and meet with the people. Also, the investigation of human social structures is normally done by a socialist external to society. Social network analysis organizes study can be utilized as a part of a notoriety framework that considers the social measurement of notoriety. The combination of complementary strategies that utilization diverse parts of the communication and social relations, enables the specialist to compute notoriety esteems at various phases of its knowledge of the society[14] (Table 1).

This research intends to comprehend the client's behavior (features) and strong/ties inside the social network and if clients have been drifted on two social media. Analytic tool for social media networks UCINET is utilized in the research which examines the client highlights and floating inspiration of these two environments. To measure the centrality, three markers such as degree centrality, closeness centrality, and betweenness centrality are used [15].

A. *Analysis of Centrality.*
A total of 20 samples is used to create two social networks in view of two platforms (Instagram and Twitter). The created systems depended on the discussion

Table 1 Degree of interaction

Degree of interaction	Explanation
0	No interaction
1	Interact with others every 2 days
2	Interact with others every 5 days
3	Interact with others every week
4	Interact with others every two weeks
5	Interact with others every month

data which is equally to the level of communication. Quantities of centralities are contrasted to decide if the actors drifted or not (Figs. 1, 2 and 3).

B. *Degree Centrality.*
To characterize the incident quantity of a node along the lines, degree centrality is utilized. The most potential node among nodes can be defined through degree centrality. In order to obtain this, direct connection is essential between the nodes, and it is mathematically expressed as

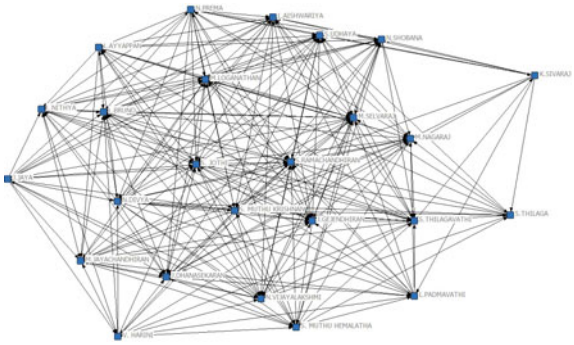

Fig. 1 Social network generated for 25 members on Instagram

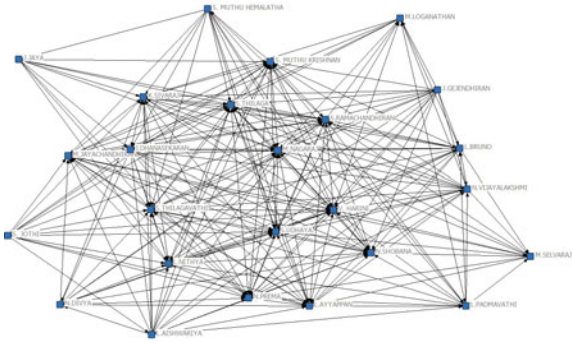

Fig. 2 Social network generated for 25 members on Twitter

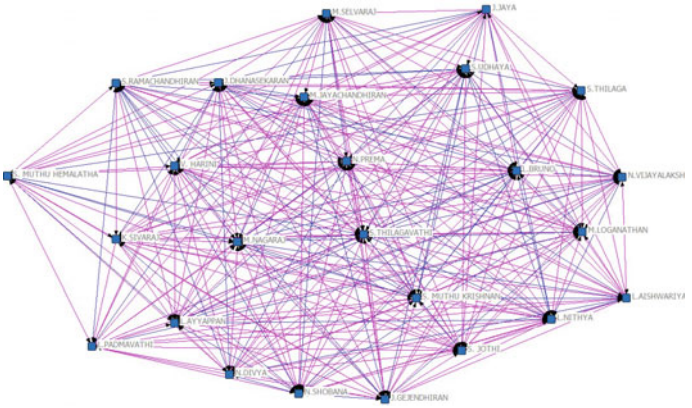

Fig. 3 Social network generated for 25 members on combined Instagram and Twitter

$$C_D(P_k) = \sum_{i=1}^{n} a(p_i, p_k)$$

The relative measure of degree centrality

$$C'_D(P_k) = \frac{\sum_{i=1}^{n} a(p_i, p_k)}{n-1}$$

The normal degree centrality of Twitter is observed to be 21.000 by L. Ayyappan, and Instagram is observed to be 21.000 by S. Jothi, and a combination of Instagram and Twitter is observed to be 39.000 by J. Dhanasekaran.

C. *Closeness Centrality.*

The distance between one node and other node is used to represent the closeness centrality. Subsequently, it is used to quantify the magnitude request of a node that is close to another node in the network by computing the shortest path from one node to all nodes in the system as a graph. Mathematically, it is expressed as

The relative closeness centrality is

$$C_C(P_k) = \left[\sum_{i=1}^{n} d(p_i, p_k)\right]^{-1}$$

S. Jothi has a higher incentive in Instagram of 88.889, L. Ayyappan has a higher incentive in Twitter of 88.889, and M. Nagaraj has a higher incentive in both Instagram and Twitter of 100.

D. *Betweenness Centrality.*

Table 2 Comparison value of betweenness and in-betweenness

Name	Betweenness	Nbetweenness
S. Ramachandhiran	46.348	8.396
V. Harini	36.636	6.637
N. Prema	33.08	5.993
S. Thilagavathi	27.008	4.893
S. Muthu hemalatha	24.603	4.457
S. Muthu krishnan	23.778	4.308
L. Nithya	18.122	3.283
S. Udhaya	15.957	2.891
L. Ayyappan	14.762	2.674
L. Padmavathi	13.277	2.405
K. Sivaraj	10.418	1.887
N. Shobana	8.409	1.523
S. Thilaga	8.202	1.486
M. Nagaraj	6.763	1.225
J. Dhanasekaran	5.56	1.007
N. Vijayalakshmi	5.145	0.932
M. Jayachandhiran	4.494	0.814
M. Loganathan	2.555	0.463
N. Divya	1.834	0.332
L. Bruno	1.833	0.332
L. Aishwariya	1.229	0.223
S. Jothi	0.894	0.162
M. Selvaraj	0.726	0.132
J. Jaya	0.365	0.066
J. Gejendhiran	0	0

Betweenness centrality is used to define the node which lies between other nodes in a network. In the event, if a particular node is the only element which connects two different groups, then that node is considered as vital node in order to keep the cover the network

$$C_B(p_k) = i_{ij}(p_k) = \frac{1}{g_{ij}} * g_{ij}(p_k) = \frac{g_{ij}(p_k)}{g_{ij}}$$

S. Thilagavathi has a value of 27.750 plays an essential in the mediation of the network on Instagram. S. Ramachandhiran has a value of 46.348 plays an essential in the mediation of networks on Twitter. S. Muthu Krishnan has a value of 16.593 plays an essential in the mediation of networks on Instagram and Twitter.

Using Table 2, the graph can be generated using the values shown above.

The above graph gives the generated curve for betweenness and in-betweenness (Fig. 4).

Thus, from the above analysis, calculated value of betweenness and in-betweenness is found (Fig. 5; Table 3).

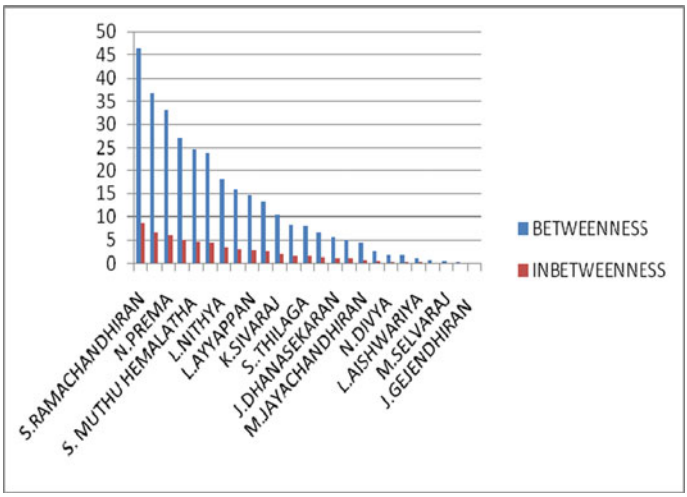

Fig. 4 Generated graph of betweenness and in-betweenness

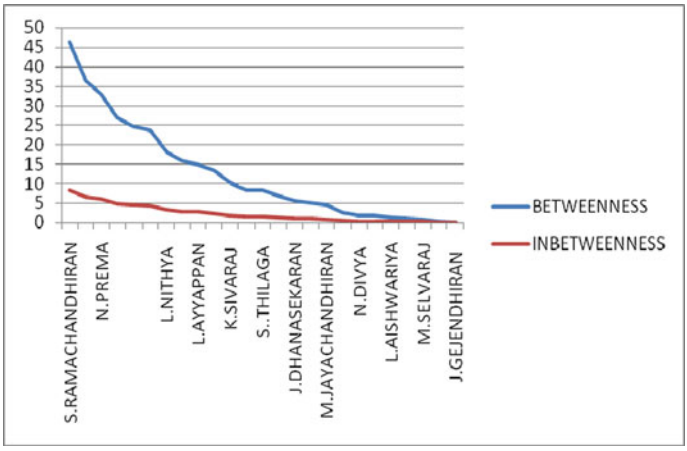

Fig. 5 Generated curve of betweenness and in-betweenness

Table 3 Mathematical calculation

Calculation	Betweenness	In-betweenness
Mean	12.48	2.261
Std Dev	12.577	2.278
Sum	312	56.522
Variance	158.171	5.191
SSQ	7848.046	257.563
MCSSQ	3954.286	129.775
Euc Norm	88.589	16.049
Minimum	0	0
Maximum	46.348	8.396
N of Obs	25	25

4 Conclusion

In the proposed work, the results show up that there is a noteworthy impact of implication from Twitter to Instagram. In three centralities, regular clients are practically identical case in two phases. User interface and preference are the two fundamental contrast between the platforms. The outcomes additionally demonstrate the effects of network as various clients select media in view of their companion's utilization. As per research recognition, an inadequacy exists on Twitter. At that point, again the strong bonds existed on Instagram. Numerous members of the research demonstrated contingency behavior since they endeavored to get used to diverse platforms. Therefore, this analytical model is unclear about the drifting behavior. The results of Instagram match the present reality state and associations between performing actors are robust.

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AndroHealthCheck: A Malware Detection System for Android Using Machine Learning

Prerna Agrawal and Bhushan Trivedi

Abstract With the boom of malware, the area of malware detection and the use of gadget assist to gain knowledge in research drastically with the aid of researchers. The conventional methods of malware detection are incompetent to detect new and generic malware. In this article, a generic malware detection process is proposed using machine learning named AndroHealthCheck. The malware detection process is divided into four phases, namely android file collection, decompilation, feature mining and machine learning. The overall contributions made in AndroHealthCheck are as follows: (1) designing and implementing a crawler for automating the process of benign files download, (2) collection of unstructured data from the downloaded APK files through the decompilation process, (3) defining a proper mechanism for the feature selection process by performing a static analysis process, (4) designing and implementing a feature mining script for extracting the features from unstructured data collection from APK files, (5) generating a rich homemade data set for machine learning with a huge variety and different flavours of malware files from different families and (6) evaluating the performance of the generated data set by using different types of supervised machine learning classifiers. In this article, the overall architecture and deployment flow of AndroHealthCheck are also discussed.

Keywords Malware detection · APK files · Static analysis · Unstructured data · Feature mining · Machine learning

1 Introduction

The malware detection domain using machine learning is an emerging area that is being researched extensively these days. The conventional methods used for the

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detection of malware are more resource and time consuming and are incompetent to detect generic and new malware [1]. The conventional methods used for malware detection include signature-based, resource-based, components-based and permission-based analysis [2], which are not enough to detect the new and generic malware. Machine learning methods acquire on their own from the knowledge given to them as training data and use performed classification on testing data and are highly used for the investigation of the malware [1].

Here, the Android files are used as a proof of concept for the proposed malware detection process. For the proper investigation of the malware, the independent flavours of features and a variety of malware files from different malware families are needed. The existing malware data sets are available and that can be used in machine learning directly, but the Drebin data set is found to be with lesser features and with malware files having less variety of malware families. To generate our data set with independent flavours of features, they were decided to have a huge variety of malware files for better performance in malware detection. It can be directly used by researchers in machine learning.

The overall contributions performed in AndroHealthCheck are as follows: (1) designing and implementing a crawler for automating the process of benign files download [3], (2) collection of unstructured data from the downloaded APK files through the decompilation process [4], (3) defining a proper mechanism for the feature selection process by performing a static analysis process [5], (4) designing and implementing a feature mining script for extracting the features from unstructured data collection from APK files [5], (5) generating a rich data set for machine learning with a huge variety and different flavours of malware files from different families [5] and (6) evaluating the performance of the generated data set by using different types of supervised machine learning classifiers [6]. Using the machine learning classifiers, the performance of the CatBoost classifier is highest with 93.15% accuracy and ROC value of 0.91 [6]. The layout of this article is divided into the following sections. Section 2 describes the overall architectural flow of the AndroHealthChecka—malware detection system. Section 3 describes the overall deployment flow of the AndroHealthCheck—a malware detection system. Section 4 describes the conclusion of the research work.

2 Architecture of AndroHealthCheck

This section represents the overall architecture of AndroHealthCheck—the malware detection system. Figure 1 represents the overall architecture of AndroHealthCheck. The AndroHealthCheck is divided into four phases: They are android file collection, decompilation, feature mining and machine learning. In the android file collection [3] phase, the malware and the benign file collection were concentrated as it is the first step for the data collection. In the android file collection phase, the user enters the website URL for downloading the files. This module connects to the website, and after the successful establishment of connection, the website sends the file request

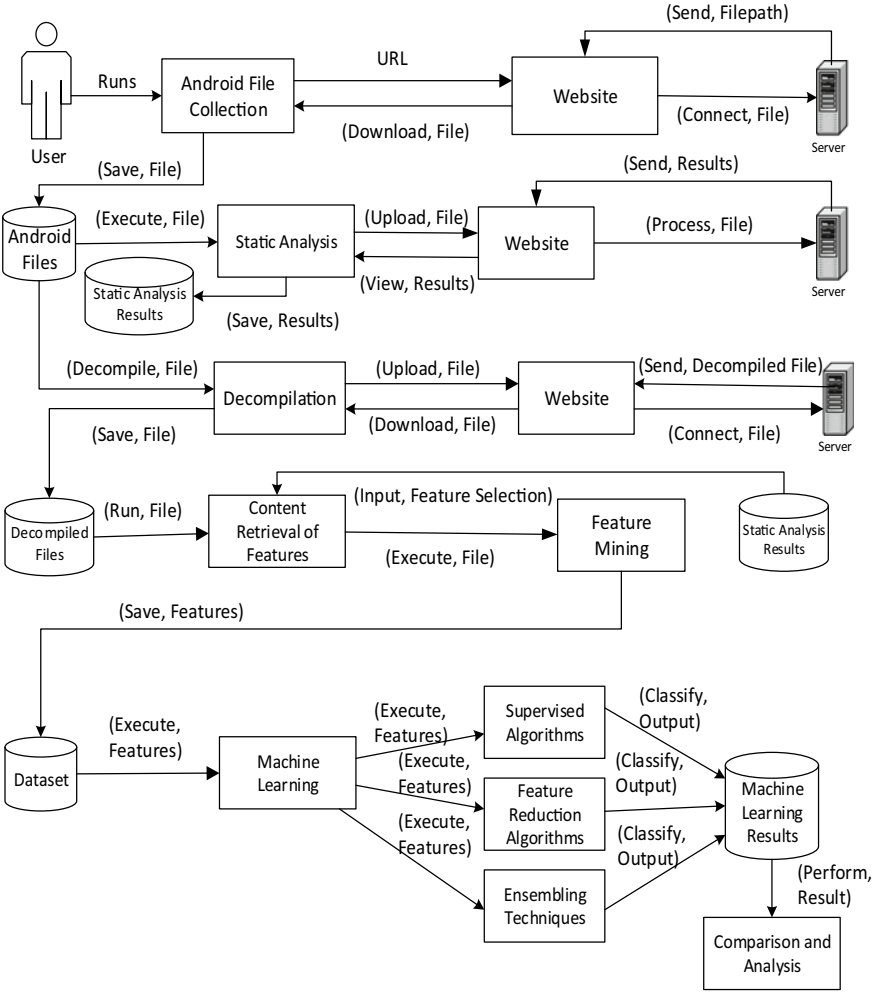

Fig. 1 Overall architectural flow of AndroHealthCheck

to the server for download. The server responds with the file path to the website, and the file gets downloaded and stored in the physical location. Using the android file collection phase [3], a total of 15,506 files of malware files were downloaded from the world's famous android malware projects like Drebin, Androzoo, AndroPRAGuard, Kharon and Kudoos [3]. To automate the process of benign file downloads, a crawler is developed [3] and downloaded for 4000 benign files [3]. The android files contain an unstructured data format like text files, Java files and.xml files. For extracting the features from the APK files, reverse engineering of these files is necessary. So the decompilation phase [4] collects the unstructured data from the APK files. In the decompilation phase, an APK file is given as input. The APK file is uploaded on the

website and sent to the server for decompilation. The server processes the APK file, decompiles it and sends the decompiled file back to the website in the form of a zip file. The decompiled zip file is saved to a physical location. Using the decompilation phase, the collected malware and benign files are decompiled, and unstructured data like XML and Java files are collected from each decompiled APK file [4].

For mining, the features from the decompiled files feature selection are an important criterion as there is no proper mechanism available for the feature selection process. So for the proper selection of features, the static analysis [5] was performed using the online malware scanners [7]. In the static analysis phase [5], an APK file is given as an input to the website, and the file is uploaded on the website. The file is sent to the server for processing. The server processes the file and returns the results to the website. The user can view the results of the file, and those results are saved to a physical location. All the collected APK malware files were scanned using the online malware scanners, and their reports were collected and analysed. From the analysis of the reports of the online malware scanners, total of 215 features were selected that included various permissions, API calls and Intents. In the feature mining, all the 215 selected features were extracted from the unstructured data collection from the APK files. For the feature mining process, a feature mining script was developed and implemented to extract features from the decompiled APK files. In the feature mining phase [5], the feature mining script looks for a decompiled file in the decompiled files repository and extracts all the 215 features from a decompiled file. A vector for each Android file is generated with extracted features and will be saved in a CSV file. Using this feature mining phase [5], a final data set is generated with a total of 16,300 records in which it includes both malware and benign files [5]. For the evaluation and performance of the generated data set, various supervised machined learning classifiers were implemented in the machine learning phase [6]. In the machine learning phase [6], the features from the generated data set were given as input, and various supervised machine learning classifiers were applied to the features for the classification of the malware and benign files. Different types of supervised classifiers, feature reduction classifiers and ensembling techniques were applied, and the classification result of each classifier is saved into an Excel file. The classification results of each classifier are compared and analysed for better performance and detection of malware. The machine learning phase is explained in our previous paper [6]. The next section describes the overall deployment flow of the AndroHealthCheck system.

3 Deployment of AndroHealthCheck

This section discusses the overall deployment flow of the AndroHealthCheck malware detection system. Figure 2 represents the overall deployment flow of AndroHealthCheck. The AndroHealthCheck is divided into four phases such as android file collection, decompilation, feature mining and machine learning. The deployment scenario of the AndroHealthCheck model is discussed according to its phases.

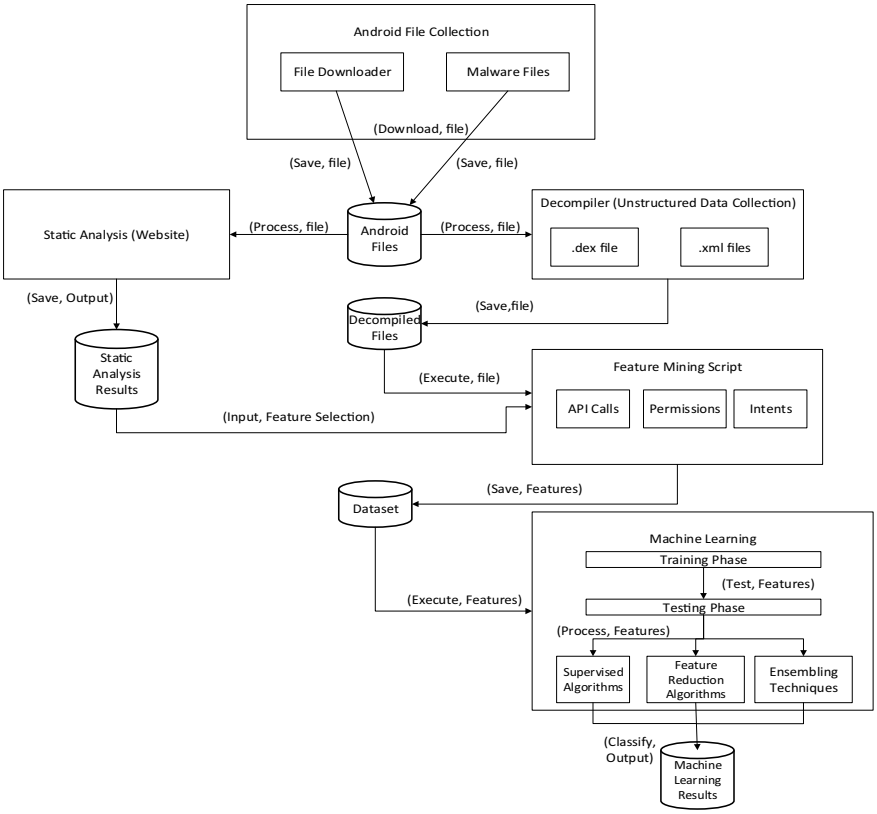

Fig. 2 Overall deployment flow of AndroHealthCheck

In the android file collection phase, the malware files were downloaded from different android malware projects. A variety of malware files are downloaded from different cloud servers and online sources. For benign files download, we have designed and implemented a crawler/file downloader to automate the process of automatic file download from websites [3]. The crawler is designed using technologies like node package and Cypress framework. The version of Node 10.16.3 is used with Cypress 4.0 along with Chrome browser. The crawler can be deployed on any local machine and executed using Chrome browser. The crawler needs to be initialized with a website URL, and it will fetch and parse a web page by downloading the APK files. The malware files and benign files downloaded are saved into android files repository. In the static analysis phase [5], different online malware scanners were used to process the file and to obtain the results. The downloaded APK file is given as an input to the website, the file processing is done on the cloud servers itself, and the processed zip file is returned to the website and downloaded at a physical location. In the decompilation phase [4], an online decompiler is used for the collection of unstructured data from the APK files. The APK file is given as an input to the website,

and the file is uploaded on the server and is decompiled on the cloud server only. The decompiled file is returned to the website back and saved to a physical location. The decompiled file contains .dex files and .xml files. The .dex files are further processed to extract the Java files.

In the feature mining phase [5], the selected 215 features from analysing the reports of the static analysis phase are extracted from the decompiled APK files. A feature mining script is developed and implemented in Python for extracting the features from the decompiled files. The feature mining script can be deployed on any local machine and executed using Python, and features can be extracted from the decompiled files and saved in a CSV file. The feature mining script mainly extracts API calls, permissions and Intents from the APK files. A vector of extracted features is generated for each Android file and saved in the CSV file. Using the feature mining script a final data set of a total of 16,300 records is generated. For the performance and evaluation of the generated data set of various machines, learning classifiers are used. In the machine learning phase [6], various experiments are carried on the data set by using various machine learning classifiers. The experiments are carried on Intel Core i7-7500U CPU @ 2.90 GHz with 8 GB RAM and Windows 10. The technologies used for experiments are Python and Anaconda Package having a suite of various machine learning libraries for supervised and unsupervised algorithms. For obtaining good results, the data set is divided into a training set and a testing set. From the data set, 75% of data is trained to perform classification and testing on 25% of data. Various machine learning classifiers applied are KNN, random forest, decision tree, linear SVM, logistic regression, Naive Bayes, linear discriminant analysis (LDA), non-negative matrix factorization (NMF), principal component analysis (PCA), bagged decision tree, extra trees and random forest using bagging, gradient boost, CatBoost, AdaBoost, XGBoost, softmax voting and hardmax voting. The classification results of all the machine learning classifiers are stored in an Excel file.

4 Conclusion

AndroHealthCheck is a malware detection system to investigate that a file is malware or not by using machine learning methods. A data set is a prerequisite for machine learning models to determine themselves and gain knowledge from the training data for the proper classification of malware and benign files on the testing data. For the investigation of proper malware, a homemade data set with rich variety and with different flavours of malware families was needed. The objective is to create our own data set which can be directly used by researchers for machine learning. A generic malware detection process named AndroHealthCheck is proposed for malware detection using machine learning.

The AndroHealthCheck defines the generic process of data set generation for machine learning and also defines a mechanism for malware detection using machine learning. The architectural and deployment flow of AndroHealthCheck were discussed. In AndroHealthCheck, the design and implementation of a crawler

for automating the process of benign files download were discussed. The unstructured data were collected from the APK files through the decompilation process from all downloaded 15,506 malware and 4000 benign APK files. A proper mechanism is defined for the feature selection process from the APK files through static analysis. The design and implementation of a feature mining script are used for feature mining from unstructured data collection from APK files. A rich data set is generated for machine learning of a total of 16,300 records and 215 features with a huge variety and different flavours of malware files from different families and independent flavours of features. The performance of the generated data set is evaluated with different supervised machine learning classifiers and found that the performance of the CatBoost classifier is highest with 93.15% accuracy and ROC value of 0.91.

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Use of Machine Learning Services in Cloud

Chandrashekhar S. Pawar, Amit Ganatra, Amit Nayak, Dipak Ramoliya, and Rajesh Patel

Abstract Machine learning services are the comprehensive description of integrated and semiautomated web devices covering most facilities problems such as preprocessing information, design preparation, and design assessment, with the further forecast. REST APIs can bridge the outcomes of predictions with one's inner IT infrastructure. Like the original SaaS, IaaS, and PaaS cloud delivery models, ML and AI fields cover high-level services to provide infrastructure and platform, exposed as APIs. This article identifying the most used Cloud Technologies for Machine Learning as a Service (MLaaS): Google Cloud AI, Amazon, and Microsoft Azure.

Keywords Machine learning (ML) · Machine learning as a service (MLaaS) · Application program interface (API) · Artificial intelligence (AI) · Technology–organization–environment (TOE) framework · Information system (IS)

1 Introduction

The development of ML alternatives involves sophisticated, understanding, and costly assets because of this ML was mostly available to big firms that had such capacities. However, it was difficult to harness ML's authority for larger businesses or personal IT experts. One way to address the above-mentioned issues would be to have an ML as a service (MLaaS) capable of providing on-demand computing funds and an obviously specified API for ML procedure. Such a website would allow consumers to concentrate on the issue, and they are attempting to fix rather than the information of execution.

The algorithms of machine learning which are built on deep neural networks (NN) have been widely used in diverse fields. As the use of cloud services grows, MLaaS is accessible, and the training and deployment of these machine learning models are achieved on cloud providers' infrastructure [1].

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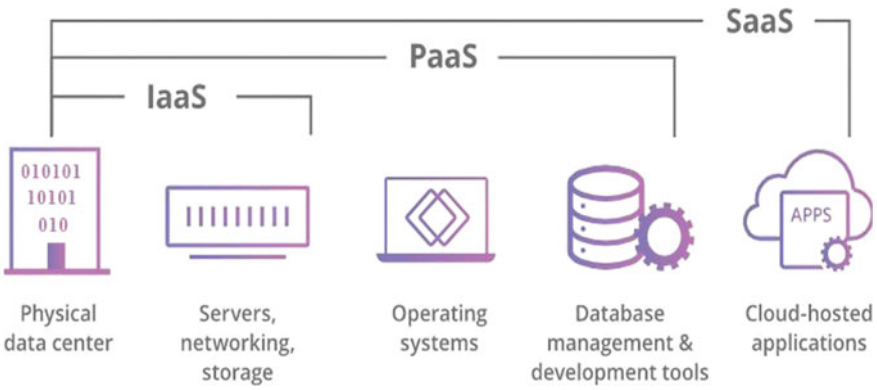

Fig. 1 Cloud computing service models

Machine training systems are one of the government cloud's highest increasing facilities. ML and AI systems are accessible through various distribution systems such as GPU-based computing, cognitive computing, ML model management, automated machine learning, and ML model serving, and, unlike other cloud-based facilities. Google Cloud AI, Azure machine learning, and Amazon machine learning are major MLaaS cloud amenities that enable quick model instruction and implementation with little or no knowledge in data science [2]. In Fig. 1, the different service models of cloud computing were observed, and Fig. 2 shows how ML cloud services are useful in each service model of cloud computing.

This paper contributes an analysis of Amazon, Google, and Microsoft's primary machine learning as a service application and then compares the machine learning APIs supported by these suppliers. The provided review is not proposed to provide in-depth instructions on what point and how to apply these platforms, but it focuses on what to know before one starts to use machine learning services on the cloud.

2 Cognitive Services

Speech recognition, computer vision, and natural language processing services are provided as a set of APIs by cognitive computing [3].

On the daily basis the size of data increase, the use of the services also increases, which force the cloud providers to provide better accuracy for the predictions. With the use of AutoML, a machine learning pipeline with limited computational budgets can be built. AutoML offers an extent territory to temperamental previously trained models vs. training required models from raw information [4].

IBM Watson APIs, Google Cloud AI APIs, Microsoft Cognitive Services, and Amazon AI Services are types of cognitive services. Table 1 gives a comparison of cloud machine learning services.

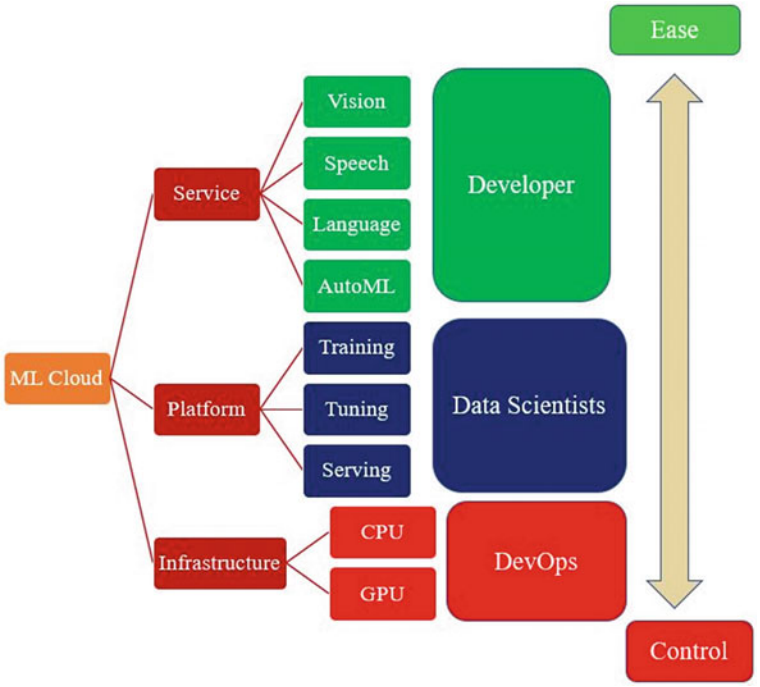

Fig. 2 ML cloud services

Table 1 Cloud ML services comparison for custom predictive analytics tasks [5]

	Amazon	Microsoft	Google	IBM
Automated and semiautomated ML services				
	Amazon ML	Microsoft azure ML studio	Google prediction API	IBM Watson ML model builder
Classification	√	√	Deprecated	√
Regression	√	√		√
Clustering	√	√		X
Anomaly detection	X	√		X
Recommendation	X	√		X
Ranking	X	√		X
Platforms for custom modeling				
Built-in algorithms	√	X	X	√
Supported frameworks	TensorFlow, MXNet, Keras, Glucon, Pytorch	TensorFlow. Sckit-Learn, Microsoft Cognitive tool-kit, SparkML	TensorFlow, Scikit-Learn, XGBoost, Keras	IBM SPSS, PMML, TensorFlow, Scikit-learn, XGBoost, Spark Mllib

In [30], through the introduction of cloud-based cognitive radio networks, the user will benefit from a seamless link and wireless Internet access, so the suggested model uses the cloud to control and distribute the space available of license users to the ULU by tracking the spectrum using collective spectrum mapping and the sparse Bayesian algorithm to analyze free space and communicate it to the cloud servers and use a spectrum lessor to assign free spaces to the ULU.

3 Machine Learning APIs of Google, Amazon, and Microsoft

MLaaS has become popular during the last few years. The leading Internet companies have deployed their own MLaaS. It offers an easy way to a service provider so that the machine learning (ML) model can be deployed and a quick way for a user/client for making use of the various applications offered by the model [6].

One can provide their own data to these services with trained models and obtain the outcome. APIs do not need proficiency in machine learning. The provided APIs are mainly categorized into three categories as image plus video recognition, text recognition, translation, and textual analysis, and other analysis which includes specific unclassified services.

Table 2 shows the comparison of speech and text processing APIs [5] as below-

Amazon, Microsoft, and Google also provide Video analysis APIs as a service for various analysis purposes. The comparison of these Video Analysis APIs [5] is shown in Table 3.

4 ML Services Serve as a Platform

At the point when cognitive APIs miss the mark regarding prerequisites, one can use ML PaaS to construct many tweaked AI models.

For instance, while an intellectual API might almost certainly distinguish the vehicle as a vehicle, it will most likely be unable to order the vehicle-dependent content for advancement and model. Expecting a huge dataset of autos marked with the brand and type, the information science group can depend on ML PaaS to prepare and convey a prototype that is customized for the commercial situation [7].

Like PaaS conveyance archetypal where designers take their code and host it at scale, ML PaaS anticipates that information researchers should bring their individual dataset and code that can prepare a model against custom information. They will be saved from running the register, stockpiling, and systems administration situations to run complex AI occupations [7, 8]. Information researchers are relied upon to make and assess the code with a little dataset in their nearby surroundings before executing it as work in the open cloud stage.

Table 2 Comparison of speech and text processing APIs [5]

	Amazon	Microsoft	Google
Speech recognition (speech into text)	√	√	√
Text into speech conversion	√	√	X
Entities extraction	√	√	√
Key phrase extraction	√	√	√
Language recognition	100 + languages	120 languages	110 + languages
Topics extraction		√	
Spell check	X	√	X
Auto completion	X	√	X
Voice verification	X	√	X
Intention analysis	√	√	√
Sentiment analysis	√	√	√
Syntax analysis	X	√	√
Tagging parts of speech	X	√	√
Filtering inappropriate content	X	√	√
Low-quality audio handling	√	X	√
Translation	6 languages	60 + languages	100 + languages
Catbot toolset	√	√	√

ML PaaS expels the grating associated with configuring up and designing information science situations. It gives pre-arranged conditions that can be utilized by information researchers to prepare, configure, and host the model. ML PaaS productively handles the complete execution of an AI model by giving apparatuses from the information willingness stage to demonstrate facilitating.

They accompany mainstream apparatuses, for example, Jupyter Notebooks which are recognizable to the information researchers. ML PaaS handles the unpredictability associated with running the preparation occupations on a bunch of PCs. These are conceptual underpinnings through basic Python or R API for the information researchers [8].

IBM Watson Studio, Amazon SageMaker, Google Cloud ML Engine, and Microsoft Azure ML Services are instances of ML PaaS in the cloud.

In the event that a business needs to bring readiness into AI model improvement and sending, consider ML PaaS. It joins the demonstrated strategy of CI/CD with ML model administration. The ML PaaS is shown in Fig. 3.

Table 3 Comparison of video analysis APIs [5]

	Amazon	Microsoft	Google
Object detection	√	√	√
Scene detection	√	√	√
Activity detection	√	X	X
Facial recognition	√	√	X
Facial and sentiment analysis	√	√	√
Inappropriate content detection	√	√	V
Celebrity recognition	√	√	X
Text recognition	√	√	X
Person tracking on video	√	√	X
Audio transcription	X	√	X
Speaker indexing	X	√	X
Keyframe extraction	X	√	X
Video translation	X	9 languages	X
Keyword extraction	X	√	X
Annotation	X	√	X
Dominant colors detection	X	X	X

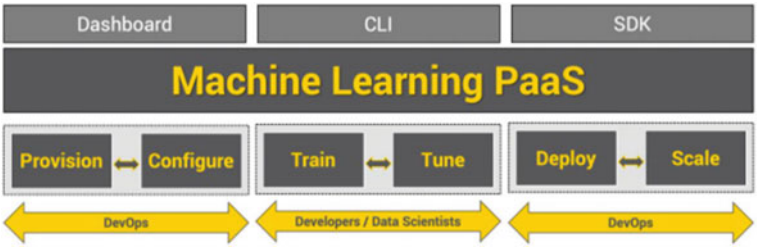

Fig. 3 Machine learning PaaS

5 ML Services Serve as an Infrastructure

Consider ML framework as the infrastructure service of the AI stack. Cloud suppliers recommend crude VMs sponsored by the top of the line CPUs and quickening agents, for example, graphical processing unit (GPU) and field-programmable gate array (FPGA).

Engineers and information researchers that need access to crude process power go to ML foundation. They depend on DevOps groups for arrangement and design required situations. The work process is the same as configuring a testbed for web

or portable application improvement dependent on VMs. From picking the number centers of the CPU to introducing a particular adaptation of Python, DevOps groups claim to start to finish arrangement [9].

For complex profound learning ventures that intensely depend specialty on toolbox and libraries, associations pick ML framework. They deal with the equipment and programming setup which may not be accessible from ML PaaS contributions [10].

The equipment speculations from Microsoft, Google, Amazon, and Facebook are the made ML foundation less expensive and productive. Cloud suppliers are presently configuring equipment as per the requirement that is exceptionally streamlined for running ML remaining burdens in the cloud [11]. Google's TPU and Microsoft's FPGA contributions are instances of custom equipment quickening agents solely implied for ML occupations. At the point when joined with the ongoing processing patterns, for example, Kubernetes, ML framework turns into an appealing decision for endeavors.

Amazon EC2 deep learning AMI sponsored by NVIDIA GPU, Google Cloud TPU, Microsoft Azure Deep Learning VM dependent on NVIDIA GPU, and IBM GPU-based Bare Metal Servers are instances of specialty IaaS for ML.

In Table 4, the past studies were summarized and classified the driving variables (factors) in technical, operational, and environmental contexts, technology adoption.

6 ML for Attack Detection and Prevention

Completely decentralized cloud computing and open structure of the Internet and cloud computing. This includes multi-tenancies, multi-domains, and automated multi-user more fragile administrative structures, and sensitive to danger to safety. Missing full oversight of cloud service technology is of great concern to customers. It means the task of detection of intrusion programs and prevention of intrusion programs in protecting cloud computing application information assets [18].

Table 5 [20] represents the paper that suggest deep learning models and big data analytics for collecting and analyzing information.

Intrusion prevention systems (IPS) will respond to any anomalies found. IPS shuts down access of the server infected or the device program (it/IP). The address the detected traffic originates from is blocked. Unlike IDS and IPS, intrusion can be a host or network-based Prevention programs according to whether or not they are protects a host or operate at the network level. These methods of antiviruses are used for the prevention [19].

Today's IDPS required improved aspect architecture of speed and quantity of data required Precise. Cloud services come with elastic tools network bandwidth, data, power transmitter, virtualization, high-quality delivery, and accordingly, they form the basis for the analysis of big data and the creation of through cloud services, security services.

Table 4 Study using the structure for the TOE in IS disciplines [12]

Refs no	Study	Technological context	Organizational context	Environmental context
[13]	Implementation of cloud computing	Intricacy compatibility of relative advantage	Top management assistance firm scale preparation for technology	Strong competition, the pressure of trading partners
[14]	RFID adoption in Chinese companies	Gain usability expense use of IS firm size	IS unit practitioner's Top management service	Consumer competitor RFID supplier government
[15]	In the Malaysian tourism market, e-commerce use and business performance	Competence of technology	Firm size business scale Web investment technology Management beliefs	Regulatory support strength of the pressure
[16]	Innovation as-simulation, a view of technological diffusion	Integration of Technology Readiness	Size global barriers to management	Regulatory environment: rivalry level
[17]	Effective B2B e-commerce (adoption and diffusion of e-commerce)	Service discontinuity Compatibility incorporation Benefits of emerging technologies EDI precision of assets	IT policymakers readiness-knowledge administrative framework	Competitive environment market partner partnership dynamics of industry external capital support for industry institutional factors

7 Conclusion

Machine learning and artificial intelligence can be expensive—skills and resources can cost a lot. For that reason, MLaaS goes to be a massively influential development inside the cloud. The ranges of services are offered from AWS, Azure, and GCP. It is really the ease and convenience that is most remarkable. To enhance the business processes and operations, client communications, and in general business policy, these services help due to their effortless configuration and execution of ML algorithms. So, this review work can help the readers to check and decide which ML service is available in which cloud model.

Table 5 Summary of paper which analyze the attacks using deep learning and big data analytics

Ref No.	Dataset	Algorithm and technology	Research field
[21]	User dataset	MOA, NeuralNetwork, Filing Storm, Spark Storm, Hadoop	New techniques for NIDS in cloud
[22]	User dataset	Hadoop, Ganglia and Nagios1	Architecture for anomaly detection
[23]	KDD-99	Restricted Boltzmann Machine (RBM), Logistic Regression	Real-time novel attacks detection
[24]	–	Predictive performance anomaly prevention	Comprehensive analytics in business, Service-Level Agreement (SLA)
[25]	– -	Twitter: R studio, Hadoop	Limits of relational databases
[26]	User dataset	HAMR, next-generation in-memory MapReduce engine	Detection of anomalies on a distributed architecture
[27]	User dataset	Hadoop, decision tree	Detection of anomalies on the Big Data platform
[28]	User dataset	Hadoop, eagle, density estimation, PCA	User behavior analysis
[29]	User dataset	Net sniffer NetL, process log, HDFS, k-means	Detection of anomalies over events from various logs

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An Experimental Analysis on Selfish Node Detection Techniques for MANET Based on MSD and MBD-SNDT

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Abstract Mobile ad hoc network (MANET) is a network that permits mobile servers and customers to convey without fixed infrastructure. MANET is a promptly developing region of investigation as it employs a group of uses. To encourage effective information access and update data sets are conveyed on MANET. Since information openness is influenced by the portability and power imperatives of the servers and customers, the information in MANET is reproduced. As in ad hoc network, since portable host moves unreservedly network panel happens habitually in this way information accessibility is decreased bringing about execution debasement. The majority of the replication strategies expect that each node advances each packet provided to it and combine completely as far as sharing the memory space. A portion of the nodes may go about as selfish nodes which may selfishly conclude and participate incompletely with all the different nodes. In this manner, selfish conduct of nodes could lessen the general information openness in the network. At first, a design model of a MANET is built and the correspondence between the versatile is started. The packet drop can occur in MANET because of the selfish node or network clog. In this paper, MSD-SNDT and MBD-SNDT method is proposed to recognize the selfish nodes effectively in MANET. The reproduction study shows that the proposed MSD-SNDT and MBD-SNDT strategy improves the selfish node detection ratio, packet delivery proportion (PDP), and normal packet drop proportion.

Keywords Selfish nodes · Selfish node detection technique · Throughput · Packet delivery rate · Modified Skellam distribution (MSD) · Modified Bates distribution (MBD) · Constant bit rate (CBR)

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1 Introduction

In a mobile ad hoc network (MANET), the constancy of the portable nodes toward pack sending is made plans to be a basic substance for ensuring dominating bundle sending rate. This unfaltering nature of mobile nodes is influenced by their prideful lead toward data sending development to remain dynamic in the framework. A gigantic number of fundamental applications, exceptionally selected express the control over the frameworks and achieved fewer troubles and stresses concerning assurance and security of the data toward the coordinating information. The framework with intrinsic exceptional geography is crucial clarification of security-related concerns. Establishing fewer frameworks organizes the absence of united control impacts the establishment and restoration of security-related information. The center points present in the framework bit by bit extending the coordinating overhead, since the groups are separated by the flexible centers while sending them.

Skellam scattering is considered as the most serious scattering that models the boundaries used for intolerant center point. It is a recognizable proof for the discrete sporadic variable for achieving common revelation. Moreover, it is recognized for assessing the particular estimation about the negative impact constrained by the selfish nodes under coordinating. Along these lines, a biased node revelation and disengagement approach that depends upon Skellam scattering is essential for the exact improvement in the framework to extent the package during transport and throughput.

This proposed MSD-SNDT and MBD-SNDT utilize the key preferences of Skellam and Bates distribution for ensuring potential selfish acknowledgment measure.

2 Literature Review

From the outset, a selfish node id scheme using essential level and extent of node correspondence was propounded for perceiving the malignant intolerant development of the portable nodes in the framework [1]. The imperative level and extent of node correspondence are based on the narcissistic NODES area approach. It was assessed to improve the movement of recognizable proof with the ultimate objective that the selfish motivation behind the mobile nodes is prevented as far as possible.

Network monitor canine [2] approach and a deliberate model that evaluates season of distinguishing the extremist nodes, they have extended the work incase pretentious node assembles a mean-max gauge for achievable calculation. The display of the on-demand multi-way controls [3] in portable exceptionally designated frameworks, and the proposed structure is conceivable and versatile to find the most concise method to send the data groups in a secured strategy with malicious node distinguishing proof. The pleasing distinguishing proof attack is watching [4] all the new segment nodes in sort out, accommodating nodes are passed on between the neighbor nodes two

successive nodes in the course, and if attacker nodes are perceived, by then reversing to the all-nodes through mix places.

An enthusiastic pleasing trust [5] building up a plan for reaching on the groups securely and constantly in multi-ricochet courses, in the arrangement choosing the trust for each center. In the indirect node trust, it is happened by MAC layer and reused node is by recommendation of the neighboring nodes to perceive and send packages; this is incredible on the counterfeit information of noxious nodes. Moreover, Distributed Detection Of Selfish Nodes Utilizing Dynamic Associativity (DDSN-DA) was proposed for diminishing the degree of false revelation in the biased centers of the framework [7]. The degree of trust and acknowledgment supported by this DDSN-DA plot was turned being expanded during the route toward arranging mobile nodes into extremist and reliable. Finally, An exponential reliability factor-based selfish node detection technique (ERF-SNDT) was proposed for likely id and controls the selfish nodes in the framework [8]. This ERF-SNDT approach was set to diminish the group drop, essentialness usages, bundle inaction, and hard and fast overhead to the great level that appeared differently with the DDSN-DA and SRA-FSND approaches added to potential biased center point acknowledgment measure. The movement of a false certain movement of this proposed ERF-SNDT approach was set out to be generally extraordinary with diminished overhead in figuring and correspondence of the framework.

Finally, the semi-Markov process mechanism utilizing selfish node detection technique (SMPM-SNDT) was proposed for productive gauging in malignant development subject to the current status of bundle sending rate [6]. The SMPM-SNDT was assessed for maintaining unparalleled execution to the extent of improved throughput, diminished total overhead, and control overhead [9].

3 Related Work

The authors [10] overviewed the problems and pointers to mild execution corruption and network packing in MANET's. A large portion of the tries to alleviate selfish behavior might be ordered into the incentive-based mechanism, and reputation-primarily based on mechanism and various additives. The authors [11] format self-designing because of the capability to adjust automated associate and powerfully to herbal adjustments. The difficulty of animating collaboration in self-arranging transportable unintentional companies for non-military network packages is self-tended to [12]. This methodology is utilized to regulate secure system module alluded to as a safety module in every mobile node. A credit-based complete convention is applied to animate the participation among flexible nodes in packet sending. This is a good way to upgrade the employer execution through relieving the miserly conduct [13]. The authors [14] organized a decent, sensible and at ease collaboration in motivating the pressure of the machine for multi-jump remote businesses. To parsimony

assaults and invigorate hub collaboration is enhanced to upgrade the business enterprise execution and reasonableness. It is performed by means of charging each of the appropriate and target nodes of the correspondence.

Selfish node detection technique exploitation organization head became predicted call and dependableness of flexible mobile nodes inside the network [15]. This cluster head-based call turns the difficulty into the firm level of directing overhead and power utilizations. This contrasted the canine-based totally agreeable to the contact technique. The distinguishing evidence attack is attentive [4], and the all of the new segment middle point in arrange, precious middle point is arranged in the rectangular degree which is passed among the neighbor hubs and resulting hubs in course. Within this event, the attacker facilities are apprehend, and round then add weights to the all middle factors via combo locations. SHRCDM changed into preparations for encouraging crucial participation among the mobile nodes [8]. This SHRCDM engine aided better segregation of mobile nodes to agreeable and stingy nodes for main execution development inside the network.

In this nearby aspect-based totally miserly node identity technique includes a number of the chose nodes utilized in rectangular measure for investigating the features of mobile nodes to look the extent of deliberate behavior ascribed by them toward the network. A gradable area conscious Hash Table-Based totally Selfish Node Detection Mechanism (HLAHT-SNDM) turned into contributed through ceaseless notion [16]. Finally, the Hash Table-Based totally Selfish Node Detection Technique (HLAHT-SNDT) changed into made preparations for effective predicting in malevolent action upheld the contemporary remaining of packet sending charge [9]. The SMPM-SNDT changed into measurable for actualizing universal execution as a long way as elevated outturn, reduced the overhead and executives overhead. The identification pace of this system head-based totally calls technique to become conjointly resolved to the maximum under any assortment of selfish nodes inside the network.

4 Modified Skellam Distribution -Based Selfish Node Detection Technique (MSD-SNDT)

The MSD-SNDT is created in this examination for identifying Selfish Nodes.

MSD-SNDT follows three stages:

(A) Computing mean packet deviation
(B) Calculation of variance and standard deviation for computing MSD
(C) Detection of such nodes.

(A) ***Computing mean packet deviation***

The deviation in the number of packets received to the number of the packet forwarded by each mobile node to their neighbors as recommended through neighbor-based interaction in each session 'c' is

$$\text{DEVIATION}_{\text{PACKET}(c)} = \text{PR}_{(c)} - \text{PF}_{(c)} \tag{1}$$

$\text{PF}_{(1)}$, $\text{PF}_{(2)}$, …., $\text{PF}_{(s)}$ and $\text{PR}_{(1)}$, $\text{PR}_{(2)}$, …, $\text{PR}_{(s)}$ define packet forwarded and packet received, respectively, by each of its neighbors in 's' sessions.

Packet forwarding capability identified by their neighbor is

$$P_{\text{PFC}(C)} - \frac{\text{PF}_{(C)}}{\text{PR}_{(C)}} \tag{2}$$

The mean packet deviation is given by

$$\text{MDEV}_{\text{PACKET}(C)} = \sum_{c=1}^{s} \frac{\text{DEVIATION}_{\text{PACKET}(C)}}{S} \tag{3}$$

(B) ***Calculation of variance and standard deviation for computing MSD***

$$\text{STD}_{\text{DETECT}} = P_{\text{PFC}(s)} * (1 - P_{\text{PFC}(s)}) \tag{4}$$

$$\text{VARIANCE}_{\text{DETECT}} = \sum_{c=1}^{s} (\text{MDEV}_{\text{PACKET}(c)} - \text{DEVIATION}_{\text{PACKET}(c)})2 \tag{5}$$

(C) ***Detection of such nodes***

Then MSD computed based on (4) and (5) is

$$\text{MSD}_{\text{DETECT}} = \frac{s}{s-1}\left(1 - \frac{\sum_{c=1}^{s} \text{STD}_{\text{DETECT}}}{\text{VARIANCE}_{\text{DETECT}}}\right) \tag{6}$$

5 Detection and Isolation of Selfish Nodes Misbehavior Utilizing Computed MSD

The mobile nodes found with MSD esteem under 0.35 are distinguished as selfish nodes and isolated.

5.1 The Proposed Algorithm—MSD-SDNT

The accompanying algorithm represents the means engaged with distinguishing selfish nodes utilizing MSD

5.1.1 The Steps for Proposed Algorithm MSD-SNDT

1. Let N be the number of Nodes.
2. Let GN be Group Node (GN), in which SN is Source Node and DN is Destination Node.
3. Set of nodes in the routing path can be set up by sending 'RREQ' message by the NS to all different nodes in the network
4. Mobile node reacts to the source node by 'RREP'.
5. Let this algorithm STEP (6–14) be executed for a node say, k, which has a place with the rundown GN that utilizes 't' number of sessions for transmission.
6. For each node 'k' of GN in the routing path.
7. Determine deviation N utilizing condition 1.
8. Compute packet forwarding capacity utilizing Eq. 2.
9. Calculate mean deviation utilizing Eq. 3.
10. Using Eqs. 4 and 5 decide STD and variance separately
11. Compute MSD utilizing Eq. 6.
12. if (MSD(k) < 0.35) at that point
13. node k is selfish node misbehavior bargained
14. Call Selfish_Node_-Mitigation (k)
15. Else
16. node k is reliable.
17. End if
18. End for
19. End for

6 Experimental Results and Discussions of MSD-SNDT

The predominant function of the proposed MSD - SNDT plot is researched the simulation experiments utilizing ns-2.31. The simulation time for the execution is 100 s with the CBR traffic pattern of data. The quantity of mobile nodes in the network is 100 disseminated randomly with the size bytes of 512 packets.

Figure 1 models the throughput of the proposed MBD-SNDT plot examined under a substitute number of mobile nodes in the framework. The proposed MBD-SNDT is found to increase the throughput to a most outrageous level of 11, 13, and 18% better than the ERF-SNDT, DDSN-DA, and SRA-FSND approaches.

Figure 2 portrays the control overhead of the MBD-SNDT plot researched under a substitute number of portable nodes in the framework. The proposed MBD-SNDT is shown to restrict the control overhead to a most extraordinary level of 10, 14, and 18% better than taking a gander at ERF-SNDT, DDSN-DA and SRA-FSND

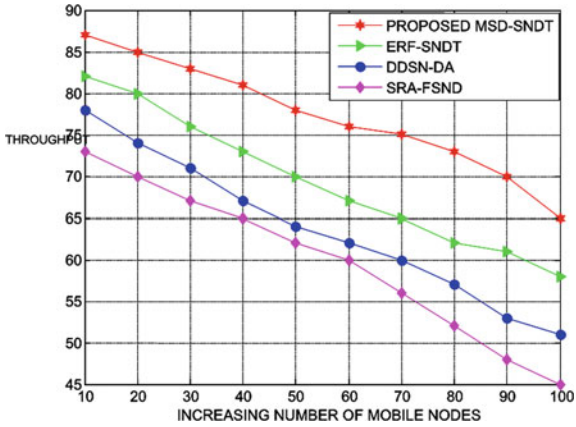

Fig. 1 Performance of MSD-SNDT-throughput-different mobile nodes

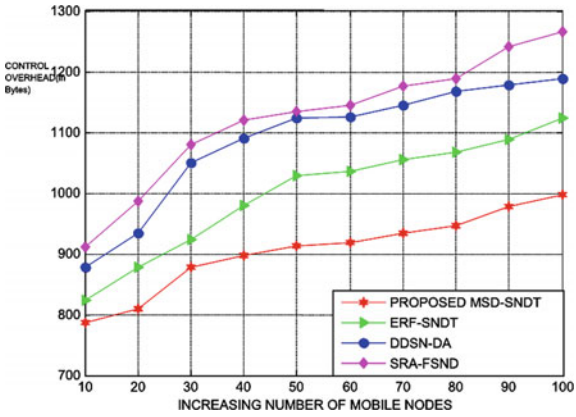

Fig. 2 Performance of MSD-SNDT-control overhead-mobile nodes

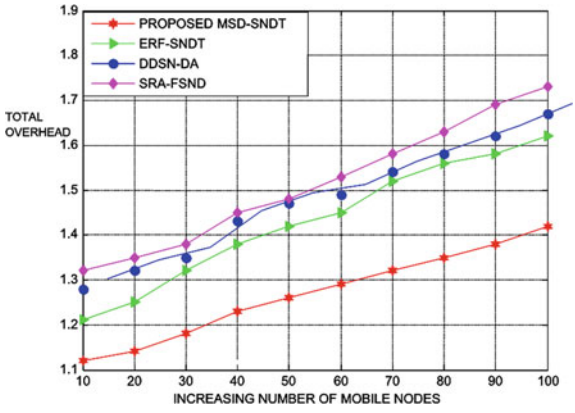

Fig. 3 Performance of MSD-SNDT-total overhead-different nodes

Figure 3 highlights the total overhead of the proposed MBD-SNDT plot researched under a substitute number of portable nodes in the framework. The proposed MBD-SNDT is set out to diminish total overhead to the biggest level of 9, 12, and 18% better than the idea about ERF-SNDT, DDSN-DA, and SRA-FSND approaches.

Figure 4 presents the plots in the group lethargy of the proposed MBD-SNDT plan investigated under a substitute number of mobile nodes in the framework. The proposed MBD-SNDT is set out to check the pack inertness to a great level of 12, 18%, and 21 better than the dissected ERF-SNDT, DDSN-DA, and SRA-FSND.

Figure 5 highlights the throughput of the proposed MBD-SNDT plan explored under a substitute number of pompous nodes in the framework. The proposed MBD-SNDT is inferred to grow the throughput to a most extraordinary level of 11, 15, and 19% better than they took a gander at ERF-SNDT, DDSN-DA, and SRA-FSND approaches.

Additionally, Fig. 6 models control overhead of the proposed MBD-SNDT plot examined under a substitute number of prideful NODES in the framework. The

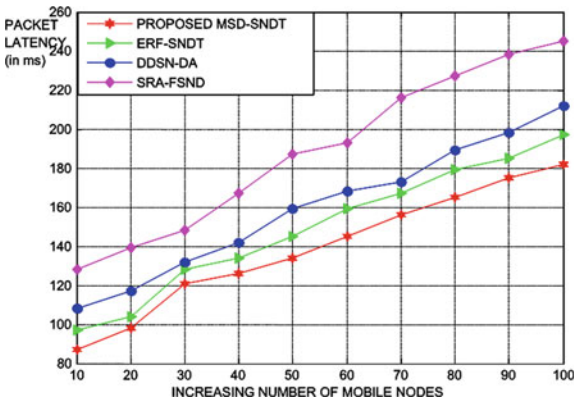

Fig. 4 Performance of MSD-SNDT-packet latency-different mobile nodes

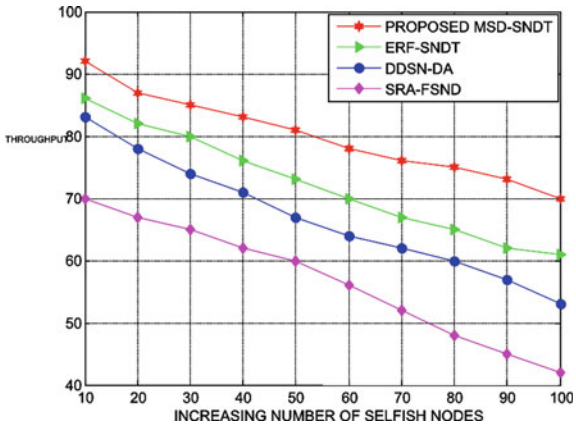

Fig. 5 Performance of MSD-SNDT-throughput-different selfish nodes

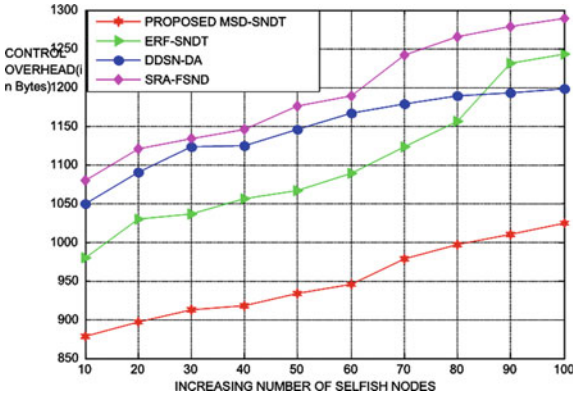

Fig. 6 Performance of MSD-SNDT-control overhead-selfish nodes

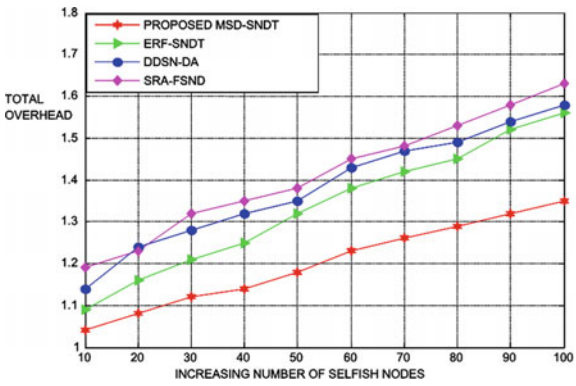

Fig. 7 Performance of MSD-SNDT-total overhead-different selfish nodes

proposed MBD-SNDT is shown to restrict the control overhead to the biggest level of 11, 14, and 16% better than the dissected ERF-SNDT, DDSN-DA and SRA-FSND approaches.

Figure 7 depicts the proposed MBD-SNDT is set out to decrease full-scale overhead to a most outrageous level of 9%, 12%, and 16% better than they took a gander at ERF-SNDT, DDSN-DA, and SRA-FSND approaches.

Figure 8 uncovers the proposed MBD-SNDT is set out to restrict the packet inactivity to a critical level of 12, 15 and 18% better than the examined ERF-SNDT, DDSN-DA, and SRA-FSND approaches.

7 Modified Bates Distribution—Based Selfish Node Detection Technique (MBD-SNDT)

The projected MBD-SNDT, the detection, and separation of selfish nodes include

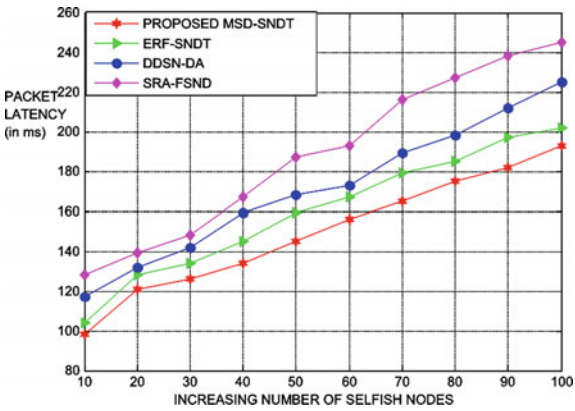

Fig. 8 Performance of MSD-SNDT-packet latency-different selfish nodes

1. Intention of mean packet deviation,
2. Assessment of variance and standard deviation for computing MBD and
3. Detection and separation of selfish node

(a) **Mean Packet Drop**

If the number of packets forwarded and obtained by using every node '*i*' is PF(1), PF(2), …, PF(s) and PR(1), PR(2), …, PR(s), respectively, as monitored by every one of its peers in '*s*' sessions. The range of packets dropped via every mobile node as monitored via their neighbors in every consultation '*k*' is

$$\mathrm{DROP}_{\mathrm{PACKET}(k)} = \mathrm{PR}_{(k)} - \mathrm{PF}_{(k)} \tag{7}$$

The mean packet drop is

$$\mathrm{MDROP}_{\mathrm{PACKET}(k)} = \sum_{k=1}^{s} \frac{\mathrm{DROP}_{\mathrm{PACKET}(k)}}{S} \tag{8}$$

(b) **Total variance**

The total variance is

$$T - \mathrm{VAR}_{\mathrm{DETECT}} = \sum_{c=1}^{s} \frac{(\mathrm{PR}(C) - \mathrm{MDROP}_{\mathrm{PACKET}(C)})}{S} \tag{9}$$

The MBD computed based on (9) and (10) is

$$(\mathrm{BDITF})_{\mathrm{DETECT}} = \frac{S}{S-1}\left(1 - \frac{\sum_{k=1}^{s} \mathrm{DROP}_{\mathrm{PACKET}(k)} * \mathrm{PR}_{(k)}}{T - \mathrm{VAR}_{\mathrm{DETECT}}}\right) \tag{10}$$

The mobile nodes are recognized by way of MBD less than 0.35 (received from simulation) are detected as selfish node misbehavior.

7.1 MBD-SNDT Algorithm

The subsequent algorithm illustrates the stairs involved in detecting selfish node misbehavior the use of MBD and keeping apart them from the multicasting activity.

1.	Let N be a number of nodes.
2.	GN – Group of nodes of the routing path, SN (the source node) and DN (the destination node), respectively.
3.	The cell node which is prepared for statistics transmission acknowledges SN through 'RREP' message.
4.	Allow this set of rules step (5–12) to be accomplished for a node 'n' wide variety of sessions for transmission.
5.	For every node 'u' of GN in the routing course
6.	Estimate $DROP_{PACKET(k)} = PR_{(k)} - PF_{(k)}$
7.	Compute $MDROP_{PACKET(k)} = \sum_{k=1}^{S} \frac{DROP_{PACKET(k)}}{S}$
8.	Calculate $T - VAR_{DETECT} = \sum_{c=1}^{S} \frac{(PR_{(C)} - MDROP_{PACKET(C)})}{S}$
9.	Estimate $(BDITF)_{DETECT} = \frac{S}{S-1}\left(1 - \frac{\sum_{k=1}^{S} DROP_{PACKET(k)} * PR_{(k)}}{T-VAR_{DETECT}}\right)$
10.	If (MBD(u) < 0.35) then
11.	Node u is selfish node misbehavior compromised
12.	Name selfish_node_attack-mitigation (u)
13.	Else
14.	Node u is reliable
15.	End if
16.	End for
17.	End

8 Experimental Results and Discussions of MBD-SNDT

The strength of the proposed MBD-SNDT is explored dependent on duplicate tests led utilizing ns-2.33. The capability of the proposed MBD-SNDT approach is contrasted and the modern SMPM-SNDT, HLAHT-SDNM, and SHRCDM approaches utilizing the packet conveyance share, throughput, entire overhead and also utilizes electricity underneath the expanding variety of flexible hubs and narrow-minded hubs. The facts visitors layout utilized for utilization are constant bit rate (CBR) information traffic. The simulation time applied for the proposed MBD-SNDT is 300 s with an offseason of 20 s.

Figures 9 and 10 model the capability of the proposed MBD-SNDT method utilizing package conveyance proportion and throughput researched under the expanding pace of mobile nodes. The packet conveys proportion of the proposed MBD-SNDT technique which is affirmed to be the main via 6%, 10%, 13% contrasted, and the cutting-edge SMPM-SNDT, HLAHT-SDNM and SHRCDM processes. Consequently, the throughput of the proposed MBD-SNDT approach

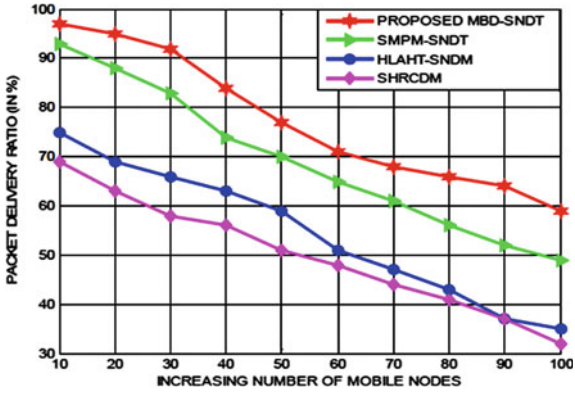

Fig. 9 Performance of MBD-SNDT utilizing package delivery ratio under increasing mobile nodes

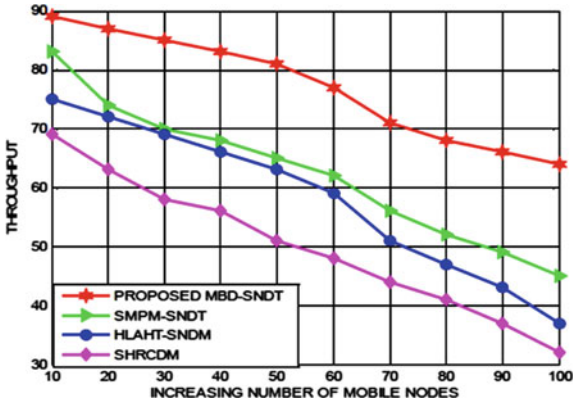

Fig. 10 Performance of MBD-SNDT making use of throughput underneath increasing mobile nodes

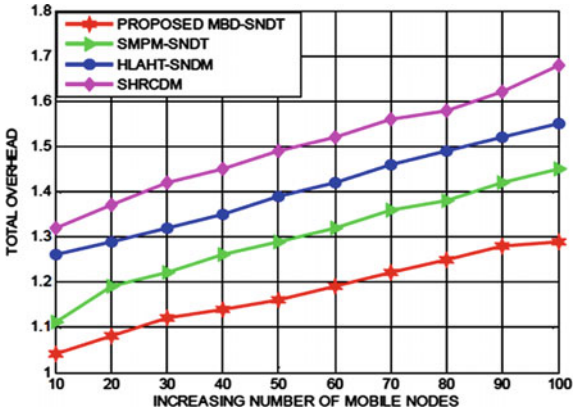

Fig. 11 Performance of MBD-SNDT making use of packet delivery ratio below expanding mobile nodes

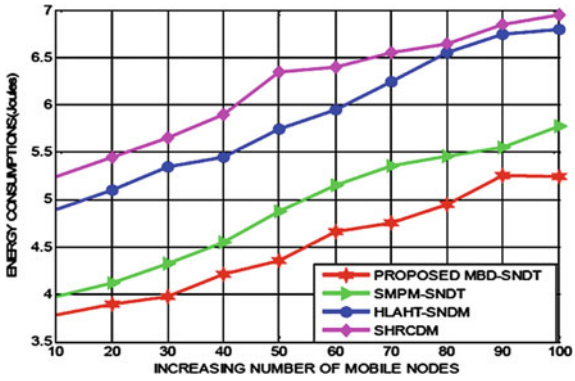

Fig. 12 Overall performance of MBD-SNDT utilizing energy utilization under increasing mobile nodes

is resolved to be surprising via 9, 11, 14% contrasted, and the cutting-edge SMPM-SNDT, HLAHT-SDNM, and SHRCDM processes.

Figures 11 and 12 exhibit the PROPOSED MBD-SNDT method using all-out overhead and strength utilizations examined under the increasing tempo of mobile nodes. The entire overhead of the proposed is basically restrained through 10%, 13%, and 15% extraordinary with the contemporary SMPM-SNDT, HLAHT-SDNM, and SHRCDM approaches. Moreover, the power utilization of the proposed technique is resolved to be enormously decreased via 8, 10, and 13% contrasted, and the cutting-edge SMPM-SNDT, HLAHT-SDNM, and SHRCDM procedures.

Figures 13 and 14 measure the capability of the proposed SDITF-SNDT method using packet conveyance share and throughput examined below the expanding tempo of selfish nodes. The packet deal conveyance share of the proposed technique underneath expanding selfish nodes is affirmed to improve 9%, 13%, and 16% impressive to the benchmarked SMPM-SNDT, HLAHT-SDNM, and SHRCDM procedures. Basically, the throughput of the proposed approach under increasing selfish nodes

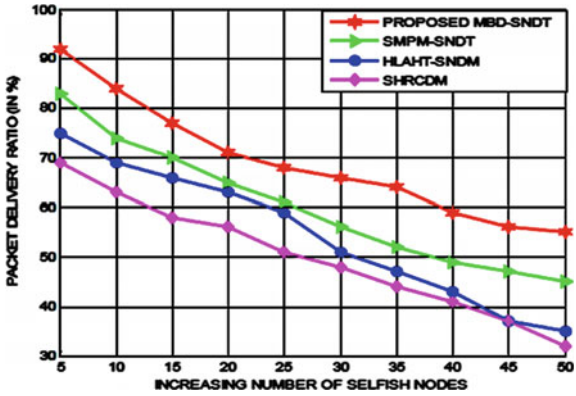

Fig. 13 Overall performance of MBD-SNDT utilizing packet delivery ratio share under increasing selfish nodes

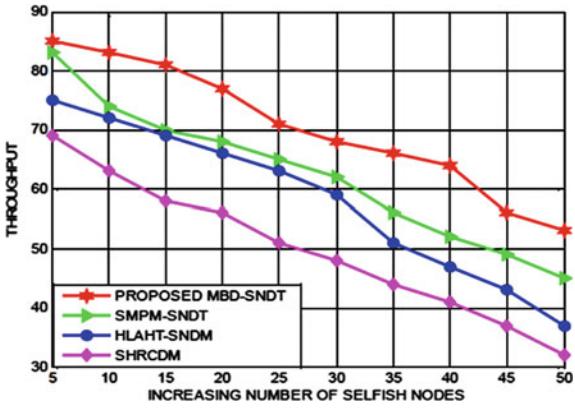

Fig. 14 Overall performance of MBD-SNDT utilizing energy utilization under expanding mobile nodes

is resolved to be extremely good via 10, 12, and 15% contrasted and the current SMPM-SNDT, HLAHT-SDNM, and SHRCDM tactics.

Figures 15 and 16 show capabilities the criticalness of the proposed MBD-SNDT approach utilizing absolute overhead and strength utilizations researched underneath increasing tempo of slender minded hubs. Absolutely the overhead of the proposed technique is resolved to be essentially limited using 10%, 13%, and 16% immediate to the modern-day SMPM-SNDT, HLAHT-SDNM, and SHRCDM tactics. Additionally, the strength utilizations of the proposed approach are resolved to be magnificently diminished by 7, 9, and 12% contrasted and the current SMPM-SNDT, HLAHT-SDNM, and SHRCDM approaches.

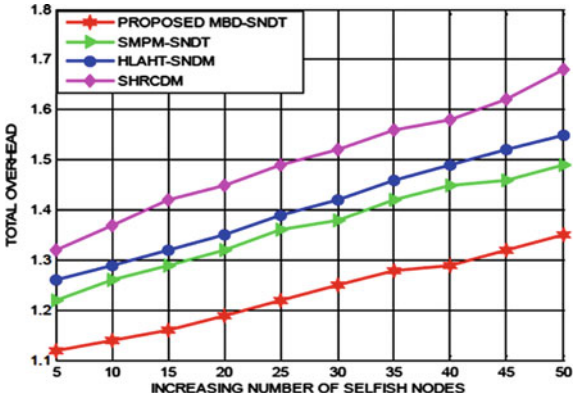

Fig. 15 Performance of MBD-SNDT utilizing packet delivery ratio under expanding mobile nodes

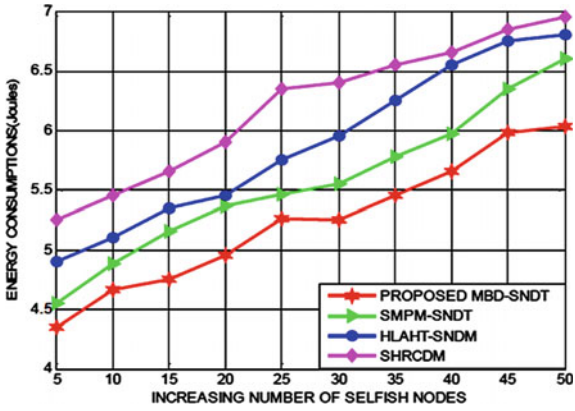

Fig. 16 Performance of MBD-SNDT utilizing energy utilization underneath expanding mobile nodes

9 Conclusion

The MSD-SNDT was presented as a strong undertaking for basic acknowledgment of extremist direct by researching different degrees of incredible components that contribute toward convincing egotism area. This Proposed APPROACH was also assessed to be unmatched in the productive ID of SELFISH NODES through the multi-dimensional assessment. Each PORTABLE NODES and its characteristic toward the sending ability of other cooperating MOBILE NODES are monitored. The reenactment tests and delayed consequences of the PROPOSED MSD-SNDT approach were set out to be astounding in diminishing the control overhead, outright overhead, and PACKET torpidity on ordinary by 19, 15, and 17% overwhelming than the biased hub area plans used for analysis. The area movement of the PROPOSED MSD-SNDT approach was, moreover, asserted to be redesigned by 12% which was excellent to the saw biased NODE acknowledgment plans.

This proposed MBD-SNDT became the use of variance and mean packet forwarding rate for estimating the degree of effect. Through the selfish characteristics

of the mobile node in the direction of the network such that correct detection and isolation of selfish nodes can be imposed for reinforcing the degree of network overall performance. The simulation experiments of the planned MBD-SNDT revealed a median development rate of 19% and 17% in packet shipping and throughput with 20 and 12%. This minimizes the energy consumptions and routing overhead rate as compared to the selfish nodes isolation tactics contributed in the literature. The mean rate in the discovery of the proposed became improved via 18% superior on par with the compared selfish nodes isolation strategies.

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Metaheuristic-Enabled Shortest Path Selection for IoT-Based Wireless Sensor Network

Subramonian Krishna Sarma

Abstract IoT is defined as a pervasive and global network that aids and provides the system for monitoring and controlling the physical world through the processing and analysis of generated data by IoT sensor devices. Wireless sensor networks (WSNs) are comprised of a large number of nodes distributed in a vast region. Routing protocols are responsible for the development and the management of network routes. This paper intends to propose an optimized routing model for selecting the optimal shortest path in IoT-based WSN. More particularly, a dragonfly algorithm with Brownian motion (DABR) model is introduced to select the optimal route by taking into consideration of certain constraints such as (i) delay (ii) distance (iii) packet drop rate (PDR) and (iv) energy. Finally, the performance of the proposed work is compared with the conventional models to demonstrate the superior performance.

Keywords Wireless sensor network · Routing protocols · Dragonfly algorithm · Optimization · Brownian motion · Packet drop rate

1 Introduction

In day-to-day life, the IoT for smart cities has introduced vast technical improvements gradually that brings more comfortable and easiest life style [1]. Sensing and disseminating the information to the base station in a timely manner is the main feature of IoT-enabled applications [2]. The improvements in IoT aid in improving the communities by enhancing the infrastructure, providing more reliable and cost-effective municipal facilities, enhancing public transport, reducing road congestion and ensuring that citizens are healthy and more active in the society [3–5]. In an IoT model, the WSN is an essential feature. WSN is a network made up huge sensor nodes, in which every node has a sensor for detecting physical phenomena [6]. Here, the key challenge is to solve the problem of delivering sensed data with energy-efficient communication between sensor nodes through the shortest path routing [7,

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8]. A routing protocol seems to be a procedure for determining the appropriate path for the data transmission from source to destination. While selecting the route, this process faces several difficulties that depend on the network performance metrics, channel characteristics and types of networks [9]. Usually, the sensor node information in WSN will be sent to the base station linking the sensor network to some other networks, in which the data is collected, analysed and some action being taken if necessary [10]. The sensor nodes does not generate and distribute the information in multihop communication, but often acts as a route to the base station for many other sensor nodes [11]. The optimization algorithms find rapid usage in many engineering problems [12–14]. The major contribution of the research work is to propose the DABR algorithm for selecting the optimal shortest route in IoT for data sharing among nodes. In addition, the constraints like PDR, energy, distance and delay are considered for optimal route selection.

This paper deals with the following sections: Sect. 2 describes the reviews on optimal shortest path routing protocol in WSN. Section 3 deploys the proposed routing strategies in IoT. Section 4 provides the description on varied constraints for shortest route selection. Section 5 presents the optimal shortest path selection methodology via dragonfly algorithm with Brownian motion. Moreover, Sect. 6 portrays the results and their discussions, and in Section 7, conclusion of the research work is presented.

2 Literature Review

2.1 Related Works

In 2018, Manu et al. [15] have projected a suitable way for routing based on IoT applications in WSN. Finally, the experimental outcomes of the proposed method indicated better end-to-end (e2e) delay, network throughput, energy level and packet delivery ratio. In 2020, Ahmad et al. [16] have introduced an energy-efficient geographic (EEG) routing protocol based on the performance and energy alert of routing in IoT permitted WSN. At last, the simulation results of the proposed method have shown better energy consumption and PDR than other methods. In 2019, Thangaramya et al. [17] have suggested a neuro-fuzzy and energy-aware cluster-founded routing algorithm in IoT for WSN. Finally, the experimental outcomes of the proposed method indicated superior performance in delay and network lifetime, packet delivery ratio and energy utilization. In 2019, Yu et al. [18] have determined a sector-based random routing (SRR) protection system in IoT for the privacy of the source site. At last, experimental outcomes of the proposed protocol have revealed its superiority with improved network lifetime and better security. In 2018, Guangjie et al. [19] have developed a source position security protocol for IoT using dynamic routing in WSNs. Finally, the simulation results of the proposed method have shown better performance than other traditional methods. In 2020, Tang et al. [20] have

presented the adaptive dual-mode routing-based mobile data gathering algorithm (ADRMDGA) in RWSNs for IoT. Finally, the experimental outcome shows that the ADRMDGA had better energy equilibrium as well as efficiently expanded the lifetime of the network. In 2018, Tang et al. [21] have presented the mathematical model designed for the innovative generation of promoting QoS routing determination. Finally, the simulation results reveal the presented method had more green efficiency over multihop IoT. In 2020, Deebak and Al-Turjman [22] have suggested the authentication and encryption model. Finally, the result of the presented model demonstrates that it had a superior percentage of monitoring nodes when compared with the conventional routing models. Table 1 depicts the features and challenges of IoT-based wireless sensor network using various techniques.

Table 1 Features and challenges of IoT-based wireless sensor network using various techniques

Author [citation]	Methodology	Features	Challenges
In 2018, Manu et al. [15]	Congestion and interference aware energy-efficient routing technique	Higher delivery rates	More improvement is needed with the optimization algorithm
In 2020, Ahmad et al. [16]	Mean square error algorithm	Reduces the energy holes in the network	Computational delay of the proposed work is higher
In 2019, Thangaramya et al. [17]	Convolution neural network with fuzzy rules	Higher network lifetime	Routing overhead
In 2019, Yu et al. [18]	The sector-based random routing scheme	Efficient protection for source location privacy	Privacy issue in multiple source nodes
In 2018, Guangjie et al. [19]	Source Location Protection Protocol Based On Dynamic Routing (SLPDR)	Improved network lifetime	Need a more effective protocol to protect the source location
In 2020, Tang et al. [20]	Dual-mode routing-based mobile data gathering algorithm	Improved energy equilibrium	The calculation amount is too large
In 2018, Hasan et al. [21]	Traffic system model designed with Markov discrete-time M/M/1 queuing model	High throughput	The lifetime of the network is low
In 2020, Deebak and Al-Turjman [22]	OLSR and AOMDV protocols	Less energy consumption and successful delivery factor	Not suitable for a high dynamic network

3 Proposed Routing Strategies in IoT

3.1 Network Model

The Internet of Things helps to connect the objects such as computing devices, machine and automation systems by using the internet. Figure 1 shows the principle of IoT concept, and it helps to identify and manage the things from anywhere in the world via Internet.

WSN is used to monitor and control various domestic and industrial automations. Emerging IoT devices makes it possible to develop cost-effective wireless sensor nodes with Internet connectivity. The combination of IoT and WSN is moving towards edge technology. In the conventional IoT-based WSN system, the radio frequency (RF) is used to send their information to the Internet. But, in the proposed network model, the WSN is connected to each IoT device, and the data is transmitted using the Internet protocol. The pictorial representation of IoT scenario is shown in Fig. 2.

Let $S_1, S_2, \ldots, S_n$ be the sensor nodes, in which S_n represents the total number of nodes. Here, this scenario includes decentralized data centre (DDC) $P_1, P_2, \ldots, P_m$ and centralized data centre (CDC) $Q_1, Q_2, \ldots, Q_m$, where P_m and Q_m refer to the total number of connected DDCs and CDCs, respectively. Throughout data transmission process, the receiver is decided on the basis of two perspectives: if DDC is the destination, the receiver who received the information from the source is considered to be its neighbourhood node. If the endpoint is CDC, it serves as a receiver; however, the node does not specify the PDR as well as energy values. The presented

Fig. 1 Components of IoT

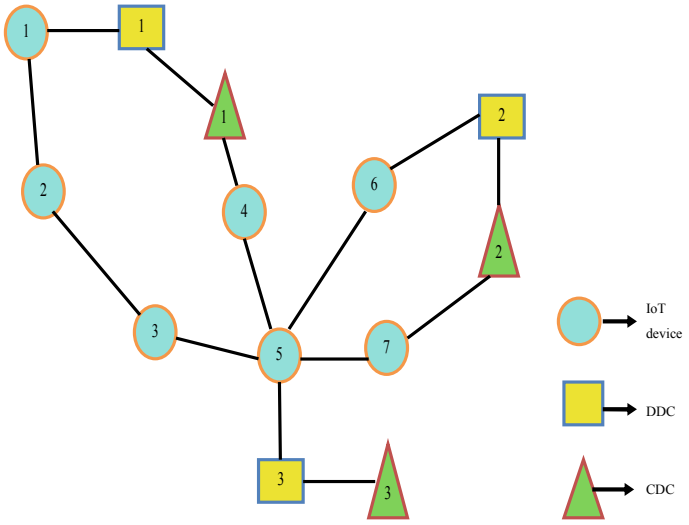

Fig. 2 Pictorial representation of IoT scenario (IoT device is nothing but sensor)

work focuses on optimal shortest route selection among all the nodes with safe transmission of data. The nodes are configured with the specifications including distance (D), delay (Del), energy (E) and PDR for data transmission. Here, a new single-objective function would be depending on these limitations to choose the optimal route.

4 Description on Varied Constraints for Shortest Route Selection

4.1 Distance Model

Consider two sensor nodes such as s(normal node) and r(another node) and their locations be u and v, respectively. The distance D among the consecutive nodes can be represented by Eq. (1), which portrays the Euclidean distance among the nodes.

$$D = \sqrt{(r_u - s_u)^2 + (r_v - s_v)^2} \tag{1}$$

4.2 Delay

The delay can be defined as the ratio of distance divided by the data speed H transmission. The formulation for delay Del can be expressed using Eq. (2) [23].

$$\text{Del} = \frac{D}{H} \tag{2}$$

4.3 Energy Model

Energy utilization remains a big problem when transmitting the data in IoT. In addition, the consumed battery could not be re-energized; thereby, if the battery is low, the transmission could fail. Usually, the network absorbs extra energy by performing a different function such as sensing, aggregating, transmitting and receiving. Here, the design of energy requirement used in data transmission is given in Eq. (3), where E_g represents the electronic energy depending on diverse constraints, E_{fs} signifies the energy essential while using free space, E_{pw} indicates energy of the power amplifier and $E_T(M : f)$ determines the total utilized energy required for transferring M bytes of packets at distance f. The model for electronic energy can be represented using Eq. (4) where c denotes the utilized energy during data aggregation. The total utilized energy required for attaining M bytes of packets at distance f can be determined in Eqs. (5), and (6) indicates the energy required for amplification E_a.

$$E_T(M : f) = \begin{cases} E_g * M + E_{fs} * M * f^2, if \ f < f_0 \\ E_g * M + E_{pw} * M * f^2, if \ f \geq f_0 \end{cases} \tag{3}$$

$$E_g = E_T + E_d \tag{4}$$

$$E_R(M : f) = E_g M \tag{5}$$

$$E_a = E_f f^2 \tag{6}$$

$$f_0 = \sqrt{\frac{E_f}{E_p}} \tag{7}$$

In Eq. (3), the threshold distance f_0 is evaluated as per Eq. (7), in which E_p indicates the energy of power amplifier and E_f determines the needed energy while exploiting the free space model. On the whole, the entire network energy can be represented by Eq. (8), and hence, E_{id} indicates the energy required during the idle

state, E_R determines the total energy received and E_{sen} denotes the cost of energy during the sensing process. However, it is essential to decrease the total energy as exposed in Eq. (8).

$$E_{\text{tot}} = E_T + E_R + E_{\text{id}} + E_{\text{sen}} \tag{8}$$

4.4 PDR

SF attack and black hole attack: Here, the malevolent sensor node transfers only specific data packets in the SF attack and removes some other packets. The malicious node declines all packets earned without transferring them in the event of a black hole attack [24]. If the PDR on a node C_i goes beyond the threshold value $\chi_{pdr_{\text{SF}}}$, here C_i, the thought can be taking those SF attack. In addition, if the PDR value of node C_i goes further than the threshold values $\chi_{pdr_{\text{BH}}}$, respectively, thus it forms a blackhole attack.

Wormhole attack: Throughout this wormhole attack, the malicious node moves all the data packets through the tunnel to another malicious node, rather than transferring to another legal node [25]. If PDR rate of $C_i's$ nearest node is better than the threshold cost $\chi_{pdr_{\text{WH}}}$ of the node C_i, then C_i takes out a wormhole attack.

5 Optimal Shortest Path Selection via Dragonfly Algorithm with Brownian Motion

5.1 Objective Function

The proposed research work on shortest path routing focuses on identifying the optimal path besides data communication, taking into account the significant challenges including such delay, distance, PDR and energy. The objective function of the proposed work seeks to reduce the distance between consecutive nodes and also at reducing the delay in transferring data from one node to the next. Furthermore, the security threats and packet drop rates should be minimized for better system performance. On the other hand, the network energy should be greater indicating that this would only use a limited amount of energy when transferring the data.

Here, the defined single-objective function is expressed in Eq. (12), where the fitness functions such as F_1,F_2 and F_3 are calculated as per Eqs. (9), (10) and (11). However, the values of α, β and δ are fixed as 0.8.

$$F_1 = (\alpha \times D) + (1 - \alpha) \times \text{Del} \tag{9}$$

$$F_2 = (\beta \times F_1) + (1 - \beta) \times \text{PDR} \tag{10}$$

$$F_3 = \delta \times F_2 + (1 - \delta) \times \frac{1}{E} \tag{11}$$

$$F = \text{Min}(F_3) \tag{12}$$

5.2 Solution Encoding

The solution specified in the adopted method is the nodes as demonstrated in Fig. 3. Here,K_N indicates the sum number of nodes ($K_N = 1000$). The maximum and minimum bounds are provided as $X_{\max}$ and $X_{\min}$ that may be either 1's or 0's. Consequently, the nodes can be represented as 1's for selected data transmission, whereas the remaining nodes that fall with 0's are dropped.

5.3 Proposed DABR Algorithm

However, the existing Dragonfly algorithm (DA) model results in effective approximations; this also includes few disadvantages like low internal memory and slow convergence [26]. The Brownian motion seems to be the random motion of suspended liquid molecules arising through collisions of quickly flowing fluid molecules [27]. Therefore, to prevail over the drawbacks of existing DA, some improvements are made in the proposed work by integrating the concept of Brownian motion with the proposed work. The proposed DA process involves the following steps with two significant stages: exploitation and exploration.

The variation of DA using the Brownian motion can be determined in Eqs. (13), (14) and (15).

$$Y_{t+1} = Y_t + h * \text{rand}() \tag{13}$$

$$h = \sqrt{\frac{TP}{N}} \tag{14}$$

$$N = 100 * TP \tag{15}$$

In Eq. (14), the TP indicates the motion time period in seconds of an agent in dragonfly. Moreover, the TP rate can be chosen as 0.01 and N denotes the number of sudden motions in proportion to time for a similar agent. Figure 4 shows the flowchart

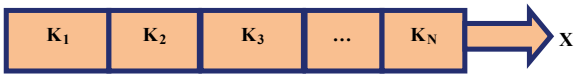

Fig. 3 Solution encoding

Table 2 Simulation parameters

Methods	Parameters	Value
Brownian motion	Motion time	0.01 s
	n	n = 100*motion time

representation of the proposed DABR algorithm. In contrast to conventional methods like particle swarm optimization (PSO), the proposed DABR updates the position by both attraction and diffraction, whereas the standard PSO considers only attraction-based update.

6 Results and Discussion

6.1 Simulation Procedure

The proposed method for optimal shortest path selection using DABR was implemented in MATLAB, and the following results were achieved. The proposed DABR method was evaluated over other traditional methods like PSO [28], grey wolf optimization (GWO) [29] and DA [26], and the their outcomes were observed in terms of **cost function, delay, distance, energy and PDR**. Here, 1000 nodes were considered, and among that 78th node was taken as source node and 900th node was taken as destination node. Here for analysis purpose, the location, PDR and energy were varied for two sets of values that were considered as Data 1 and Data 2 in results section. Moreover, the analysis was carried out by varying the count of iterations from 0, 20, 40, 60, 80 and 100 (Table 2).

6.2 Performance Analysis

The performance of the proposed DABR model for optimal shortest path routing selection in terms of cost function, delay, distance, energy and PDR for Data 1 and Data2 is given in Figs. 5 and 6. Here, the analysis was carried out based on various iterations such as 0, 20, 40, 60, 80 and 100, respectively. From the graphical analysis, the proposed DABR method obtains lower values for cost function, delay, distance, energy and PDR with increased in iteration. In Fig. 5a, the cost function of the proposed DABR method at 100th iteration is 6.77%, 5.08% and 4.23% better than the traditional methods such as PSO, GWO and DA, respectively. Further in Fig. 5b,

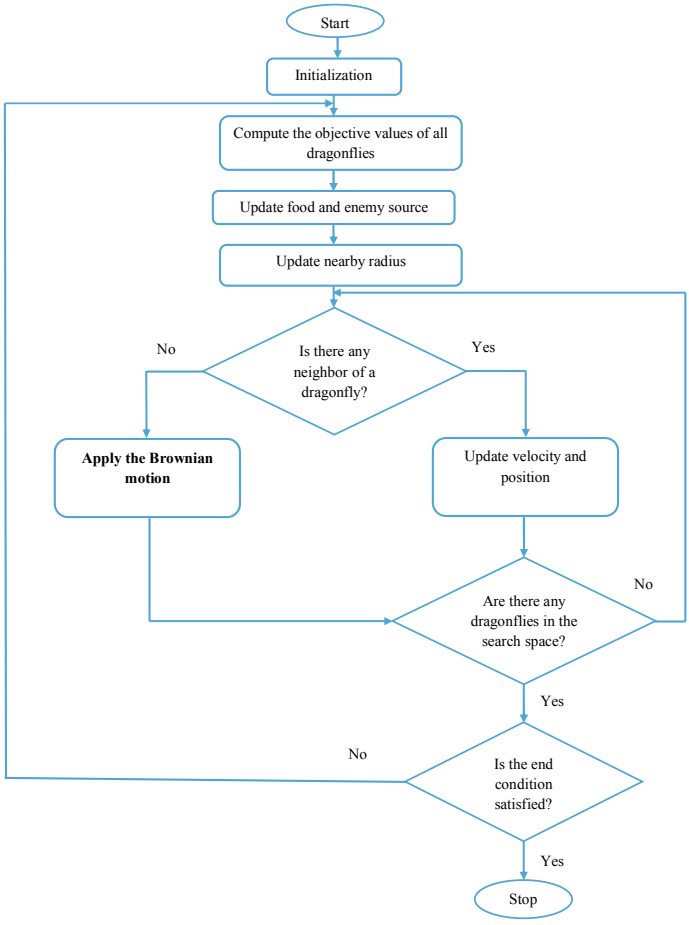

Fig. 4 Flowchart of the DABR algorithm

the delay of the proposed DABR method at 80th iteration is 7.69, 5.64 and 7.69% better than the existing models like PSO, GWO and DA. In Fig. 5c, at 100th iteration, the distance measure of the proposed DABR method obtains the value of 0.35 which is superior to the existing models such as PSO, GWO and DA that holds the values of 0.38, 0.37 and 0.384, respectively. However, in Fig. 5d, the energy measure of the proposed DABR method at 60th iteration is 6.80, 5.23 and 2.35% better than PSO, GWO and DA models. Also, in Fig. 5e, the PDR values of the proposed DABR method at 80th iteration is 0.12 that is better than the existing models like PSO and GWO with the values of 0.128 and 0.133. From the graphical analysis on Data 2, the proposed DABR method at 100th iteration obtains better values for cost function, delay, distance, energy and PDR. In Fig. 6a, the cost function of the proposed DABR method at 100th iteration is 10.85%, 11.38% and 11.90% superior to the traditional

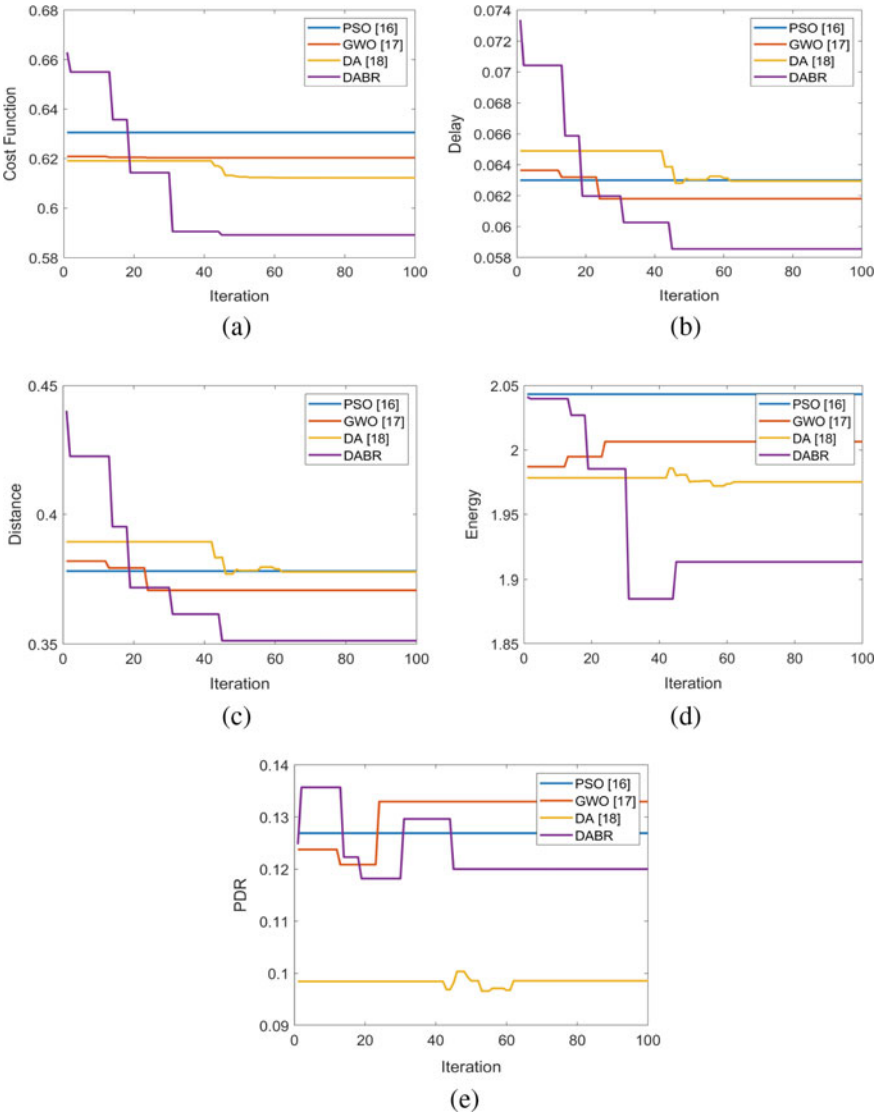

Fig. 5 Performance analysis of the proposed method over the traditional models with respect to constraints such as **a** cost function, **b** delay, **c** distance, **d** energy, **e** PDR for data 1

models such as PSO, GWO and DA, respectively. In Fig. 6b, the delay value of the proposed DABR method obtains 0.0626, whereas the compared existing models like PSO, GWO and DA hold the values of 0.064, 0.0674 and 0.065 at 80th iteration. The distance measure of the proposed DABR method is 0.7%, 5.4% and 2.08% better than the existing models such as PSO, GWO and DA models at 100th iteration as shown in Fig. 6c. Further, in Fig. 6d, the energy utilization of the proposed DABR

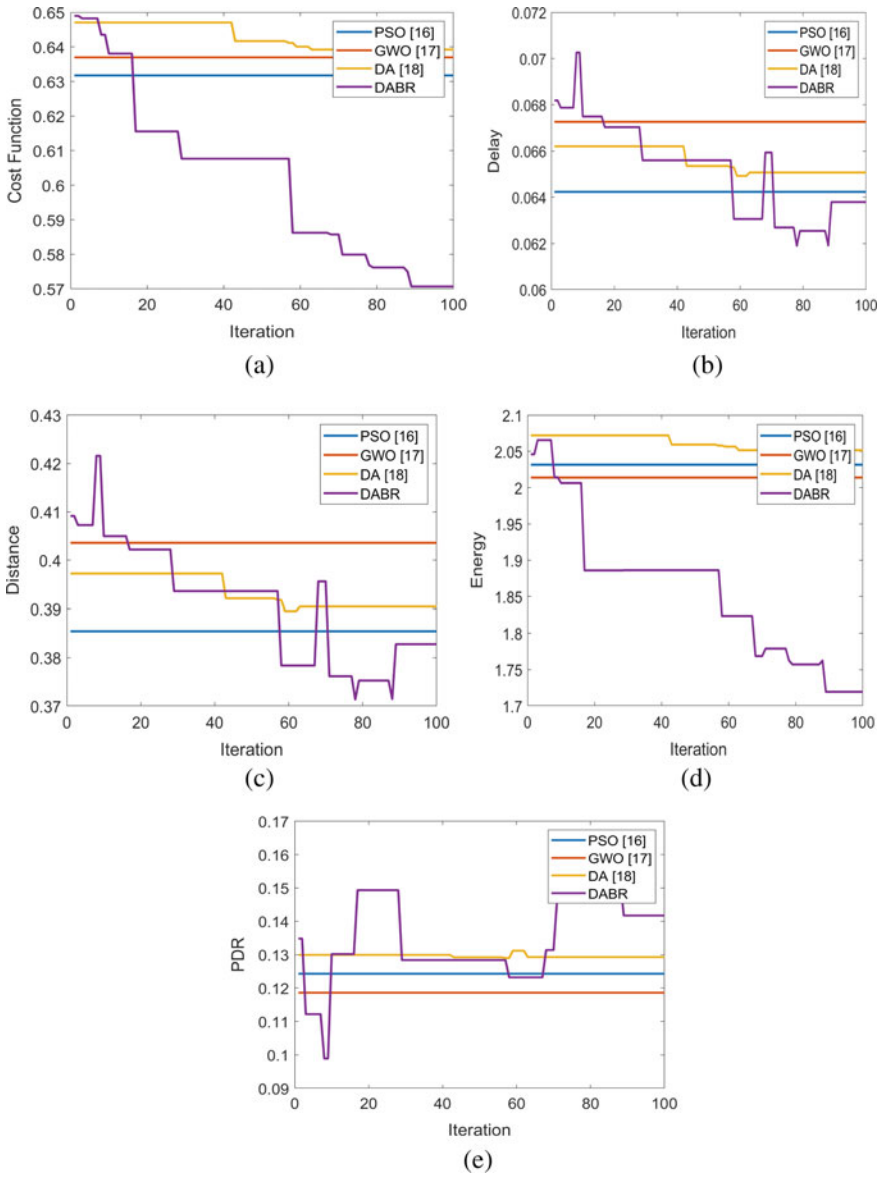

Fig. 6 Performance analysis of the proposed method over the traditional models with respect to constraints such as **a** cost function, **b** delay, **c** distance, **d** energy, **e** PDR for data 2

Table 3 Statistical analysis of the proposed DABR method over other traditional models

Methods	PSO [28]	GWO [29]	DA [26]	DABR
Best	0.63056	0.62033	0.61224	0.5707
Worst	0.63175	0.637	0.63923	0.58918
Mean	0.63115	0.62866	0.62574	0.57994
Median	0.63115	0.62866	0.62574	0.57994
STD	0.00084656	0.011787	0.019085	0.013071

method is 18.31, 17.44 and 19.18% better than PSO, GWO and DA models at 100th iteration. Also, in Fig. 6e, the PDR value of the proposed DABR method at 80th iteration is 0.148, which is lower than the values attained by existing models such as PSO, GWO and DA. Thus, the improvement of the presented DABR model is proved over other traditional models.

6.3 Statistical Analysis

The statistical analysis of the proposed DABR method over other traditional models is given in Table 3. Since metaheuristic algorithms are stochastic in nature, the simulation is carried out for two times and the results are taken. The proposed DABR method obtains better outcomes over the existing methods such as PSO, GWO and DA. For bestcase scenario, the proposed DABR method is 10.48%, 8.69%, and 7.27% better than the existing models like PSO, GWO and DA, correspondingly. Further, the proposed DABR method for worst-case scenarios 7.22%, 8.11% and 8.49% is lower than the traditional models such as PSO, GWO and DA, correspondingly. The proposed DABR method for both mean and median case scenarios is 8.83, 8.40 and 7.89% lesser than the existing models like PSO, GWO and DA. Also, the proposed DABR method for standard deviation scenario is 0.013071 that is lower than the values obtained by PSO(0.00084656) and GWO (0.011787), respectively. Thus, the proposed DABR methods have shown better outcomes when compared to other traditional models.

6.4 Overall Analysis of the Proposed Model

Tables 4 and 5 determine the overall analysis of the proposed DABR method over the traditional models for both Data 1 and Data 2, respectively. Here, the proposed DABR method obtains lower values than the other existing models in terms of total cost, distance, delay, PDR and energy. Table 4 demonstrates the overall performance analysis of the proposed DABR method over the existing models for Data 1. The total cost for the proposed DABR method is 7.02%, 5.28% and 3.91% better than the

Table 4 Overall analysis of the proposed DABR method over other traditional models for data 1

Metrics	PSO [28]	GWO [29]	DA [26]	DABR
Total cost	0.63056	0.62033	0.61224	0.58918
Distance	0.37798	0.3708	0.37768	0.35132
Delay	0.062996	0.0618	0.062947	0.058553
PDR	0.12689	0.13295	0.098566	0.12
Energy	2.0433	2.0065	1.9752	1.9131

Table 5 Overall analysis of the proposed DABR method over other traditional models for data 2

Metrics	PSO [28]	GWO [29]	DA [26]	DABR
Total cost	0.63175	0.637	0.63923	0.5707
Distance	0.3854	0.40358	0.39042	0.38275
Delay	0.064234	0.067264	0.06507	0.063792
PDR	0.12427	0.11858	0.12928	0.14173
Energy	2.0316	2.0139	2.0516	1.7194

traditional methods such as PSO, GWO and DA, respectively. Further, both distance and delay of the proposed DABR method are 7.58, 5.54 and 7.50% better than the existing models like PSO, GWO and DA. For PDR value, the proposed DABR method is 0.12 superior to the existing models such a PSO (0.12689) and GWO (0.13295). Moreover, the energy utilized for the proposed DABR method is 6.80%, 4.88% and 3.246% better than existing models like PSO, GWO and DA, respectively.

Similarly from Table 5, the total cost of the proposed DABR method is 10.69, 11.61 and 12% better than the traditional methods such as PSO, GWO and DA models for Data 2. Moreover, both distance and delay of the proposed DABR method is 0.6, 5.44 and 2% superior to the existing models like PSO, GWO and DA. The PDR value of the proposed DABR method is found to be 0.14173, which is better than the existing models such as PSO, GWO and DA that holds comparatively higher values of 0.12427, 0.11858 and 0.12928, correspondingly. Finally, the energy utilized by the proposed DABR method is 18.15%, 17.12% and 19.32% superior to the existing models like PSO, GWO and DA, respectively. Thus, the proposed DABR method was found to offer better performance including the total cost, distance, delay, PDR and energy.

7 Conclusion

An optimized routing model for selecting the optimal shortest path in IoT-based WSN is presented in this research work using DABR model. The optimal route is obtained by considering the parameters such as PDR, distance, delay and energy.

From the analysis, the cost function of the proposed DABR method is observed as 6.77, 5.08 and 4.23% which is better than the traditional methods such as PSO, GWO and DA. In addition, the PDR value of the proposed DABR method is obtained as 0.14173, which is much better than the existing models such as PSO, GWO and DA that holds comparatively higher values of 0.12427, 0.11858 and 0.12928, correspondingly. Finally, the energy utilized for the proposed DABR method is 18.15%, 17.12% and 19.32% better than existing models like PSO, GWO and DA, respectively. In the IoT-based WSN, if the practical constraints of security and QoS measures such as throughput and packet delivery ratio are considered, the objective model becomes more complicated. Hence, in this work, physical constraints such as PDR, energy distance and delay are considered for optimal route selection. In addition, attack detection is also framed and it can be framed in two ways such as rule-based approach [30] and predictive approach [31]. In future, this work will be extended to solve the above-mentioned issues in IoT for data sharing among nodes.

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Improved Harris Hawks Optimization Algorithm for Workflow Scheduling Challenge in Cloud–Edge Environment

Miodrag Zivkovic, Timea Bezdan, Ivana Strumberger, Nebojsa Bacanin, and K. Venkatachalam

Abstract Edge computing is a relatively novel technology, which is closely related to the concepts of the Internet of things and cloud computing. The main purpose of edge computing is to bring the resources as close as possible to the clients, to the very edge of the cloud. By doing so, it is possible to achieve smaller response times and lower network bandwidth utilization. Workflow scheduling in such an edge–cloud environment is considered to be an NP-hard problem, which has to be solved by a stochastic approach, especially in the scenario of multiple optimization goals. In the research presented in this paper, a modified Harris hawks optimization algorithm is proposed and adjusted to target cloud–edge workflow scheduling problem. Simulations are carried out with two main objectives—cost and makespan. The proposed experiments have used real workflow models and evaluated the proposed algorithm by comparing it to the other approaches available in the recent literature which were tested in the same simulation environment and experimental conditions. Based on the results from conducted experiments, the proposed improved Harris hawks optimization algorithm outperformed other state-of-the-art approaches by reducing cost and makespan performance metrics.

Keywords Cloud–edge computing · Harris Hawks optimization · Swarm intelligence · Workflow scheduling

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1 Introduction

The Internet of things (IoT) is a novel technology that incorporates numerous remote devices connected via the Internet. These remote devices can collect data from their surroundings, process that data and share it with other devices in the network. The IoT includes several technologies, such as computing and communications, which should be carefully integrated in order to provide stable, reliable, and robust service to the users [1]. Some examples of such technologies are cloud computing, wireless sensor networks (WSN), radio frequency identification devices (RFID), and sensor technology.

Moreover, the IoT incorporates artificial intelligence methods and algorithms, that enable the connected devices to collaborate together and learn from previous experiences without human supervision. The IoT's nature is even more complex, as it also requires interaction with humans, and must meet users' demands while being able to dynamically adapt to the environment. Latency in data processing presents a considerable challenge, as in numerous applications data that has been collected and processed by the IoT devices is not valid after a defined time period. Latency is caused by the large amount of data processed by the IoT applications. Therefore, IoT must allow data collection and processing in real time. This challenge can be addressed by implementing edge computing in the cloud environment. The edge computing paradigm relies on the idea to bring the resources close to the end users, which in turn allows efficient handling of the tasks sensitive to the latency. On the other hand, cloud computing is flexible and scalable. Together, edge computing and cloud computing technologies complement each other [2]. The general architecture of the cloud–edge computing model consists of three layers [3]. Smart IoT devices (such as sensors and mobile phones) which are located in the end user layer send a request for services to the edge layer. Edge devices can process time-sensitive tasks and minimize latency. Edge layer is on the other side connected to the cloud system layer which can provide on-demand resources and data storage.

The biggest challenge in edge computing is considered finding an efficient task scheduling algorithm, which should minimize the task schedule duration and completion time. The problem of workflow scheduling in the edge computing is an NP-hard problem by nature, and an exhaustive and thorough search through the entire solution space cannot be performed. Unfortunately, as the amount of computing tasks rises, solution space grows exponentially, making it practically impossible to find the optimal solution in the acceptable time frame [4]. As the result, different stochastic approaches, such as metaheuristics, must be used to solve this problem.

This paper has devised an upgraded Harris hawks optimization (HHO) algorithm, that belongs to the swarm intelligence family, to specifically target the problem of workflow applications scheduling in hybrid cloud–edge environments, with a goal to keep the balance between makespan and cost.

The remainder of this paper is structured in the following way: Sect. 2 presents a survey of the recent metaheuristics and heuristics applications for workflow scheduling in cloud–edge surroundings, Sect. 3 provides insights of the utilized cloud–edge

model. Section 4 provides the details of the original and enhanced HHO approaches. Section 5 exhibits the simulation results and discussion, while Sect. 6 provides a conclusion and final remarks of this research along with the future work.

2 Background and Related Work

The main goal of any task scheduling algorithm is the minimization of performance metrics of the execution environment, such as the duration of all task execution, average response times, costs, and so on. Numerous heuristics that already exist can be used to improve task scheduling efficiency. Some of these approaches include first come first served (FCFS) heuristic, last come first served method (LCFS), join the shortest queue (JSQ) policy, heterogeneous earliest finish time approach (HEFT), etc.

However, since the workflow scheduling challenge is part of the NP-hard category, heuristics, as well as other classical deterministic approaches, cannot achieve satisfying results within a reasonable time frame. Therefore, the utilization of metaheuristics is a necessity. In general, metaheuristics are separated into those that are not inspired and the approaches that are motivated by nature (bio-inspired). Distinguished representatives of nature-inspired algorithms include evolutionary algorithm (EA) and swarm intelligence metaheuristics.

The most famous exemplar of the evolutionary algorithms is a genetic algorithm (GA). The GA has already been utilized with great success in solving numerous real-life NP-hard problems, including cloud computing load balancing and task scheduling [5, 6].

The second large group of nature-inspired algorithms, known as swarm intelligence metaheuristics, is inspired by social behavior expressed by the large groups of otherwise simple individuals such as ants, moths, fireflies, fish, wolves, and beetles. When these individuals are in the swarms, they can manifest very intelligent social behavior and coordinated movement, and this property inspired a huge variety of different swarm intelligence algorithms [7]. Swarm algorithms were successfully validated for many benchmark [8–10] and real-life challenges [11, 12].

Some of the swarm intelligence approaches that were successfully implemented and tested for cloud–edge scheduling problems in original and modified/hybridized versions include: bat algorithm (BA) [13], particle swarm optimization (PSO) [14], [2], cuckoo search (CS) [15], monarch butterfly optimization (MBO) [16], and whale optimization algorithm (WOA) [17].

3 Model Formulation

Edge–cloud computing is a novel approach that offers numerous new possibilities, but since it is a compound domain with a high amount of different types of resources, it still has some serious challenges which must be taken into the consideration. The

first challenge is the process of scheduling business tasks, which should be executed in real time, in the environment with a large amount of data flowing around. To address this challenge, it is necessary to choose a scheduling algorithm which will be efficient in making all business tasks being finished on time, which in turn will result in real-time execution.

The second major challenge for edge–cloud environment is handling business workflows, where workflows should be completed with respect to the QoS requirements (typically deadline and cost). Some tasks can be flexible in the scope of resource allocation, while other tasks require real-time execution on specific resources, and are considered to be not flexible. The selected scheduling algorithm should be capable to efficiently determine the appropriate resource allocation for each task, and at the same time to minimize the cost and task completion deadline.

Research conducted in [2] provided an excellent example which demonstrates the typical business workflow scheduling problem by considering a video surveillance/object tracking (VSOT) application on a use case of mobile and geo-distribution requirements. The proposed research work uses the same workflow scheduling problem formulation as this paper. The problem of workflow scheduling in the cloud–edge system, within the described context of VSOT application, can be formulated as follows—how to assign the resources (which can be of different types and with heterogeneous processing capabilities) to the individual tasks of the observed workflow with a goal to minimize the overall time required for the completion of all tasks and overall cost. Workflow is a sequence of tasks, which is usually observed in the shape of a directed acyclic graph (also known under the acronym DAG) and in turn, the DAG model can be used to directly express a typical workflow application.

Each task is denoted as one node in DAG, while the edges of the graph represent dependencies between the tasks. From a mathematical point of view, DAG exhibits the following properties: it is a finite graph with directed edges and without any directed cycles. Edges in DAG represent the sequences of execution. With these properties of DAG, it can be utilized to graphically denote various business activities together with the mutual dependencies that exist between the individual activities, namely the partial ordering and a sequence of execution.

The formal definition of the DAG can be summarized as follows: it is a graph $G = (T, E)$, where T represents a collection of tasks of a workflow, and E denotes the set of mutual time-related dependencies and possible communication constraints among the individual tasks. For every individual task in the collection of tasks, $t_s \in T(T = \{t_1, t_2, \ldots, t_n\})$ has assigned value of computational workload cw_s. A directed edge $e_{ij} = (t_i, t_j)$ means that the task t_i must be finished before the start of the execution of the task t_j. Each edge e_{ij} is assigned a weight, cv_{ij}, a non-negative value which marks the quantity of data transfer from the task t_i to the task t_j. The workflow has one starting node, the task without direct predecessors, which is denoted with t_{start}. The workflow ends with task which does not have any direct successors, and it is denoted with t_{end}. Task t_{end} is not possible to be executed unless all directly preceding tasks have been finished.

In the observed VSOT application scenario, makespan is defined as the maximum time for executing the workflow. Cloud–edge resources are split into two separate

groups, where the first group includes cloud servers, while the second group consists of edge servers. Every task of the workflow can be executed on either type of servers, and this is depending on the selected resource allocation approach. After allocating task t_s to a specific server, the time required for the execution of the task t_s can be calculated as given in Eq. (1):

$$T_{t_s}^{l} = \frac{cw_s}{\delta_l}, \tag{1}$$

where δ_l marks the processing power of the $l-th$ server. If it has been considered that $ct(e_{ij}^{l})$ denotes the time which is required for data transfer from task t_i to the task t_j, it is possible to be calculated by using Eq. (2):

$$ct(e_{ij}^{l}) = \frac{cv_{ij}}{B} \tag{2}$$

Parameter B in Eq. (2) marks the bandwidth of the links connecting the servers on which tasks have been allocated. Every individual task t_s is allocated to only one server, it has the starting time ST_{t_s}, specified with Eq. (3), and finishing time FT_{t_s}, which can be calculated by using Eq. (4).

$$\mathrm{ST}_{t_s} = \max\{\mathrm{FT}_{t_p} + ct(e_{ps}^{l}), t_p \in \mathrm{pre}(t_s)\} \tag{3}$$

$$\mathrm{FT}_{t_s} = \mathrm{ST}_{t_s} + T_{t_s}^{l} \tag{4}$$

In Eq. (3), $\mathrm{pre}(t_s)$ denotes the collection of tasks that are directly preceding the current task t_s. The total amount of time required for completing a whole workflow can be calculated as the time from the beginning of the first task in the observed workflow, until the finish of the last task of the workflow, as given in Eq. (5):

$$T_{\mathrm{total}} = \max\{\mathrm{FT}_{ts}, t_s \in T\} \tag{5}$$

The cost is second important parameter, and it can be separated into the computational cost and the cost required for communication, for both types of resources, edge and cloud. The computational cost, from the task t_i to the task t_j on the server l, can be obtained by applying the expression:

$$C_{t_s}^{l} = pp_l \times (\mathrm{FT}_{t_s} - ST_{t_s}), \tag{6}$$

where parameter pp_l denotes the price for processing unit on the server l. On the other hand, the communication cost from the task t_i to the task t_j on the server l, can be mathematically modeled with Eq. (7):

$$cc(e_{ij}^{l}) = cp_l \times ct(e_{ij}^{l}), \tag{7}$$

where cp_l denotes the price of communication unit on the l-th server. The overall cost can then be defined and calculated as the sum of the costs required for computation and communication, as described in Eq. (8):

$$C_{\text{total}} = \sum_{l=1}^{m} \sum_{s=1}^{n} C_{t_s}^{l} + \sum cc(e_{ij}^{l}) \tag{8}$$

At the end, with previously defined calculations of makespan and cost, the objective function in cloud–edge environment can be defined with Eq. (9):

$$\text{obj} = \omega T_{\text{total}} + (1 - \omega) C_{\text{total}}, \tag{9}$$

where ω denotes weight coefficient, that determines the importance of each objective and it takes a value between 0 and 1. The goal of the objective function specified by Eq. (9) is to minimize the value of obj by balancing between the makespan and cost for a given task of workflow scheduling.

4 Proposed Method

Harris hawks optimizer algorithm (HHO) was originally introduced in 2019 by Heidari et al. in [18]. HHO metaheuristics draws the inspiration from the group hunting practice and pursuit tactics of the Harris hawks, which is known as surprise pounce. More information regarding the HHO's background can be retrieved from [18].

The HHO metaheuristics exploration and exploitation phases are motivated by the hawks' exploration for the prey, their special surprise pounce tactic, and various capturing strategies employed by the Harris hawks during the pursuit. The exploration phase of the HHO approach mimics the hawks' process of tracking and detecting the prey. Hawks can wait for hours and observe the target area to identify possible prey. In HHO implementation, each hawk is represented as the candidate solution, while the best solution in every step is observed as the target or close to the optimum. The hawks position themselves on several locations in a random fashion and wait to detect a prey on the basis of two possible strategies. There is an equal probability q for both strategies because hawks in the hunting party position themselves based on the other hawks' locations (to be in the proximity when attacking) and the prey, which can be modeled by using Eq. (10).

$$X(t+1) = \begin{cases} X_{\text{rand}}(t) - r_1 |X_{\text{rand}}(t) - 2r_2 X(t)|, q \geq 0 \\ (X_{\text{best}}(t) - X_m(t)) - r_3(\text{LB} + r_4(\text{UB} - \text{LB})), q < 0.5 \end{cases} \tag{10}$$

where $X(t)$ represents the current hawk (solution) position vector, $X(t+1)$ denotes the solution for the next round t, $X_{\text{best}}(t)$ represents the location of prey (current best solution), coefficients r_1, r_2, r_3, r_4, and q are random values within the [0, 1] range

that are being updated in each round, factors LB and UB represent the lower and upper borders of decision variables, $X_{\text{rand}}(t)$ denotes a randomly chosen solution from the current population, and X_m represents the average position of the current solutions population.

The mean location of the current solutions in population ($X_m(t)$) can be obtained by utilizing the following expression:

$$X_m(t) = \frac{1}{N}\sum_{i=1}^{N} X_i(t) \tag{11}$$

where $X_i(t)$ marks the location of i-th individual in iteration t, while N marks the number solutions in the population.

When transitioning from the exploration process to the exploitation, the HHO approach can switch between several exploitation strategies depending on the prey's available energy (strength of current best solution), which decreases while the prey escapes, as modeled by Eq. (12):

$$E = 2E_0(1 - \frac{t}{T}). \tag{12}$$

where E denotes the prey's energy level that it uses for escaping, T denotes the maximal number of iterations, while E_0 represents the initial state of the prey's energy. Parameter E_0 switch in random fashion between $(-1, 1)$ in every iteration.

In exploitation phase, the HHO will perform the surprise pounce maneuver to attack the prey which was detected in the previous phase. On the other hand, the prey will try to run away from danger. Depending of the escaping behavior of the rabbit, hawks can employ four possible strategies, which were incorporated in the HHO for modeling the attacking process.

The parameter r is the probability that prey will successfully escape ($r < 0.5$) or not ($r \geq 0.5$) prior to the surprise pounce maneuver. The hunting party of hawks will in both cases encircle the prey and perform hard or soft besiege (determined by the remaining available energy level of the escaping target). The hawks will start with soft besiege, getting closer and closer to the target, and as the prey loses the energy the hawks will intensify the besiege. Parameter E is used for switching between soft and hard besiege process. Soft besiege takes place in case $|E| \geq 0.5$, and hard besiege happens in case $|E| < 0.5$

During the soft besiege, when $|E| \geq 0.5$ and $r \geq 0.5$, the prey still has enough energy for escaping through random jumping. The hawks proceed to encircle the target softly to exhaust it and attack by applying the surprise pounce maneuver, which can be modeled through Eqs. (13) and (14):

$$X(t+1) = \Delta X(t) - E|JX_{\text{best}}(t) - X(t)| \tag{13}$$

$$\Delta X(t) = X_{\text{best}}(t) - X(t) \tag{14}$$

here, $\Delta X(t)$ denotes the distance between the prey's position vector and the current location in the iteration t. $J = 2(1 - r_5)$ marks the random jumping strength of the prey during the escape, and r_5 is a random value in the interval (0, 1).

Hard besiege, on the other hand, happens when the prey is tired, in other words when $|E| < 0.5$ and $r \geq 0.5$. The hawks in the party proceed to encircle the target hard to finally catch it, and the current positions can be updated by utilizing Eq. (15)

$$X(t+1) = X_{\text{best}}(t) - E|\Delta X(t)| \tag{15}$$

The situation where $|E| \geq 0.5$ and $r < 0.5$ represents the case that the prey's remaining energy is still enough to escape, and soft besiege is still going on prior to the surprise pounce maneuver. This stage is marked with progressive rapid dives around the prey. To simplify the algorithm, it is assumed that the hawks in the group are able to progressively choose the best possible dive toward the best solution. Equation (16) models the hawk's ability to evaluate their next move during the soft besiege:

$$Y = X_{\text{best}}(t) - E|JX_{\text{best}}(t) - X(t)| \tag{16}$$

After evaluation, hawks compare the eventual outcome of dive to the previous one to decide whether it would be a good attempt or not. If they decide that the dive is not reasonable, as the rabbit (best solution) is still moving in misleading steps, hawks additionally commence to dive rapidly and irregularly when approaching the target. To simplify the algorithm, it is assumed that the hawks dive conforming to the LF-based patterns modeled with Eq. (17):

$$Z = Y + S \times \text{LF}(D) \tag{17}$$

where D stands for the problem's dimension, while S denotes the random vector with a size $1 \times D$. The LF is a function that describes the levy flight, which is given with Eq. (18):

$$\text{LF}(x) = 0.01 \times \frac{u \times \sigma}{|v|^{\frac{1}{\beta}}}, \sigma = \left(\frac{\Gamma(1+\beta) \times sin(\frac{\pi\beta}{2})}{\Gamma(\frac{1+\beta}{2}) \times \beta \times 2^{(\frac{\beta-1}{2})}}\right)^{\frac{1}{\beta}} \tag{18}$$

here, u, v are numbers randomly chosen within the interval (0, 1), β denotes a fixed value set to 1.5 in the experiments. Finally, the strategy for the soft besiege of the hawks and position updates can be summarized by Eq. (19).

$$X(t+1) = \begin{cases} Y, if\, F(Y) < F(X(t)) \\ Z, if\, F(Z) < F(X(t)) \end{cases} \tag{19}$$

where Y and Z are calculated with Eqs. (16) and (17), respectively.

Finally, in case $|E| < 0.5$ and $r < 0.5$, prey is tired and cannot escape, and hard besiege takes place before surprise pounce maneuver which is used to kill the prey. It

is similar to the soft besiege, however, hawks are closing to the target by decreasing the distance of their average location to the prey, which can be modeled with Eq. (20):

$$X(t+1) = \begin{cases} Y, if\, F(Y) < F(X(t)) \\ Z, if\, F(Z) < F(X(t)) \end{cases} \tag{20}$$

where Y and Z are now calculated with the new Eqs. (21) and (22), respectively:

$$Y = X_{\text{best}}(t) - E|JX_{\text{best}}(t) - X(t)| \tag{21}$$

$$Z = Y + S \times \text{LF}(D) \tag{22}$$

By performing simulations on standard unconstrained instances with the basic HHO, it is noticed that the diversity of population can be enhanced in early phases of the run, while at later stages convergence and the fine searching in the proximity of the current best solution can be accelerated. In this way, original HHO can be improved in terms of the following: if it misses the right portion of the search space, better solutions' diversity will prevent trapping in sub-optimal regions and at later stages, with rational assumption that the right section of the search space is hit, better final solutions' quality can be generated.

Inspired by approach presented in [19], in the basic HHO, this research work has introduced opposition-based learning (OBL) procedure, which can be described as follows: Let X_j denotes jth parameter of solution X and the X_j^o represents its opposite number. The opposite number of jth parameter of individual X can be calculated as:

$$X_j^o = \text{LB}_j + \text{UB}_j - X_j, \tag{23}$$

where $X_j \in [\text{LB}_j, \text{UB}_j]$ and $\text{UB}_j, \text{LB}_j \in R, \forall j \in 1, 2, 3, \ldots, D$. Notations UB_j and LB_j represent lower and upper bound of jth parameter, respectively, and D denotes the number of solution dimensions (parameters).

The OBL procedure is implemented in the original HHO in the initialization phase (after the initial population is created) and at the end of each round. For every solution X_i in population P, opposite individual X_i^o is generated, and eventually, an opposite population P^o is created. Original and opposite populations are merged together ($P \cup P^o$), solutions in such merged population are sorted in descending order depending of the fitness and first N solutions are chosen as the new population P for the next round.

Inspired by included changes in the original HHO, the proposed approach HHO is named with OBL procedure (HHOOBLP). The pseudocode for the proposed HHOOBLP is summarized in Algorithm 1.

Algorithm 1 Proposed HHOOBLP pseudo-code

```
Inputs: The population size N and maximum amount of rounds T
Output: The location of the best solution and its fitness value
Generate the initial population P_INT of random solutions X_i, (i = 1, 2, 3, ... N)
Generate opposite initial population P^o_INT, perform P_INT ∪ P^o_INT and select N best solutions
while exit criteria has not been fulfilled do
   Determine the fitness values for each hawk
   Set X_best as the rabbit's position (best location)
   for each solution X_i do
      Update the starting energy E_0 and jumping strength J : E_0 = 2rand() − 1, J = 2(1 − rand())
      Update the value E by using Eq. (12)
      if |E| ≥ 1 then
         Exploration stage
         Update values of the location vector according to the Eq. (10)
      end if
      if |E| < 1 then
         Exploitation stage
         if r ≥ 0.5 and |E| ≥ 0.5 then
            Soft besiege phase
            Update values of the location vector according to the Eq. (13)
         else if r ≥ 0.5 and |E| < 0.5 then
            Hard besiege phase
            Update values of the location vector according to the Eq. (15)
         else if r < 0.5 and |E| ≥ 0.5 then
            Soft besiege phase with rapid diving
            Update values of the location vector according to the Eq. (19)
         else if r < 0.5 and |E| < 0.5 then
            Hard besiege phase with rapid diving
            Update values of the location vector according to the Eq. (20)
         end if
      end if
   end for
   Generate population P^o, perform P ∪ P^o and select N best solutions
end while
Return X_best
```

5 Experiments

First, this section provides the details of simulation environment and experimental setup and then the empirical simulations' results are shown and comparative analysis has been performed between our proposed HHOOBLP and original HHO along with other outstanding heuristics and metaheuristics.

5.1 Simulation Environment Setup

The same environment and experimental setup is used as in [2], because this research work intends to conduct fair comparative evaluation with other sophisticated approaches that are validated against the same workflow instance that were shown in this paper.

The workflow simulator which is utilized in all conducted experiments is WorkflowSim-1.0, created and maintained by the Pegasus WMS group at the University of Southern California, and published under the GNU General Public License [20].

This simulator is chosen due to its ability to provide an environment, which is the excellent approximation of real distributed system. The simulations were executed on the system with Intel® 7700 i7 3.6 GHz, 16 GB of RAM and with Windows 10 OS.

The HHOOBLP is implemented in Java and tested it for the five workflow models with small number of tasks, which are developed by Pegasus group: CyberShake, Epigenomics, Inspiral, Montage, and Sipht with 30, 24, 30, 25, and 30 task nodes, respectively. Moreover, the proposed research work has utilized *Montage* 100 workflow to determine the proper value of the weight parameter ω for the objective function. All workflows simulate different real applications and follow typical DAG structure, which is visualized in Fig. 1. Properties of models are given in Table 1. Moreover, to measure performance improvements of proposed HHOOBLP over the original HHO, also the basic HHO is implemented and tested. Both approaches were integrated in the WorkflowSim environment. As in [2], 6 cloud and 4 edge servers are used in simulations. The parameters of the cloud/edge servers, with different processing rates and communication properties, are presented in Table 2.

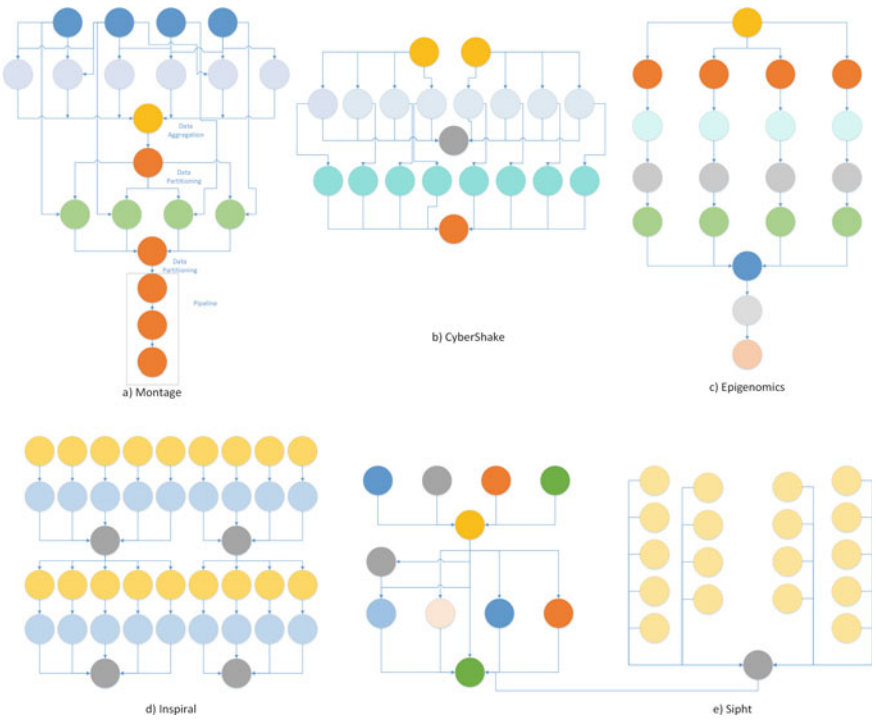

Fig. 1 Workflow models used in the experiments

Table 1 Properties of real-world DAGs

DAG	No. of nodes	No. of edges	Average data size (MB)	Average task runtime
CyberShake_30	30	112	747.48	23.77
Epigenomics_24	24	75	116.20	681.54
Inspiral_30	30	95	9.00	206.78
Montage_25	25	95	3.43	8.44
Sipht_30	30	91	7.73	178.92
Montage_100	100	433	3.23	10.58

Table 2 Parameters for the cloud and edge computing resources

Parameter	Servers	Proc. rate (MIPS)	Proc. cost (per time units)	Bandwidth (Mbps)	Com. cost (per time units)
Cloud servers	0	5000	0.5	800	0.5
	1	5000	0.5	500	0.4
	2	3500	0.4	800	0.5
	3	3500	0.4	500	0.4
	4	2500	0.3	800	0.5
	5	2500	0.3	500	0.4
Edge servers	6	1500	0.2	1500	0.7
	7	1500	0.2	1000	0.6
	8	1000	0.1	1500	0.7
	9	1000	0.1	1000	0.6

5.2 Comparative Analysis and Discussion

This subsection exhibits the summed results of the comparative evaluation of the proposed HHOOBLP approach with other metaheuristics and heuristics which are considered to be state of the art. The experimental environment, experimental conditions, and the tested workflows were the same for all observed approaches. Throughout conducted experiments, the practice has been followed from [2]. The proposed HHOOBLP is evaluated by comparing it to the original HHO version, directional and non-localconvergent PSO (DNCPSO) [2], and also other heuristics (HEFT and MIN-MIN), as classic scheduling methods and metaheuristics (original PSO and GA), as algorithms that perform dynamic scheduling. For the purpose of performing objective comparative evaluations with opponent approach, the original HHO has been tested and proposed HHOOBLP with 300 iterations ($T = 30$) and with population of 50 solutions (N=50). Moreover, for each experiment instance the algorithms are executed in 10 independent runs and average results are reported.

Weight coefficient ω of objective function, given in Eq. (9) for all algorithms included in comparative analysis was set to 0.8, because with this settings, best trade-off between makespan and cost can be established. The simulations are conducted with different ω values within the range of $[0.1, 0.9]$ with step length of 0.1 for *Montage* workflow with 100 task nodes, as in [2]. Based on obtained results, this research work has been concluded that by changing ω, makespan has higher variance than the cost, which further means that the makespan has greater influence on the objective. Visual representation of simulation results of makespan, cost, and objective metrics for variable ω of proposed HHOOBLP is given in Fig. 2.

Simulation results for other methods which were covered in the comparative analysis have been obtained from [2]. The graphical representation of the conducted evaluation for makespan, cost, and combined objective for all observed approaches is shown in Fig. 3. The smaller values of the makespan, cost, and combined objective indicate better performances of the algorithm. As it can be clearly observed from the simulation results given in Fig. 3, on average, by taking into the account all observed test instances, the proposed HHOOBLP achieves the best performances for all three evaluated metrics (makespan, cost, and comined objective). The original PSO established the worse performance, as expected, since it does not implement efficient exploration mechanism and can be trapped in sub-optimal region. The GA performed better than the original PSO for all indicators, as it can be easily adapted for discrete optimization problems by using proper encoding strategy. Original HHO performed better than the PSO, however, like PSO, it can also get trapped into the sub-optimal regions of the search space, but due to the more efficient exploitation procedure, it obtained better results.

The DNCPSO has proven as an efficient metaheuristics, that overcomes issues exposed by the original PSO. Nevertheless, our proposed HHOOBLP metaheuristics has proven to be even more efficient. For instance, when *Cybershake 30* test is observed, the DNCPSO achieved slightly lower value of cost, however, HHOOBLP established better result for the makespan, and the objective value. Similar pattern can be seen on *Montage 25* and *Sipht 30* instances, where DNCPSO obtained slightly lower values for cost, but HHOOBLP outperformed it in terms of makespan and

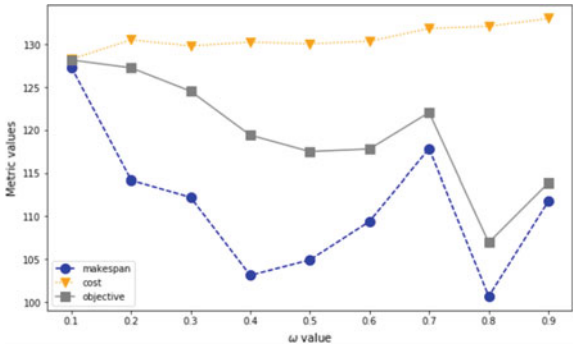

Fig. 2 Makespan, cost, and objective for different values of ω for *Montage* 100 workflow of proposed HHOOBLP

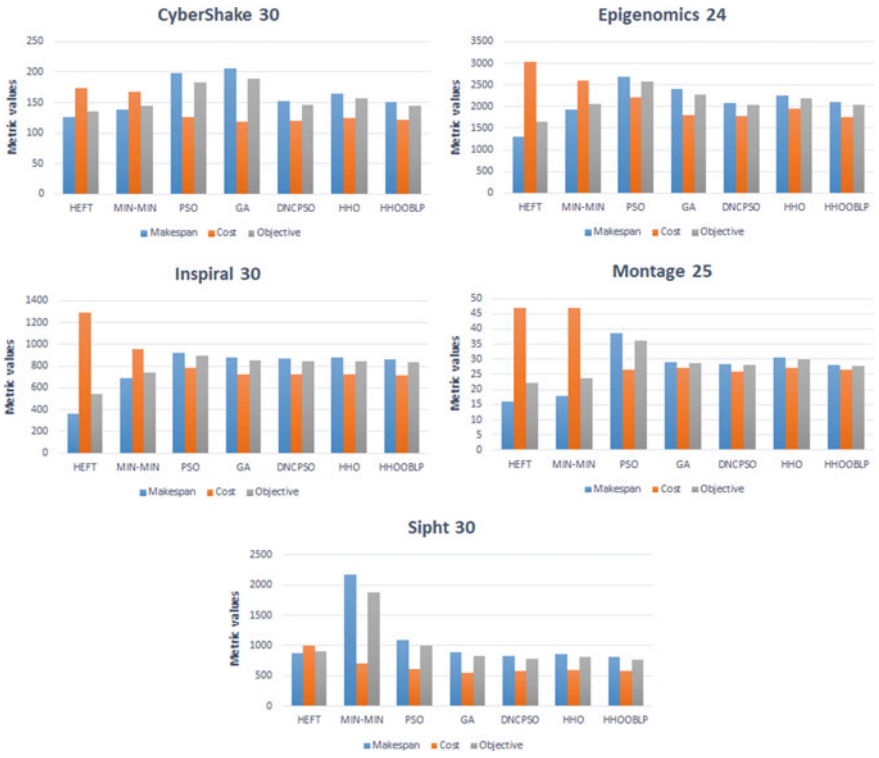

Fig. 3 Simulation results—comparison between HHOOBLP, original HHO, DNCPSO, and other approaches for datasets with smaller number of task nodes

overall objective value. In case of *Inspiral 30* instance, the HHOOBLP outperformed DNCPSO both in cost and makespan, consequently obtaining better objective value as well. Only on the instance of *Epigenomics 24* DNCPSO achieved better values than HHOOBLP, both in terms of makespan and cost and objective. The original HHO metaheuristics also achieved solid results, with the performances just behind the DNCPSO.

On the other hand, heuristic approach represented in conducted experiments with HEFT and MIN-MIN algorithms is oriented to minimize the makespan, due to the static scheduling process. Consequentially, makespan for HEFT and MIN-MIN algorithms is in general very short. On the other hand, the cost of these algorithms is very high. The *Sipht 30* test simulation is the only exception, where MIN-MIN allocates some tasks with heavy computational load to the units with low processing power, therefore making the makespan much higher. In general, as the chosen value $theta = 0.8$ favors makespan, which in turn has more influence on the combined objective than the cost, value of objective for both observed heuristics is quite low.

However, even with the good makespan values, and consequently good objective value, the cost of HEFT and MIN-MIN approaches is very high. This is typically not

acceptable for the real-life workflow applications, where cost plays an important role. On the other hand, dynamic scheduling provided by the metaheuristics approaches gives much better balance between the makespan and cost, and therefore they are much more suitable for the real-life applications in the real cloud–edge environments.

6 Conclusion

This research work has proposed and implemented an improved HHO approach, that enhances original HHO by including OBL procedure for solving the problem of cloud–edge workflow scheduling. Based on simulation results, it was proven that the proposed HHOOBLP obtains better results than the original HHO and other sophisticated heuristics and metaheuristics for workflow scheduling challenge in cloud–edge systems.

According to the accomplished results, main contributions of proposed research are enhancements of the basic HHO and improvements of the makespan and cost for tackling cloud–edge workflow scheduling issue. As part of our future work in this domain, our intent is to carry on the research with the promising HHO approach and tackle different problems in cloud–edge environments.

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Generation of Random Binary Sequence Using Adaptive Row–Column Approach and Synthetic Color Image

C. Manikandan, N. Raju, K. Sai Siva Satwik, M. Chandrasekar, and V. Elamaran

Abstract The security of a communication model is defined by the strength of the encryption and key generation algorithm. To ensure security, in block cipher techniques, a complex computation process is used for encryption. But, in stream cipher techniques, complex key generation techniques are used. This paper proposes a novel and complex key generation algorithm for stream cipher techniques that generate 15,72,864-bit key from a synthetic color image using a pattern-based bit extraction technique. A segmented form of a generated key can be used as a dynamic key in block cipher techniques. The proposed algorithm randomly uses eight patterns to extract bits from a synthetic color image to generate the key. The generated key's randomness is tested using the NIST statistical analysis tool and compared with the keys generated from existing techniques. The key length and keyspace are compared with existing methods.

Keywords Key generation · LSB extraction · NIST statistical analysis

1 Introduction

The growing use of digital communication like the Internet, Wi-Fi, Li-Fi, Internet of Things (IoT) devices, and so on demands improving security standards. Many encryption techniques are implemented for secure data transmission [1]. These encryption techniques typically use secret strings consisting of alphabets, numbers, characters, or binary digits to encrypt the sensitive data. These strings are called "keys," and encrypted data is called "ciphertext." The ciphertext is communicated to other users publicly, and keys are shared secretly through secure means. On the other side, users having a decryption algorithm receive secret keys and ciphertext to get plain text [2]. The encryption algorithm's strength is crucial in this process because a robust algorithm uses strong keys and generates ciphertext that is hard to decrypt by any

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hackers without the secret keys. Some of the more powerful and standard encryption algorithms are data encryption standard (DES), advanced encryption standard (AES), Rivest–Shamir–Adleman (RSA), Rivest Cipher (RC4), blowfish, and so on. All these algorithms use keys varying from 32 bits to 4096 bits [3]. Although the algorithms mentioned above are powerful for encryption, the key generation process in these algorithms can sometimes be decoded by hackers with excellent knowledge and access to the algorithm [4]. Therefore, to improve the strength of the key generation algorithm, various techniques had been implemented. For this paper's scope, only the methods that involve key generation from digital images are considered. Digital image key generation techniques were extracting pixel values or image properties and converting them into keys [5, 6]. The method proposed in [7] used LSB extraction and the absolute difference computation to generate the key. In [8], the histogram of the image is calculated, and the key is selected based on the peak value. In [9], a chaotic map-based key generation technique was proposed, pixels are selected based on the generated chaotic map, and LSB values are XORed for key generation. The method in [10] uses an alphabetical trie approach that matches the chosen character set to the image by dividing the image into blocks row-wise. The mean of the matched blocks is calculated and converted into a binary form to generate the key. LFSR-based key generation technique is proposed in [11], which selects bits from each pixel by mapping the generated 3-bit LFSR sequence. The algorithm proposed in [12] generates dynamic nonlinear keys using logistics and piecewise chaotic maps. These algorithms create keys of acceptable length and in less time. Many of these algorithms generate larger keys. But the logic used for these algorithms were simple and easy to understand from a hacker's perspective. Hackers can easily recreate the key. The other limitation for algorithms proposed in [5] is the memory space requirement. In [13, 14], variable size dynamic key generation techniques were proposed. In [5], various pictures in the image database generate a dynamic key by quickly changing the images. This requires more storage space to store images. In [12], the active key's keyspace is around $2^{256,}$ which is acceptable but can be cracked in very little time using quantum computing algorithms. Due to the advancement in quantum computing technology, the computational speed and time to crack an algorithm have significantly improved. Many more robust algorithms like DES and AES can be cracked in a few hours using quantum computers. Therefore, there is a huge necessity to enhance the key generation algorithm's strength and length of the key [15]. The primary goal is to design an extensive and complex key generation algorithm. It can generate larger keys, increasing the time taken to crack the key generation algorithm. This work also meets the requirements of a dynamic key generation algorithm. This paper proposes a new pattern-based key generation algorithm from a synthetic color image. The proposed work in [16, 17] uses eight different patterns, namely Straight Up (SU), Straight Down (SD), Straight Forward (SF), Straight Backward (SB), Flipped Up (FU), Flipped Down (FD), Flipped Forward (FF), and Flipped Backward (FB), for embedding binary data into LSB of the pixels. In this paper, same eight patterns are used to extract the pixels' binary values from LSB to MSB. The extracted bits from each plane are stored in buffers. A total of 3

keys are generated from each plane of the image, and those three keys are concatenated to create one final key. The proposed work is arranged as follows. Section 2 provides methodology, a flowchart, and a step-by-step process of the key generation algorithm. Section 3 analyzes the key's randomness, the complexity of the key generation, and the proposed algorithm's comparison with the existing algorithms. Section 4 concludes the proposed work based on the results and analysis.

2 Methodology

$N \times N$ synthetic images, namely red plane image, green plane image, and blue plane image, were generated using a pseudo-random generator. Each pixel in these images is represented by 8-bit values varying from 0 to 255. These three images are combined, respectively, to form a synthetic color image, as shown in Fig. 1. This synthetic color image is used for the proposed algorithm.

The proposed key generation algorithm uses eight different patterns mentioned in [16, 17] for extracting the bit values from each pixel of the selected block, as shown in Fig. 2. The numbers in Fig. 2 indicate how the columns/rows of the pixels are selected for bit extraction with 1 being the first column/row and 8 being the last column/row. The arrows in Fig. 2 indicate the direction in which the pixels in that particular column/row are selected for bit extraction. For example, in Fig. 2a, the first column is selected, and pixels are arranged from bottom to top based on the arrow

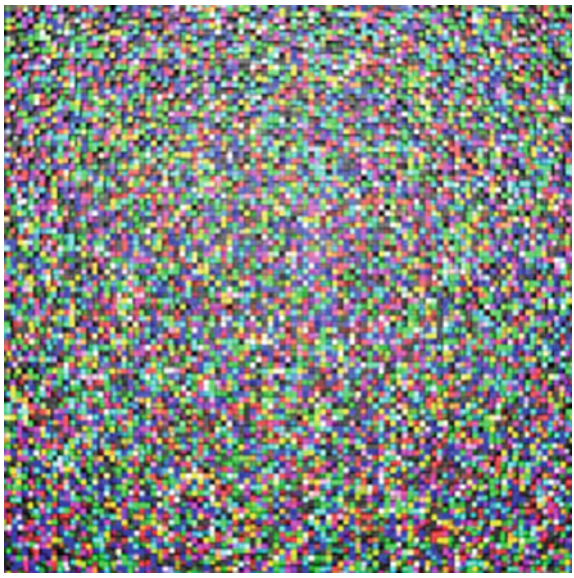

Fig. 1 Synthetic color image

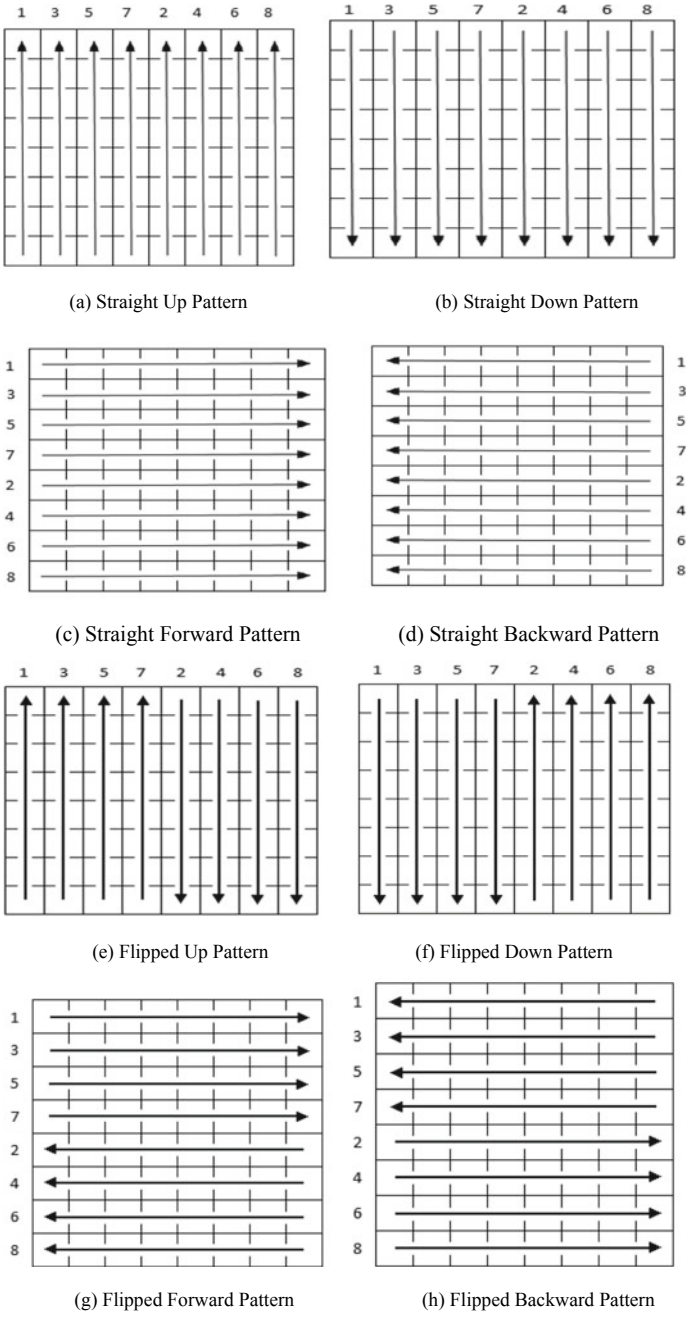

Fig. 2 Bit extraction patterns

in an array. The next fifth column is selected, and pixels are arranged from bottom to top. The same process is repeated for all eight columns, and pixels are organized based on arrows. The bit values are extracted from the arranged pixels, as proposed in the algorithm below.

The flowchart representation of the proposed algorithm is given in Fig. 3. The step-by-step process of key generation using the proposed algorithm is given below.

Step 1: Read the synthetic color image of size N × M.

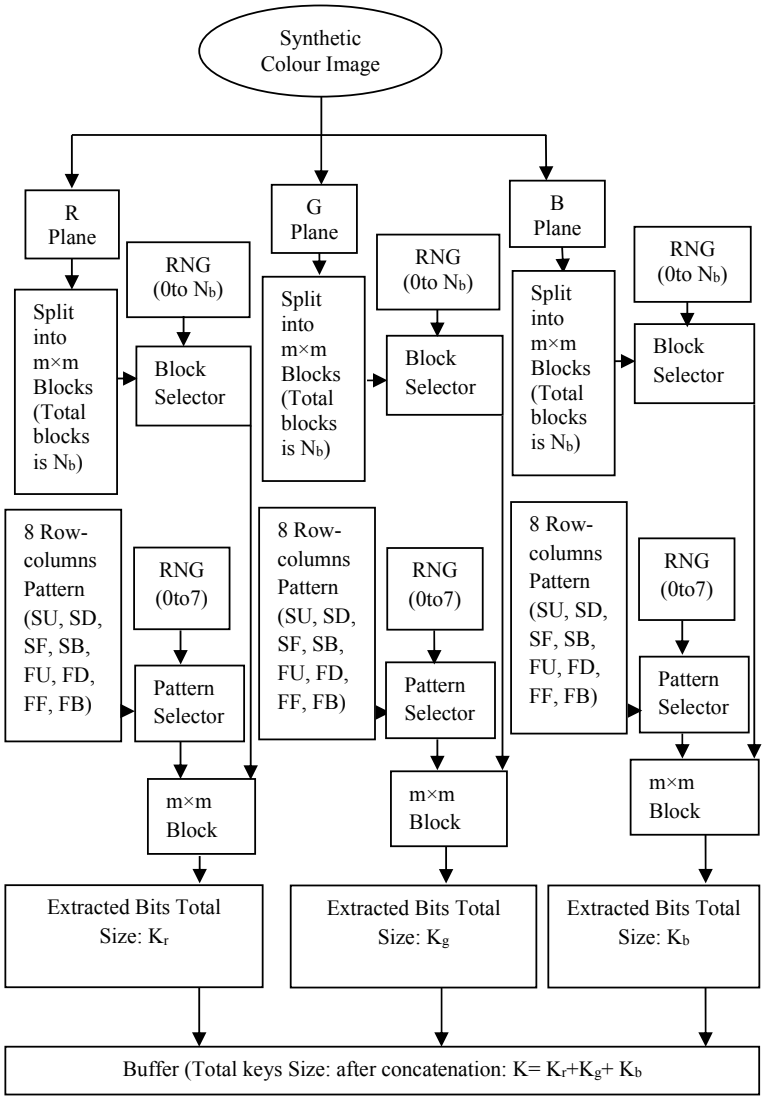

Fig. 3 Flowchart representation of the proposed algorithm

Step 2: Divide the color image into three planes, namely red, green, and blue.

Step 3: Select the red layer and divide it into m × m blocks. This gives a total of blocks $N_b = (N \times M) \div (m \times m)$.

Step 4: A random number generator that generates numbers from 0 to N_b is randomly selected. Each block is chosen randomly at a time using the random generator.

Step 5: Another random number generator that varies from 0 to 7 is created.

Step 6: Based on the number generated by the second random generator, one among the eight approaches (SU, SD, SF, SB, FU, FD, FF, and FB) is selected.

Step 7: The selected approach is applied for the selected block, and every bit of the pixels in that block is selected from LSB to MSB one at a time and stored as keys. Therefore, for one m × m block, a total of 8 keys of length m × m bits are generated.

Step 8: Concatenate the 8 keys generated from step 7 to create one key of length $K_t = m \times m \times 8$ bits.

Step 9: Repeat this process from step 4 to step 8 for the whole red layer until all the blocks are selected randomly. This gives N_b keys, each of length K_t bits.

Step 10: Concatenate N_b keys generated from step 9 to create a key of length $K_r = N_b \times K_t$ bits.

Step 11: Simultaneously, the green and blue layers are selected, and the process is repeated from step 3 to step 10. Hence, for one cycle, a total of 3 keys K_r, K_g, and K_b, each with a key length of $N_b \times K_t$ bits are generated, respectively.

Step 12: Concatenate keys from red, green, and blue planes to create a final key of length $K = K_r + K_g + K_b$ bits.

The proposed complex algorithm is implemented for a 256 × 256 synthetic color image. The algorithm gives the key's length, as shown in Eqs. (1) and (2)

$$K = \frac{(N \times M)}{(m \times m)} \times (m \times m) \times 8 + \frac{(N \times M)}{(m \times m)} \times (m \times m) \times 8 + \frac{(N \times M)}{(m \times m)} \times (m \times m) \times 8 \tag{1}$$

$$K = K_r + K_g + K_b \tag{2}$$

Using these equations, the total length of the key generated using a 256 × 256 synthetic color image is $K = 1{,}572{,}864$ bits.

3 Results and Discussion

The proposed algorithm generates a key length of 1,572,864 bits from the synthetic color image. The strength of the key places a vital role in determining the security of an encryption algorithm. The key's strength is determined by the randomness of 1s and 0s in the key. The randomness of the key is tested using the NIST statistical analysis tool. NIST statistical analysis performs various tests like frequency, block frequency, cumulative sums, runs, longest runs, rank, FFT, non-overlapping template, approximate entropy, serial and linear complexity. The results generated from the NIST statistical analysis tool are given in Table 1. It is observed that the generated key has passed the entire randomness tests with the probability value greater than the benchmark (>0.01).

The strength of the key generation algorithm must also be considered because any hacker with the knowledge of the key generation algorithm can generate his own key. If the key generation algorithm isn't strong enough, then there is a high probability of the hacker's key to match the original key. The strength of the key generation algorithm can be determined by estimating the complexity of key generation. If the hacker doesn't know the key generation's algorithm, it takes $2^{1,572,864}$ ways to identify the key. If the attacker knew the proposed algorithm used for key generation, the complexity of generating the original key is calculated. Each 8×8 block is selected randomly using a random number generator. Therefore, the total number of ways to select all the blocks is 1024! Since there are 8 different patterns were used for each block, bit extraction can be done from each block in 8 ways. Therefore, the total ways to takes to estimate the key are $8^{1024} \times (1024)!$.

The proposed algorithm is compared with the existing algorithms like LSB histogram, logistic map, LFSR key generation for key length, and keyspace are shown in Table 2. All these algorithms are implemented using MATLAB, and results

Table 1 Results from the NIST statistical analysis tool

Test	Probability	Result
Frequency	0.911413	Pass
Block frequency	0.534146	Pass
Cumulative sums	0.739918	Pass
Runs	0.739918	Pass
Longest run	0.213309	Pass
Rank	0.534146	Pass
FFT	0.350485	Pass
Non-overlapping template	0.911413	Pass
Approximate entropy	0.213309	Pass
Serial	0.739918	Pass
Linear complexity	0.012043	Pass

Table 2 Comparison of the proposed algorithm with existing algorithms

Algorithm	Key size (bits)	Key space
LSB histogram	1776	2^{1776}
Logistic map	65,536	$2^{65,536}$
LFSR	196,608	$2^{196,608}$
Proposed algorithm	1,572,864	$2^{1,572,864}$

Fig. 4 Application of the proposed framework

are generated for ideal conditions. It is observed from Table 2 that the proposed algorithm has a key length of 1,572,864 and keyspace of $2^{1,572,864.}$ which are greater than the existing algorithms. The keyspace is calculated using the standard formula 2^k, where k is the length of the key.

The proposed key generation algorithm's application is demonstrated with stream ciphers, as shown in Fig. 4. The plaint text in ASCII format is converted into a binary stream. Each bit of the plain binary stream is XORed with each bit of the key generated using the proposed algorithm, and binary ciphertext is generated. The binary ciphertext is communicated to the receiver. The binary cipher stream is XORed with the received key to generate plain binary text at the receiver side. Finally, the plain binary text is converted into ASCII format, and the message is read. This application is implemented using MATLAB GUIDE, and the obtained results are shown in Fig. 4.

The proposed key generation algorithm can also be used for block ciphers like DES, where the total length of the key is divided into individual blocks of 64-bit or 128-bit [15, 16]. Each block of the key is used to encrypt each 64-bit or 128-bit message block to generate the ciphertext. On the receiver side, Each 64-bit or 128-bit cipher block is decrypted using each 64-bit or 128-bit key block, and plain text is recovered. Table 3 shows how many attacks are required to get plaintext from the ciphertext if the proposed key is used for the existing stream and block cipher

Table 3 Robustness against malicious attacks

Encryption algorithm	Key size (bits)	No. of attacks to decrypt
Stream (XOR)	64 (standard)	2^{64}
	1,572,864	$2^{1,572,864}$
DES	64 (standard)	2^{56}
	1,572,864	$24{,}576 \times 2^{56}$

Table 4 Key length for various synthetic color image resolutions

Resolution	Size	Key length (bits)
480p	640×480	7,372,800
720p	1280×720	22,118,400
1080p	1920×1080	49,766,400
4K	3840×2160	199,065,600

encryption algorithm. For, block encryption 1,572,864 bit key is divided into 64-bit keys blocks. Therefore, a total of 24,576 keys each of length 64-bit are created. These keys are used to encrypt the incoming 64-bit message blocks.

The generated key can be used to encrypt various data like text, image, video, file, and sensor output represented in binary form. The length of the key generated using the proposed algorithm can be changed by changing the synthetic color image's resolution. Table 4 provides various lengths of the key generated using different synthetic images of standard resolutions. These resolutions vary from 480p to 4K, which is in practical use. The size of the key is calculated using Eq. 1. Table 4 shows that a maximum key length of 199,065,600 bits can be generated using the proposed algorithm when a 3840×2160 synthetic color image is used.

Although the proposed algorithm has all the advantages mentioned above over existing algorithms, there are few limitations to which the proposed algorithm may not be applicable. The proposed algorithm requires the incoming data to be as large as the generated key to avoid repetition and redundancy. The proposed algorithm cannot be used in situations where sensitive data is minimal, typically in kilobytes. The proposed algorithm is not a lightweight algorithm and sometimes more challenging for the developers to understand.

4 Conclusion

This paper presents a new key generation algorithm using a synthetic color image. The proposed algorithm uses a pattern-based bit extraction technique for key generation. There are eight different patterns were used for the extraction of bits from LSB to MSB. One pattern is selected randomly and applied for a randomly selected block

to extract bits from LSB to MSB. These extracted bits are arranged to create a key of length 1,572,864 bits. The randomness of the generated key is tested using the NIST statistical analysis tool, thus proving its strength. The proposed algorithm is compared with the existing algorithms and observed that the proposed algorithm generates a larger size key. The complexity estimation of the proposed algorithm shows that it takes $8^{1024} \times (1024)!$ Ways to break the algorithm. The results concluded that the proposed key generation algorithm suitable for a dynamic key-dependent-based stream and block cipher algorithm. The proposed key generation algorithm is applicable for massive size data and is not for small size data. In the future, the key generation algorithm can be further modified to generate keys from various image types like medical images, bitmap images, satellite images, aerial images, and so on. The randomness of the generated key using the proposed algorithm can be further improved using various computational techniques like bit inversion, s-box, binary shift, and bit rotation.

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Blockchain: Application Domains, Research Issues and Challenges

Dipankar Debnath and Sarat Kr. Chettri

Abstract Blockchain technologies offer an innovative approach to data storage, transaction execution, process automation, and confidence-building in an open and distributed environment. A wide range of blockchain-based applications have been developed and deployed since its inception, and the convergence of blockchain with other state-of-the-art technologies has been on the rise. However, the issues and challenges associated with it are also rising with the advancement of blockchain technologies and their applications. This paper provides an overview of blockchain and reviews the typical domains of blockchain application discussing the open issues and challenges. Besides, this article reviews the recent advances in addressing different blockchain issues and points out the research directions that help to develop technological innovations for future blockchain systems.

Keywords Blockchain · Consensus algorithms · Security and privacy · IoT · Smart contract · Cryptocurrency · Issues and challenges

1 Introduction

In simple terms, a blockchain can be defined as a time-stamped series of data records that are immutable and managed by a group of computers without any central authority. Such data records are securely stored as blocks, which are linked to each other using the ideologies of cryptography. Blockchain technology is seen as a recent breakthrough in an open-networked system where computation is secure and transparent and where everyone involved is accountable for their actions without any ownership by a single entity. The technology which was originally devised for digital currency has now found its potential uses in various other areas. The global annual

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revenue of blockchain-based enterprise applications is projected to be around $19.9 billion by 2025 [1]. Despite its great potential, blockchain technology faces certain issues, such as lower scalability, leakage of privacy, various types of attacks, large computing power requirements, and other technical challenges.

The rest of this article is organized as follows. Section 2 provides a quick overview of blockchain and its architecture. Section 3 describes the five typical blockchain application domains. Section 4 highlights some of the open issues and challenges in this area. Section 5 concludes the research work along with future directions.

2 Overview of Blockchain

2.1 Background

Blockchain is an emerging field with tremendous scope for research. The blockchain tale dates back to early 1979, when Ralph C. Merkle, a computer scientist, presented the idea of immutably chaining blocks with a cryptographic hash function in his dissertation at Stanford University [2]. The concept is known as the Merkle hash tree. In 1991, the digital time-stamping of documents has been implemented [3] and later in 1992, the Merkle tree was incorporated to add more documents in a single block. Much of the relevance of blockchain technology is accredited to Satoshi Nakamoto, who designed and implemented the first cryptocurrency known as Bitcoin in 2008. A Bitcoin serves as a decentralized public ledger maintained by anonymous consensus over the network. He used blockchain technology and the hashlike method to time-stamp blocks without requiring them to be signed by a third trusted party [4]. The evolution of blockchain can be staggered into four phases based on their applications:

Blockchain 1.0 (2009–2013): In this phase, blockchain technology was primarily used as cryptocurrencies for digital payments, currency transfer, and remittance. Bitcoin [5] being the most prominent example in this segment.

Blockchain 2.0 (2013–2015): The key innovation here is ‘smart contract’ which is an agreement between two people or parties. A smart contract is an autonomous computer program designed to automatically facilitate, verify, and enforcement of digital contracts without any central authorities or third party. The term ‘smart contract’ was coined by a cryptographer and legal scholar Nick Szabo in 1996. Smart contracts are applied in numerous fields such as financial services and management, health care, property ownership, voting, insurance, and the Internet of Things (IoT), among many others. A well-known example of a platform that runs smart contracts is Ethereum [6], proposed by Vitalik Buterin in 2013 and officially launched in 2015.

Blockchain 3.0 (2015–2018): DApps abbreviated for Decentralized Applications is the focus here. DApps utilizes decentralized storage and decentralized communication. A traditional app’s backend code runs on a centralized server, whereas DApps backend code runs on decentralized peer-to-peer networks. A DApp can have its frontend hosted on decentralized storages, unlike traditional apps. Ethereum was the

first blockchain that offered DApp development, followed by NEO, EOS, Stratis, Lisk, and many others [6].

Blockchain 4.0: (2018 onwards): The fourth-generation blockchain is an emerging technology and using varied techniques such as AI, machine learning (ML) promises to deliver Industry 4.0-based applications [7]. Blockchain 4.0 ecosystems offer an Integrated Development Framework (IDE) and cross-blockchain compatibility meaning most DApps will run on multiple 4.0-level blockchains.

2.2 Blockchain Transaction

The primary objective of blockchain technology is to build trust, transparency, traceability, and data integrity. A blockchain is a decentralized, time-stamped collection of immutable records called blocks distributed over peer-to-peer networks. Each block consists of a series of transactions that are secured and chained to each other using cryptographic hash functions. Blockchain technology, also known as Digital Ledger Technology [8], has three important properties: (1) Trustless: users in the blockchain system do not need to know or trust each other and there is no trusted central authority such as the banking system (2) Permissionless: the system allows any node to freely join or leave the network at will and (3) Censorship Resistant: the system does not ban any verified transaction in a blockchain network.

Figure 1 depicts the step-by-step process of a blockchain-based transaction involving user A making a transaction with another user B. The transaction is first broadcasted to the blockchain network. Each transaction is verified by the miner node(s). The miner creates a new block and adds it to the existing blockchain. The current blockchain is then distributed over the network so that the other nodes can update their ledger.

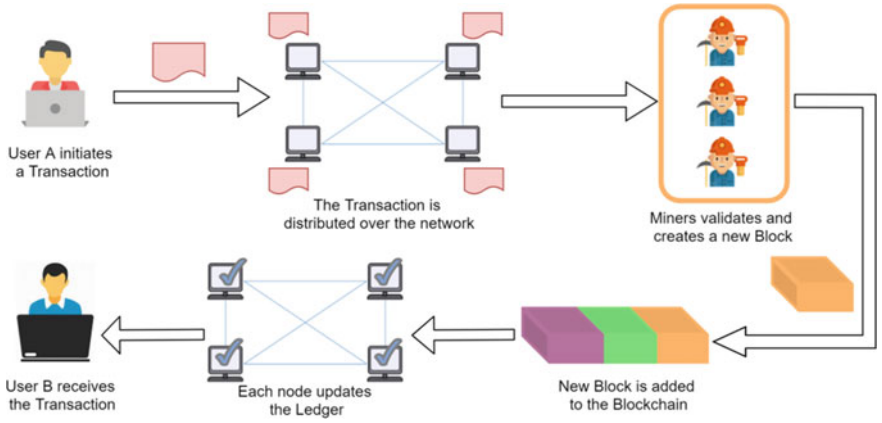

Fig. 1 A stepwise process of blockchain-based transaction

2.3 Digital Signature

Digital signatures are an effective means of validating the authenticity and integrity of digital transactions in the blockchain environment. Digital signatures are implemented using public key cryptography based on the concept of public and private keys. Here each user has a pair of public and private keys. The public key is shared, and the private key is kept secret to the user. The private key is used to sign each transaction. The digitally signed content is then distributed over the network, which can be accessed and verified using the public key. Digital signatures provide a key feature called non-repudiation, where participants cannot deny that they have participated in the transaction. The most common algorithm used for digital signature blockchain is the elliptic curve digital signature algorithm (ECDSA). Other algorithms include SHA-256, SHA-3, Scrypt, X11, X13, and Ethash [9] among many others.

2.4 Blocks

A blockchain contains a sequence of blocks chained to a cryptographic hash function [10]. As shown in Fig. 2, each block is linked to its preceding block (termed as parent block). The first block that has no parent block is called the genesis block. Each block contains a block header, a transaction count, and several verified transactions. Block header includes metadata such as block version, block hash, parent block hash, target, Merkle root, time-stamp, and nonce. Table 1 summarizes the components of a block data structure.

Merkle Root [11] is the hash value of all validated block transactions. As shown in Fig. 2, all transactions are double-hashed to a hash value; then they combine

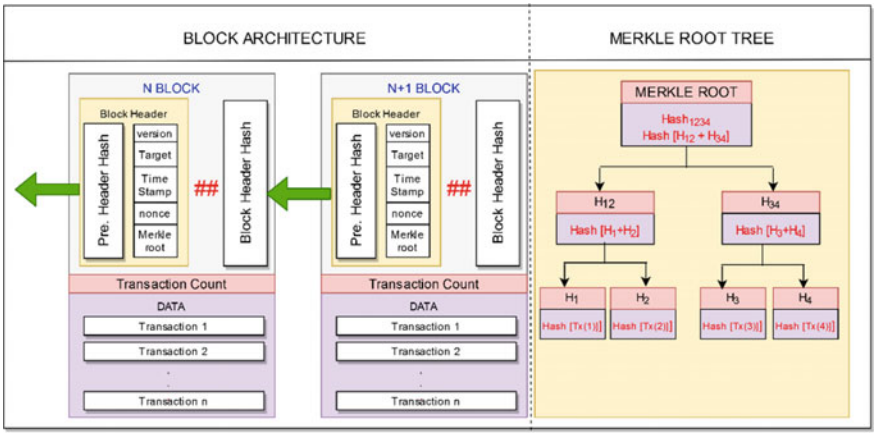

Fig. 2 Block diagram of a block and Merkle tree

Table 1 A summary of block data structure

Data item	Data type	Byte	Description
Block hash	Char	32	Block hash is a 256-bit hash value of concatenated data fields of a block
Block version	Int32	4	The block number, which governs the verification rules of a block set
Parent block hash	Char	32	A 256-bit block hash value of the parent
Time-stamp	Unit32	4	Time-stamp in seconds since 1970-01-01T00:00UTC
Target	Unit32	4	The difficulty target provided to the miner
Nonce	Unit32	4	Nonce is an abbreviation for 'number only used once' is a value adjusted by miners to meet the target value
Merkle root	Char	32	A 256-bit hash value of all transactions of a block
Transaction counter		1–9	Number of transactions
Transaction 1 Transaction 2 . . Transaction *n*		Variable	Transaction data of the block

pairwise and are entered into the parent hash function. The process is repeated until there remains a single hash value called the Merkle root or the Merkle digest. Merkle tree is also known as the binary hash tree and is used to optimally summarize and verify the integrity of large sets of block transactions.

2.5 Mining and Consensus Algorithms

The process of adding transactions to the distributed blockchain ledger is called mining. It is a mechanism that allows the blockchain system to operate without a central authority. Miners are unique network nodes that solve a complicated mathematical problem to win the right to create a new block and to win a maximum reward in terms of Bitcoin [18]. Several algorithms decide which miner wins. These algorithms are referred to as consensus algorithms. The consensus is an automatic way of reaching an agreement between untrustworthy nodes to maintain consistency in the distributed ledger [19]. There are four major consensus algorithms such as (i) Proof of Work (PoW) [12], (ii) Proof of Stake (PoS) [13], (iii) Practical Byzantine Fault Tolerance (PBFT) [14], and (iv) Delegated Proof of Stake (DPoS) [15]. Some of the other approaches include Proof of Elapsed Time (PoET) [17], Proof of Space (PoSpace) [20], Proof of Importance (PoI), Measure of Trust (MoT), Minimum Block Hash (MBT), and Tindermint [16].

In PoW, miners need to solve a complex numerical puzzle to add a new block into the ledger. In PoW, miners need specialized hardware to solve the puzzle and win

Table 2 A comparison table of different mining techniques

Mining techniques	Energy consumption	Resource required	Adversary tolerance (%)	Consensus time	Scalability	Platforms
PoW [12]	High	Specialized hardware	≤25	High	Strong	Bitcoin, Litecoin
PoS [13]	Low	Wealth or stake	<51	High	Strong	Ethereum, Peercoin
PBFT [14]	Very low	None	<51	Low	Weak	Hyperledger fabric
DPoS [15]	Very low	Low wealth or stake	≤33.3	Medium	Strong	BitShares
Tindermint [16]	Very low	Permissioned	≤33.3	Low	Medium	Tindermint
PoET [17]	Medium	Low	≤25	Medium	High	Sawtooth, fabric

rewards. PoS is a consensus algorithm where the miners (known as validators) lock-up or stake their crypto-coins as collateral to win the right to verify the transaction. PBFT is derived from Byzantine General's problem. According to PBFT, some amount of fault or wrong doing can be tolerated without affecting the integrity of the network. DPoS was developed by Daniel Larimer, is a variation of the Proof of Stack algorithm, and allows blockchain to change network parameters such as fee structure, block intervals, transaction sizes on the fly by the delegates who vote for such changes. A comparison of some of the popular mining techniques is shown in Table 2.

3 Applications of Blockchain

In diverse applications, blockchain technology is used. In this section, the five typical blockchain technology application domains were summarized. Most of the blockchain-based application areas are still in their infancy because most are at the conceptual level and need to do a lot for future blockchain systems.

3.1 Biomedical Domain

There are various issues in areas under the biomedical domain [21] being addressed using blockchain technology. Some of the popular blockchain technologies used include Ethereum, Bitcoin, NEM, and Hyperledger Fabric among others. In the biomedical domain, blockchain technology is mainly used to maintain data integrity, enable distributed access control, data lineage, and non-repudiation. The data refers

to medical records, personal health records, personal biosensor data, clinical trial data, medical insurance, etc. Mostly, blockchain is used to address the issues of data security and privacy prevalent in the distributed environment. Other uses include the assurance of non-repudiation of medical acts or transactions and to build a reliable and transparent ecosystem in the healthcare sector. The integration of blockchain with the Internet of Things (IoT) in the biomedical domain solves the issues of reliability and data privacy and secure information related to the IoT paradigm. Likewise, the amalgamation of big data, machine learning, AI, blockchain, and edge computing is becoming an important component of the innovations in the biomedical domain.

3.2 Banking and Finance

Blockchain became one of the banking sector's most popular technologies, as security is of utmost importance for the banking and finance domain [22]. In addition to security, blockchain offers operational advantages to banks, such as transparency, privacy, immutability, reduced costs, reduced human error, and quicker transactions. With different forms of payment such as stablecoin, tokenized fiat, and cryptocurrency, blockchain can reduce the remittance time with faster settlement times in domestic retail or cross-border payments. The blockchain reduces the risk of fraud and allows secured networks and distributed processes to generate more effective financing structures. With streamlined digital data verification and authentication, property and insurance claims can be revamped along with automated claims processing using smart contracts. It is possible to eliminate the necessity for a trusted third party when buying and selling stocks using blockchain technology, making it less expensive and faster transactions. Blockchain products challenge a broad range of traditional banking and financial products, but with blockchain technology, this sector is making a new paradigm shift in its services and products.

3.3 Government and Public Sectors

Blockchain technology has a tremendous potential to enable smart governance [23]. A blockchain-based government model can provide seamless services to its citizens with trust and accountability because of the key features of blockchain: auditability and persistency. Some of these services include registration of assets (e.g., land registry, property ownership), systems for income taxation, patent management, identity management, and so on. The government can leverage blockchain technology to provide cybersecurity, process automation, secure storage of government's and citizens' data, cost reduction in accountability management, transparency in voting systems, protection of sensitive data in cyberspace, and corruption reduction, among others. Besides, blockchain has potential applications in energy conservation (green energy) and education (smart learning). Furthermore, with the introduction of smart

contracts, the government bureaucratic operations that are generally complicated can be executed in a streamlined manner.

3.4 Supply Chain

A supply chain is a network that brings together individual entities, organizations, businesses, resources, and technologies to produce a product or service. Industry 4.0 tends to have a positive impact on supply chain management, supported by disruptive technologies such as big data analytics, machine learning, AI, 3D printing, cloud computing, and robotics, etc. Among these, as a distributed digital ledger, blockchain explores new ways to provide solutions [24] to various issues being faced by the supply chain industry in terms of transparency, traceability, and security. Some of the apparent benefits of using blockchain technology in supply chain management include real-time product tracking throughout its life cycle, a more transparent and traceable supply chain, improving product and service licensing, reducing the risk of fraud and product duplication, preventing tampering and building trust among suppliers, manufacturers, and customers, etc. However, there are certain challenges involved in adopting blockchains in supply chain management, such as lack of standards and protocols, legal issues, privacy issues, and error intolerance. A significant amount of collaborative work must be done by industry and academia for future research directions to understand and provide practical applications of blockchain and its performance measurement in the supply chain industry.

3.5 Internet of Things

The Internet of Things (IoT) is applied in several diverse fields practically in all areas of the daily life of individuals, organizations, and society as a whole. Some of the important IoT application areas are in the fields of healthcare and medicine, agriculture and irrigation, automotive industry, manufacturing industry (e.g., Industrial IoT), public transportation, smart homes, etc. Using blockchain, various limitations of traditional IoT applications can be addressed, such as secure data transfer between IoT devices and applications, protection of sensitive information when delivered via the IoT network, ensuring the integrity of IoT data without a third party, optimizing the computational power of IoT devices, reducing the operating costs of IoT applications, etc. In reality, blockchain provides IoT devices, applications, and platforms with a scalable and decentralized environment. Moreover, blockchain-based IoT systems allow companies to run smart applications and execute multiple legal procedures between business partners through smart contracts. However, IoT systems suffer from problems of scalability, data security, and centralization and thus the convergence of blockchain and artificial intelligence for IoT applications

[25] together with cloud and fog computing could lead to the development of a secure, scalable, decentralized, and intelligent IoT ecosystem.

4 Open Issues and Challenges

Being an emerging technology, blockchain faces various issues and challenges. The three typical parameters are summarized in the sections: scalability in Sect. 4.1, attacks on blockchain in Sect. 4.2, and privacy breach in Sect. 4.3.

4.1 Scalability

Scalability is one of the key limitations of blockchain technology. In fact, there is a key challenge in balancing the trade-off between the three key aspects of blockchain, commonly known as the Blockchain Trilemma, namely security, decentralization, and scalability. Balancing the trade-offs between these three aspects or to achieve all the three is important for the development of future blockchain systems. The problem of scalability arises due to the increasing number of transactions day by day, where there is a constraint in the network's throughput, i.e., the number of transactions that can be processed per second, for example, Bitcoin blockchain can only process 7 tx/s (transactions per second), Ethereum [26] processes 15 transactions per second while Visa and Paypal up to 1700 tx/s and 193 tx/s, respectively. Besides, with the limited block size (e.g., 1 MB in Bitcoin [4]) and the high latency or long confirmation time, i.e., the time needed to create a new block and its inclusion in the blockchain (e.g., around 10 min for Bitcoin's network and around 20 s for Ethereum's network), millions of transactions cannot be processed in real-time. Besides, throughput and latency, other factors that have an impact on scalability are storage and transaction fees paid to the miner. Currently, the blockchain size of Bitcoin (BTC) has exceeded 300 GB while Ethereum (ETH) and Litecoin (LTC) have exceeded 200 GB, and 28 GB of storage, respectively [27]. Several solutions have been proposed to address the scalability issue, such as network sharding [28, 29], consensus construction [30], lightning network [31], and directed acyclic graph [32].

Sharding is applied to blockchain to randomly break the network into small zones or shards with some teams of nodes assigned the responsibility. Thus, each node does not need to maintain the entire ledger to execute processes and validate transactions; instead, a part of the ledger is assigned to the nodes to be maintained to operate. This results in increased throughput as validation of transactions happens in parallel rather than in a linear fashion. So, scalability can be achieved with some compromise in security as hackers find it comparatively easier to take over a single shard, also known as a 1% attack. Various sharding protocols to solve the scalability issue in blockchain exist in the literature such as RSCoin [33], Chainspace [34], Elastico [29], OmniLedger [35], etc. A comparison of state-of-the-art sharding protocols

based on some parameters like safety aspects, consensus, protocol settings, and their performance can be found in the works by G. Wang et al. [28].

Such self-governing individual shards are asynchronized, so consensus among them becomes difficult to achieve. Consensus protocols are designed to make them reach an agreement on a shared state or data in a distributed environment. Broadly consensus algorithms can be classified into three broad categories [36]: (1) Incentivised consensus algorithms (Proof of Stake (PoS), Proof of Work (PoW), etc.), (2) Non-incentivised consensus algorithms that are mainly used in private blockchain systems for non-crypto-currency applications, and (3) Hybrid consensus algorithms (Proof of Research, Proof of Stake Velocity, Proof of Burn etc.). Designing and deploying a consensus protocol is another challenging task [37] because a lot of factors need to be considered such as network latency, safety, fault tolerance, transaction rate, efficient handling of corrupt inputs, and so on.

The change of the linear-chain structure of the blockchain with the DAG-based structure is another solution proposed in the literature to achieve greater scalability in the blockchain, where, through the directed acyclic graph, blockchain networks are extended and no mining occurs, it improves scalability with reduced transaction costs.

4.2 Attacks on Blockchain

With the advent of blockchain-based applications beyond Bitcoin, it is natural to have a better understanding of different types of attacks on Blockchain technology, so that a strong foundation can be established to reduce attack opportunities pursuing better security. Private Blockchains are less susceptible to adverse attacks as compared to public Blockchains due to restricted access to system resources and stronger trust models. The attacks on the public blockchain can be categorized into three broad categories [38]: (1) Attacks based on the design constructs like the mathematical techniques used to build the Blockchain structure such as forks [39], orphaned blocks [40], etc. (2) Attacks based on the applications applying Blockchain technology like cryptojacking, double-spending [41], smart contract DoS, wallet theft, etc., (3) Attacks based on peer-to-peer architecture such as selfish mining [42], consensus delay, 51% attack [43], DDoS attack [44], eclipse attack, Domain Name System (DNS) attack and so on. The taxonomy of the attacks on public Blockchain is shown in Fig. 3.

Sometimes, to achieve better scalability and to reduce the probability of orphaned blocks prevalent in decentralized mining networks, centralization of the blockchain network is done which in turn makes the network more vulnerable to attacks like double-spending and majority attacks or 51% attack where a group of miners could control more than 51% of network's mining hash rate or computing power. The 51% attack is one of the biggest threats to any Bitcoin-like currency. For example, in the year 2018, 51% of the network's mining hash rate in Bitcoin Gold (BTG) was acquired by malicious miners, stealing cryptocurrency costs of $18 million [45]

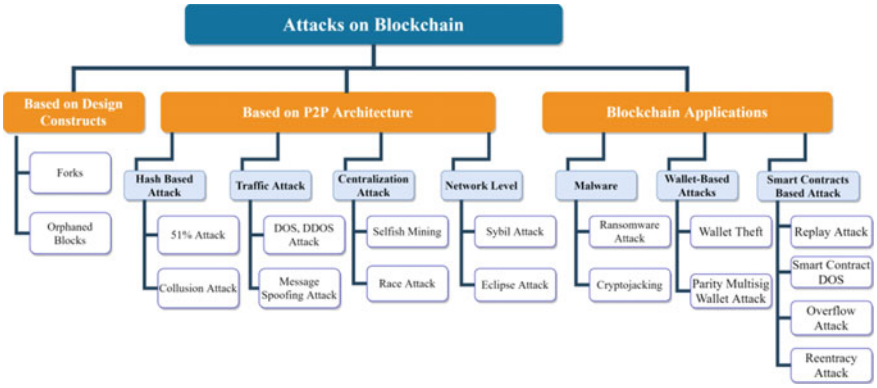

Fig. 3 Taxonomy of attacks on blockchain

followed by $72,000 in the year 2020. Another issue is the fork (hard fork or soft fork) problem, where an attack is based on the design construct of the blockchain technology. The fork problem exists because of the issues in the compatibility of the consensus between the old node and new node verification requirement in the blockchain network. These blockchain forks may cause a delay in consensus in the network leading to the double-spending attack. In recent studies, it is found that even nodes having computation power of less than 51% are still dangerous as there is a possibility of an attack known as selfish mining. The strategy applied in selfish mining by the miners is that they hide their mined blocks without broadcasting them to the public unless some requirements are satisfied. In this way, selfish miners keep mining their private chain without any competitive miners while honest or rational miners waste their resources mining the useless public chain. Attackers may launch eclipse attacks and DNS hijacks where the users and miners are kept isolated from the actual network. The attackers poison the DNS cache and modify the data and when any user makes any DNS query, they are led to some counterfeit networks. Another most common attack in the blockchain is the distributed denial-of-service (DDoS) attack. It is an attack made on blockchain-based applications such as Bitcoin and Ethereum. Even the 51% attack can cause the denial-of-service (DoS).

Another most challenging attack in the permissionless public blockchain is the Sybil attack [46], where attackers can carry out a 51% attack. In the Sybil attack, the main idea followed is that attackers create fake identities or Sybil identities in a blockchain network and use them to gain an unreasonably large influence over peers. Thus, they can take control of the hash rate of the network and could prevent confirmation of other transactions. The smart contracts are completely automated contracts, but smart contract-based attacks are due to the presence of bugs, and one of the biggest exploitation in the history of cryptocurrencies is the 'THE DAO' (distributed automated organizations) hack in the year 2016 where an attacker could pull out almost $70 million out of the crowdfunding project.

4.3 Privacy Breach

As users perform transactions in anonymity without revealing their real identity, the blockchain technology retains a high degree of user's privacy. However, Kosba et al. [47] have stated that even though the transactions use pseudonymous addresses, user's privacy in the Bitcoin blockchain cannot be guaranteed. And once the user's true identity is revealed, his transactions are seriously threatened of getting leaked to the public. Various methods for improving the privacy of future blockchain systems are suggested by the researchers. These techniques mainly use anonymization methods such as MixCoin, CoinJoin, CoinShuffle, etc., or cryptographic techniques such as Homomorphic Encryption (HE), Attribute-based Encryption, Non-Interactive Zero-Knowledge Proof (NIZK), etc.

The anonymization techniques such as Mixcoin [48] and CoinShuffle [49] enable users to make anonymous payments in Bitcoin or similar cryptocurrencies. However, the Bitcoin is pseudonymous rather than anonymous. In the proposed methods, users mix their coins with others to preserve privacy. These mixing strategies are either fully centralized where all users trust a mixer or a decentralized one without any requirement of trusted third parties like as proposed in CoinJoin [50] method developed for Bitcoin by Greg Maxwell. These methods are effective in preventing the identity of users from being disclosed and linked to, however, centralized services have a risk of privacy breach of the users and require a third party to be trusted.

In the cryptographic approach, data are stored in encrypted form over the blockchain without any substantial changes in its properties. It addresses the issue of privacy breach prevalent in public blockchains. For example, in Ethereum smart contracts, data are stored in the blockchain in encrypted form using homomorphic encryption techniques, to maintain the user's privacy. Secure multi-party communication (SMP) in a decentralized computation platform such as Enigma [51] is also proposed to provide a protection mechanism of personal data without any need to trust the third party to carry out joint computing by multiple parties in the blockchain network. The methods, however, suffer from a drawback as they only support simple operations such as additions and subtraction and suffer from lower computational efficiency for complex operations.

5 Conclusion

The traditional industry has immensely benefited from the six key features of blockchain: decentralization, transparency, anonymity, immutability, autonomy, and auditability. With an increasing interest in the application of blockchain technology at the industrial level and subsequently in academic research, the issues and challenges in blockchain are also increasing. This article reviews the current research and focuses primarily on the blockchain-based applications in various fields, ranging from finance to public services, from supply chain management to healthcare, highlighting open

issues and challenges with potential research opportunities for future blockchain-based systems and applications. It can be concluded that a deeper understanding of the key features of blockchain plays a vital role in addressing related issues such as data security and privacy, scalability, blockchain attacks, etc. and helps to develop technological innovation for future blockchain systems.

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A Study of Mobile Ad hoc Network and Its Performance Optimization Algorithm

Vishal Polara and Jagdish M. Rathod

Abstract MANET is basically used for quick transmission of data without creating infrastructure-based network. In order to do transmission in mobile ad hoc network, it is required to find out efficient path between source and destination. MANET is developed using different type of topologies which frequently get changed on the movement of node that affects network performance result in selection of inappropriate path. So to find out best path between nodes, routing protocol is required. There are number of routing protocols available based on the requirement of network it get selected and implemented. This paper provides the information of various routing protocol and optimization algorithm developed by different researcher which is applied to improve performance of MANET.

Keywords Mobile ad hoc network · Topology · Protocol · Ad hoc on-demand vector · Dynamic source routing · Zone routing protocol · Particle swarm optimization

1 Introduction

1.1 MANET

A wireless ad hoc network is a group of mobile nodes without having preplanned infrastructure, which form a temporary network. Each and every node is communicating with each other using radio or infrared communication technology. Laptop and mobile or let us say personal digital assistants which can communicate directly are the example of ad hoc network. Node is normally mobile in ad hoc networks.

Ad hoc network contains few stationary nodes for example access point to the Internet, and there are also few semi-mobile nodes available for deploying relay point

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in the area where there is a need of relay point temporarily. The outsider nodes are normally not within the transmitter range of each other. The center nodes are most useful to transfer the packet between two nodes. It acts as a router so that transmission between two nodes can establish successfully.

In an ad hoc network, there is no central administrator available for handling the packet. Network does not get collapsed because of frailer of one node or the node goes outside the network range. Node can enter and leave the network to satisfy their requirement. Nodes are having limited transmission capability so if two nodes want to establish connection they required to use multihop approach in which other nodes act as an intermediate node. Every node must be willingly transmitting the packets for other nodes [1]. So every node acts as a router and host simultaneously. A node can be defined as an abstraction of router and a number of mobile nodes which are acting as a hosts.

A router is defined as a node which has the capability to store the entry of all the nodes to which packet is transmitted. It also provides optimum path to reach one node to another node. A node is nothing but a host which contain an IP address.

In an ad hoc network, topologies are changing rapidly and there are also various possibilities of malfunctioning of nodes but ad hoc network is capable to handle all possible problems as mentioned. It fixed everything with the help of network configuration features.

If node wants to communicate with each other, they require routing protocol. Routing protocol comes with two main functions: First function is the selection of path for numbers of source and destination node available for transmission of packet at right destination. The second function is to decide and maintain routing table so that with less number of network problem or link failure transmission could be achieved.

1.2 Characteristics of MANET

MANET can be described by following characteristics [4].

No Need of Infrastructure: Mobile ad hoc network is created without having central administrator as it does not depend on any pre-established infrastructure. Here, all the nodes communicate with each other using peer-to-peer approach and with the help of their own router to generate data. Management functionality of network is distributed along various nodes. It also helps to manage fault detection. There is no discrimination between endpoints and switches in case of MANET.

Multiple hop routing: In MANET, there is no fixed router available for routing information between nodes. Here, node itself works as a router and forward information between various mobile hosts. Usually two types of routing take place like single hope and multihope based on various layer attributes and routing protocols. In single-hop routing implementation mechanism is very simple with lost cost and less functionality. In multihope mechanism, data packets use direct wireless transmission

protocol and range to forward packet from source to destination by taking more than one node as an intermediate nodes.

Dynamic topology: In MANET, nodes are moving randomly so topology of node is not fixed it is usually dynamic in nature. Normally in multihope network implementation topologies are changing rapidly and unpredictably which will result in frequent route change and partition of network with loss of packet. MANET can able to work in various propagation conditions and dynamic type of traffic as well as various types of mobility patterns. Node is creating different types of network as they are continuously moving on the fly mode. User is required to operate not only from mobile ad hoc network but also required to have public network which is normally fixed like Internet.

Variation of Node and link capabilities: All nodes are having one or more radio interfaces with different transmission and receiving capabilities as well as operating with different frequency bands. The rate of bit error of wireless connection is usually more profound in mobile ad hoc network. One direct path between two nodes is shared by the sessions. Nodes normally communicate through channel and channels are noisy or equipped with less bandwidth than a wired network. In certain case, node uses multiple wireless link for transmission.

Low-weight terminals: Mostly mobile nodes in mobile ad hoc network have low CPU processing speed with limited storage capability and also are compact in size. So these types of devices need an optimization algorithm to implement and manage computing and communication functions.

Dynamic topology: Nodes are moving arbitrarily across the network using random way point mobility model.

Limited Bandwidth: Node are available with limited bandwidth in MANET compared to wired network because of that less amount of throughput can be achieved.

Energy-constrained operation: One of the most important design considerations is node life. Node is equipped with the limited life battery in MANET.

Security: ad hoc networks are more exposed to problems compared to wired network which increased the chances of security attacks like denial of service and eavesdropping which needs to be handled efficiently.

1.3 Challenges in Ad hoc Network

Routing: Dynamic topology is used for routing in MANET. So routing of packet either by using any approach becomes more challenging compared to wire network. Mostly protocol which is used in network is reactive in nature [2].

Routing Overhead: In MANET, nodes are changing their location rapidly so the route which is generated through random movement creates a routing overhead.

Interference: when nodes are communicating with each other links are established and fail depending on the various characteristics of transmission which may result in overhearing of conversation by other nodes and which may also result in corruption of complete transmission.

Security and Reliability: ad hoc networks are less secure because of the problem mostly seen as to, e.g., depending on neighbor relaying packets. In MANET, links are having characteristics to introduce reliability problems, because of limitation of transmission range, medium is broadcast in nature, packet loss because of mobility and data loss on transmission [4].

Asymmetric links: Usually wired networks depend on the fixed symmetric links. But it is not with ad hoc networks as the nodes are randomly moving using dynamic topology and changing their position frequently within the network, e.g., when node A sends packets to node B it does not tell anything about reverse direction link.

Internetworking: MANET- and IP-based networks are usually communicating with each other. So the correlation of routing protocols between mobile devices is challenging for the harmonious mobility management.

Dynamic Topology: It has major problem of routing because topologies are dynamic in nature. In MANET, type of network routing table must reflect this change of topology and routing algorithms effectively, e.g., routing table updated after every 30 s in case of fixed network. Frequency of updating in ad hoc network is low compared to fixed network.

Energy Consumption: MANET nodes are operating usually on the batteries, so the power conservation becomes a crucial problem. Hence, power consumption must be optimized. Conservation of power-aware routing must take place [15].

2 Overview of routing protocol

Protocols are rules that govern the communication. Routing protocols are necessary in order to establish trustworthy communication. In mobile ad hoc network, there are basically three types of routing protocols proactive, reactive, and hybrid. Explanation of all categories of protocol is explained in detail.

2.1 Classification of Routing Protocol

Figure 1 shows the classification of routing protocol.

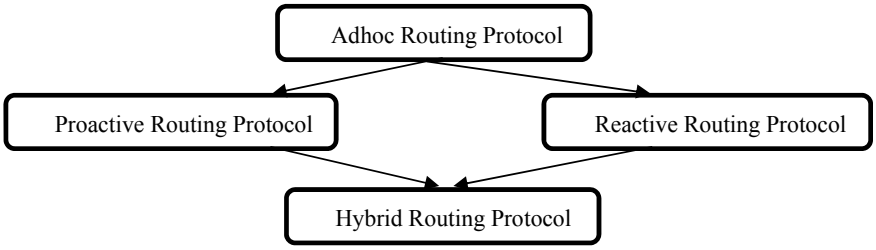

Fig. 1 Ad hoc routing protocol

- ***Reactive routing protocols***

It is also famous as a demand routing protocol. In this type of routing protocol, route discovery is based on demand. Nodes discover route on demand basis. Source node checks available route in routing table if proper route is note available it will initiate the route discovery mechanism [10].

Route discovery: In this process, route is discovered by source when it is required. Source node checks buffer for the availability of route from source to destination if the route is not present it starts the process of discovering new route. Source node contains complete path to reach destination and it also contains the information of intermediate nodes.

Route maintenance: because of network having dynamic topology there are more number of link failure that occurs so there is a requirement of proper route maintenance. Reactive protocols come with the acknowledgement mechanism because of that maintenance of route is possible. Delay is added to the network because of implementation of route discovery mechanism. Each intermediate node also adds latency which is generated in the route discovery process [5]. Routing overhead is reduced in this type of protocol but the cost of delay in network gets increase. Therefore, this type of protocols is useful when network required low routing overhead. There are many famous reactive routing protocols available in MANET, for example, DSR, AODV, TORA, and LMR.

- **Proactive routing protocols**

It is also popular as a table-driven protocol. In this mechanism, each and every node maintains one routing table which contains information about topology of network even without the requirement of it. This feature is also useful for various types of traffic like data, substantial signaling traffic, and power consumption [3, 4]. It periodically updates the routing table at the time of change in network topology. It is not preferable to use for large network as they need to maintain entry of each and every node in the routing table [6]. There are various types of protocol and each protocol has a different number of routing tables.

There are many popular proactive routing protocols available like OLSR, DSDV, and WRP. Destination sequence routing protocol (DSDV) is a table-driven routing protocol based on the distributed Bellman–Ford algorithm. There are few improvement made in existing Bellman–Ford algorithm by making it free from loop in routing tables [1]. In this algorithm, each and every node maintains routing table which contains numbers of hope to reach the destination, next hop, and sequence number. This information is attached to each node. Destination sequence routing protocol has large overhead because of routing table. Enhanced version of DSDV protocol is wireless routing protocol (WRP). It maintains all the information related to routing in routing table because of the nature of proactive routing.

Mainly four types of tables are maintained in this protocol namely routing table, distance table, cost table of links, and retransmission list of message.

- ***Hybrid routing protocol***

Mostly protocols presented here are of either proactive type or reactive type. There is some difference in working of proactive and reactive routing protocol. Usually proactive routing protocol has less latency and large overhead while reactive routing protocols have more latency and less overhead. Hence, hybrid protocol is used to overcome the drawback of proactive and reactive routing protocols.

It combined features of both the routing protocol [3]. It uses the table maintenance mechanism of proactive protocol and the route discovery mechanism of reactive protocol so as to avoid latency and overhead problems in the network. It is also suitable for large networks where large numbers of nodes are present.

In this type of protocol, larger network is divided into numbers of zones where routing inside the zone is performed with the help of reactive routing protocol and outside the zone it is done using proactive routing protocol.

There are most popular hybrid routing protocols in MANET, e.g., ZRP and SHRP [7].

In the above section, discussion about routing protocol is carried out. When routing protocols are implemented in real-time environment, lots of issues are created like link failure, power failure, inappropriate execution of path, packet loss; so to overcome all this drawback, it requires to combine protocol with optimization algorithm so overall performance of network increases with respect to parameters like routing overhead, end-to-end delay deduction and also packet delivery ration can increase so in next section discussion about certain algorithm is given which can serve the above purpose.

3 Network performance optimization algorithm

Earlier discussion of MANET contains routing protocol supported by MANET, its advantages, and the problem associated with MANET network. Here, discussion

about various algorithms which can be used to enhance performance of ad hoc network is given.

3.1 Genetic algorithms (GA)

It was developed by the Netherlands in 1975. It is working on a principal of natural selection and it is also a branch of a computational model. This method of optimization of network performance is the powerful one among the others.

Genetic algorithms are affected by humanism. Normally genetic algorithms work properly for optimization and are also called function optimizers. In this type of population solution, it is called chromosome, as it is initialized for algorithm.

Fitness is evaluated for each chromosome with the help of appropriate fitness function [8]. The best chromosome is chosen and crossover and mutation occur for better offspring. Genetic algorithm efficiently and conveniently works in the following case.

i. Search space is big, complex, and most probable not well known.
ii. There is no requirement of mathematical analysis.
iii. Knowledge of domain is scarce less to encode in order to narrow the searching area.
iv. It is used for complicated problems and the problem which are loosely coupled, it works with its own internal rules.
v. Searching method conventional approach fails.

3.2 Particle Swarm Optimization (PSO)

It is probabilistic optimization method which is based on population, and it is proposed by Kennedy and Eberhart in 1995. Grouping behavior of birds and fish swimming inspired to develop this technique. In this technique, each member is represented by particles with independent speed and position. The best position is determined by the highest fitness value of particles [8]. It contain various step in algorithm to identify best value.

Following are the steps to decide best value:

i. Particles are initialized in search space
ii. Performance of each and every particles is evaluated.
iii. If the fitness value of particle is better than pbest value, then pbest value is set as a new value of particle.
iv. The position and velocity of particles updated.

3.3 Ant Colony Optimization (ACO)

This technique is inspired by ant feeding behavior, and it is also a part of metaheuristic technique. This approach was developed by Dorgio and Dicario in 1999. It has following three main function:

i. Ant Solution Construct: In this, non-natural ants move during adjacent states of predicament.
ii. Pheromone Update: After making clarification pheromone trails are restructured.
iii. Daemon actions: In this supplementary pheromone is applied to the superlative solution.

3.4 Artificial Bee Colony Optimization (ABC)

This algorithm is based on the working style of nature bees based on this numbers of algorithm available based on intelligence. This technique is based on foraging behaviors of bee group and it was proposed by Basturk and Karaboga. These algorithms divided into two categories: breeding behavior and mating behavior. In the ABC technique, there are groups of bees:

i. Spectator
ii. Utilize.

3.5 Bacterial Foraging Optimization Algorithm (BFOA)

It is a universal optimization algorithm inspired by feeding behavior of bacteria named Escherichia coli. Bacterial foraging optimization algorithm is affected by the chemotaxis of bacteria. These bacteria use concept of gradient of chemicals to obtain a direction to food. Strategy of information processing is achieved by a series of processes.

i. Chemotaxis: Shifting of cells along with the exterior one at a time.
ii. Reproduction: Sets of bacteria are chosen on the principal of best value to so it can be donates to the subsequent generation.
iii. Elimination and Dispersal: Cells are unnecessary and new illustrations are interleaved.

3.6 Binary Particle Swarm Optimization (BPSO)

In accumulation, there is a comprehensive description of PSO called BPSO. In binary particle swarm optimization, each particle has its binary value equal to 0 or 1. Value of

particle gets changed based on a movement from 0 to 1. In BPSO, velocity of particles is defined using the probability which will change its state to 1. It is useful in many applications like iterative prisoner's dilemma, optimal input subset of SVM, dual-band and dual polarization planar antenna design. If BPSO with PSO is compared then as the BPSO algorithm was used in the binary discrete search space, computational complexity of BPSO is reduced compared to PSO and also the accuracy of the calculation is reduced. BPSO has a finite state solution and can shorten the overall time required for calculation for particle convergence compared to PSO so it is a main advantage of BPSO over PSO. Qualities of binary PSO over particle swarm optimization are[14]:

i. The computational complexity get condensed
ii. The accuracy of calculation increased
iii. State resolution is restricted
iv. Easy development.

In the next section, discussion about one of the algorithms from above algorithm is explained in detail because from earlier studies it is proved that among all above algorithms PSO gives better performance. In earlier discussion of MANET, routing protocol is supported by MANET and its advantages and the problem are associated with MANET network. Here, discussion about various algorithms which can be used to enhance performance of ad hoc network is elaborated.

4 PSO Overview

It was developed by Kennedy and Eberhart in 1995 based on swarm behavior in nature, such as fish and bird schooling.

In place of using the crossover or mutation or pheromone, it uses real number randomness and global communication among the swarm particles. That makes this algorithm easier to implement as parameters does not require to encode and decode into binary strings compared to those in genetic algorithm where it uses a real number [12].

An objective function search space is obtained by adjusting the trajectories of individual agents, called particles, as the piecewise paths formed by positional vectors in a quasi-stochastic manner. A swarming particle movement consists of two major components:

- A stochastic component;
- A deterministic component.

Particles are attracted toward the current global best g^* position and its own best location x_i * in history. It has capacity to move randomly at the same time. If particle i finds new best location than the existing one then it updates the available best location with existing one [13]. All n particles have current best location at any time t during

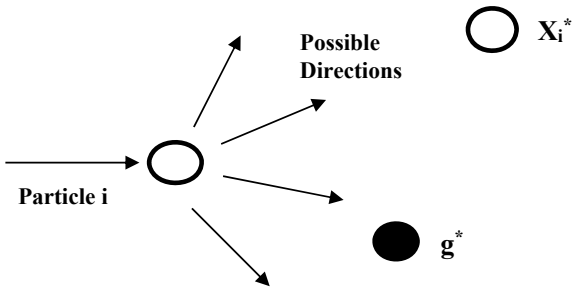

Fig. 2 Notion of particle in PSO

iterations. This process of finding global best is repeated till the objective is achieved or for a specific number of iterations [9].

Particles movement is represented in Fig. 2, where x_i *(t) is the current best for particle i and $g^* \approx \min\{f(x_i)\}$ for $(i = 1, 2, \ldots, n)$ is the current global best at t.

The following formulas are used to determine the new velocity and position vectors of the particle [11].

$$V_i^{t+1} = V_i^t + \alpha\varepsilon_1\left[g * -x_i^t\right] + \beta\varepsilon_2\left[x_i^{*(t)} - x_i^t\right] \tag{1}$$

$$x_i^{t+1} = x_i^t + v_i^{t+1} \tag{2}$$

where

- x_i^t is the position vector for particle i at instant t.
- v_i^t is the velocity vector for particle i at instant t.
- ε_1 and ε_2 are two random vectors, and each entry takes the values between 0 and 1.
- α and β are the learning parameters or acceleration constants, which can typically be taken as, say, $\alpha \approx \beta \approx 2$.

The essential steps of the PSO can be summarized as the pseudocode below:

Particle Swarm Optimization

Objective function f (x), x = $(x_1 ... x_d)^T$

Initialize locations x_i and velocity v_i of n particles.

Find g* from min {$f(x_1) ... f(x_n)$} (at t=0)

while (criterion)

for loop over all d dimensions and all n particles

Create new velocity v_i^{t+1}

Find out new locations $x_i^{t+1} = x_i^t + v_i^{t+1}$

Apply objective functions at new locations x_i^{t+1}

Each particle x_i* current position is determine

end for

Obtain the current global best g*

Update t=t+1 (pseudo time or iteration counter)

end while

Output the final results x_i* and g*.

At the initial stage, distribution of all particles is relatively uniform because of that they can make sample over most of the regions, which is very important for multimodal type of problems. Velocity of particle can be taken as zero at the initial stage, that is,

$$v_i^{t=0} = 0.$$

5 Conclusion

This paper contains information about popular routing protocol used in MANET for communication. Each protocol functionality is provided and it is observed that most of the protocol face difficulty in finding optimal path to attain optimized performance in routing. Discussion includes certain algorithms which are widely used for improving network performance. The use of protocol is it depends on the requirement of network and the kind of parameter that would like to improve like link failure and throughput. Most of the techniques are introduced to produce reliable and efficient network without having frequent link failure during data transmission. So in future any one of the techniques on more than one routing protocol could be applied to get optimal path and best result.

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Industrial IoT: Challenges and Mitigation Policies

Pankaj Kumar, Amit Singh, and Aritro Sengupta

Abstract In today's world, with the innovations of various technologies and the subsequent growth and competition in various sectors, technologies such as IoT are playing a key role in amalgamating technology and industries. This vision to use IoT in the industry is to complement the needs of industries, increase automation, receive feedback, timely response, and most importantly increase production by many folds. This drastic change and implementation of technology helped to generate more revenue but the threat of cyberattacks is still prevalent and is largely overlooked. Industrial IoT which does not follow any standardized security protocols is heavily vulnerable to cyberthreats and critical sectors like power plants, smart meters, etc., which uses IoT to connect are at high risk. In this paper, a basic overview of the cybersecurity issues in industrial IoT and various cyberattacks related to different tiers of IoT architecture is reviewed. Also, research work has discussed various mechanisms that can be used to thwart and mitigate cyberattacks on the industrial IoT systems.

Keywords Cybersecurity · Internet of things (IoT) · Industrial Internet of things (IIoT) · Cyberchallenges · Common vulnerabilities and exposures (CVE) · Vulnerability

1 Introduction

With rapid technological growth in the industrial sector, technologies such as the Internet of things, artificial intelligence (AI), blockchain technology, 5G, and cloud computing play a vital role in connecting industrial processes throughout the network.

Industrial IoT (IIoT) is rapidly becoming a reality. In critical applications, the use of intelligent network-connected devices and data management has improved productivity, optimization, and reliable communication and control. As described by Industrial Internet Consortium (IIC) [1], IIoT will significantly improve the power to

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take decisions, actions and connect multiple autonomous industrial control systems. Also, data from smart objects are being used to provide intelligence for decision making using big data analysis.

According to Gartner Inc.'s 2019 [2] report, 5.8 billion automotive and enterprise IoT systems will hit the market by the end of 2020, up to 21% from 2019. Building automation and connected lighting devices will have a high growth rate of around 42%, followed by the automotive industry (31%) and the healthcare sector (29%) in 2020. The emergence of networked IoT devices in the industry promotes innovation and improves efficiency and productivity. But the industrial Internet of things (IIoT) also faces cybersecurity issues/challenges that industries and IT professionals need to address.

An IoT threat report published by Palo Alto Networks [3] observed that 98% of all IoT network traffic is raw and does not have encryption, thereby revealing sensitive and confidential data of companies and consumers. Fifty-seven (57) percent of IoT devices are vulnerable to cyberattacks due to the low patch level of IoT systems. Attackers may exploit known vulnerabilities and password attacks via default device passwords. Eighty-three percent of medical imaging devices run on unsupported operating systems that may be exploited by vulnerabilities to exfiltrate patient data stored on these devices and disrupt patient care quality.

On September 20, 2016, a massive DDoS attack (around 6 Gbps traffic) was recognized on Brian Krebs' security blog (krebsonsecurity.com). It was an IoT botnet driven by Mirai malware. It scanned the Internet continuously for vulnerable IoT devices, which were then infected and used in a botnet attack. It was claimed that around 3.80 lakhs IoT devices were affected by the Mirai malware in the attack on Krebs' Web site. The affected IoT devices were mainly home routers, digital video recorders, network-enabled cameras, etc. [4]. Another advanced variant of the Mirai botnet, termed as Torii botnet, used new payloads to exfiltrate sensitive information instead of usual DDoS attacks. This botnet attack affected a wide range of devices and targeted several architectures, including MIPS, ARM, x86, x64, PowerPC, etc. [5].

In February 2019, Hoya, a Japanese Optics manufacturer, was target by a cyberattack that interrupted its production lines in Thailand. In March 2019, the Norwegian metallurgical company, Norsko Hydro, was attacked by LockerGoga Ransomware. This Ransomware attack disrupted the company's operations [6].

These attacks discussed above demonstrate that a lot of IoT devices suffer from multiple vulnerabilities. They do not have the requisite protection and protocols. Most devices have a lack of authentication measures, default login passwords, communication in open text format over the Internet, including insecure interfaces and vulnerable firmware.

The authors have reviewed several research articles [7–12] that discussed limited cybersecurity issues and mitigations techniques. However, in this paper, authors have provided a comprehensive and detailed overview of the cybersecurity risk faced by IIoT in recent years along with their related CVEs, detection, prevention, and latest mitigation techniques that ensure IoT-based industry's protection. The paper also aims to cover the latest cyberattacks trends and challenges faced by industries and end users.

The rest of the paper is structured as: Sect. 2 gives a brief description of IoT, IIoT, and their architectures. In Sect. 3, the authors have discussed different vulnerabilities and potential security threats and issues related to IIoT. In Sect. 4, the authors have discussed the best security practices for IoT application developers, industry, and end users. In Sect. 5, the authors have discussed future directions and concluded the paper.

2 Internet of Things (IoT) and Industrial Internet of Things (IIoT)

2.1 Internet of Things (IoT)

Basically, it is a combination of static and/or mobile devices that are interconnected. These devices are being equipped with sensors, actuators, and other measuring modules which are connected to the Internet. The main purpose of IoT is to connect billions of smart objects that can sense the surrounding environment, transmit and process the data and then feedback to the environment. It uses various kinds of communication technologies and products such as cellular devices, Ethernet, Wi-Fi, Zigbee, satellite and has machine-to-machine (M2M) capabilities.

IoT devices, coupled with industrial process/industrial communication, improve the safety and sustainability of industries and also connect the physical world to its digital counterpart (known as cyberphysical system (CPS) [7]. The different applications of IoT devices are shown in Fig. 1.

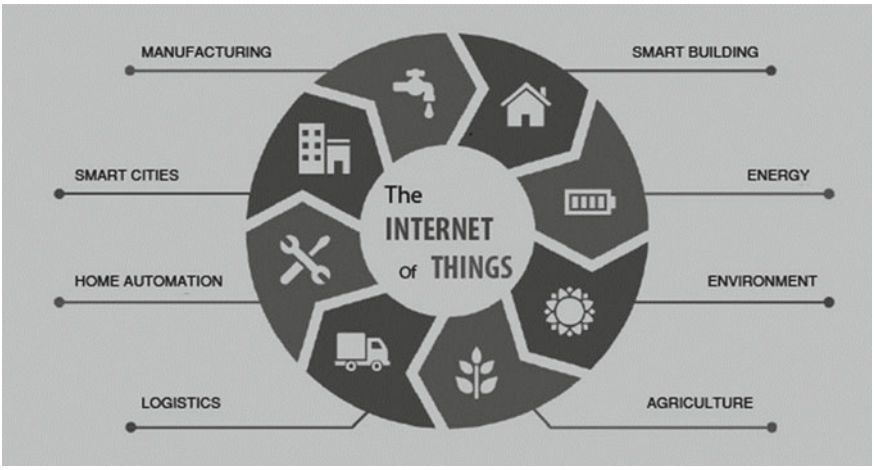

Fig. 1 Application of IoT [13]

Fig. 2 Benefits of IIoT

2.2 *Industrial IoT (IIoT)*

In the digitalized industrial world, the advent of digital and smart IoT devices aims to integrate operational technology with information technology (IT). In simple words, IIoT consists of connected smart objects, information communication technology, and cyberphysical systems. These devices provide an exchange of process, service information, real-time data by collection, processing, and communication within the industrial system, to increase overall productivity [9]. The benefits of IIoT systems have been shown in Fig. 2.

2.3 *IIoT Architecture*

The Industrial Internet Consortium (IIC) presented a three-tier reference architecture of IIoT that consists of edge, platform, and enterprise tier, as shown in Fig. 3.

In the edge tier, data received from different edge nodes collect at the edge gateways via a proximity network. This network connects various sensors, actuators, and control systems, which are collectively called edge nodes.

The platform tier receives the data, processes it, and transfers to the enterprise tier. It controls the processes and data flow among the tiers using an access network. It also enables management functions for devices.

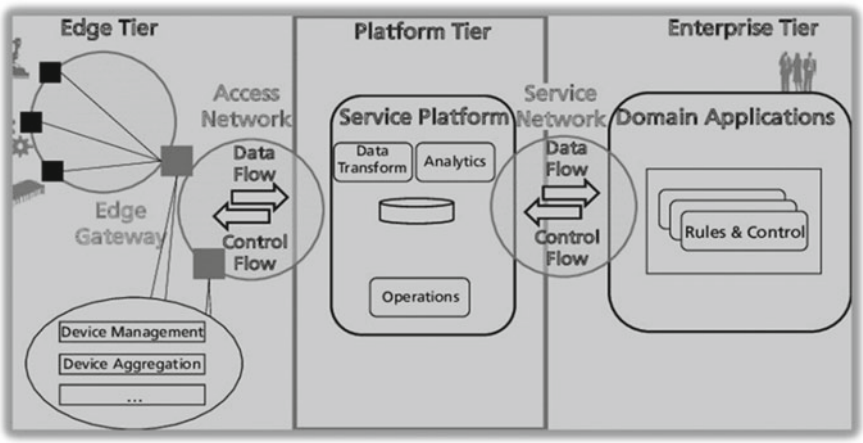

Fig. 3 Architecture of the three-tier Industrial IoT system [10]

End users are linked via an enterprise tier to IIoT systems. This tier incorporates special frameworks and decision support systems. It also gives control command to the edge tier.

In these layers, a large amount of data is been transferred using different network topologies. In order to reduce the number of computing efforts and quantum of data, IoT devices are used at the edge nodes such as smart sensors [14].

As the number of IoT devices increases in the IIoT systems, there is a high chance of increasing cyberattacks on these devices to access valuable information. Also, the network protocols which are being used for data transfer are highly targeted to the attacks. These networks are targeted easily because their communications are not encrypted. The main attacks on IIoT systems are network-based, compromise of devices, remote code execution through malicious code, etc. To secure our IIoT ecosystem from cyberthreats, we have to establish a secure and reliable industrial environment. In the next section, the authors have discussed the potential cyberthreats and their countermeasures.

3 Cyberthreats in IIoT Devices

3.1 Cyberthreat

A threat in cyberspace may be defined as an event in which an attacker disrupts/attacks organizational operation and its assets through denial of service, disclosure and modification of information, or unauthorized access, etc., of an industrial system.

Traditionally, cyberattacks happened at a single point of surface among hardware systems, software, or network level. But, advancement and sophistication of

cyberthreats and cyberattacker may find loopholes and bypass the security of IoT systems. To handle the dynamic nature of cyberthreat, IoT systems have to build up a defense strategy capable of handling such threats.

The IIoT systems have perimeter defense mechanisms such as firewalls and antivirus software installed within intrusion prevention/detection systems, all traffics coming from outside are intercepted and examined to ensure there are no cyberattacks from external sources into the IIoT systems. Also, a large-scale identity management system and traceback techniques may help to handle cyberthreats.

As discussed in the previous section, the cybersecurity threat exists in all the three tiers of IIoT architecture [8].

(a) Edge tier (i.e., from sensors and actuators);
(b) Platform tier (i.e., from network architecture);
(c) Enterprise tier (i.e., from user data storage).

The first tier is responsible for managing the sensors and reading data by multiple endpoints. This may allow an unauthorized attacker to add a node, fake input data, and read sensitive data of the system. This is commonly known as fake node vulnerability. The attacker can even attempt to snoop between two nodes and capture authentic information from the sender and reuse the same in the future sessions. This is known as a replay attack. The attacker can also block RFID tags or sensors that result in the loss of confidential data or manipulate the data. Also, there is a chance of cloning/tampering of RFID tags to vandalize the edge tier.

The platform tier manages the transfer of data over a wireless communication network. This wireless communication network depends on different platforms such as cloud, Bluetooth (Zigbee), LTE, and Wi-Fi. There are many concerns related to using these technologies. For instance, in Wi-Fi, there are 10–15 devices connected. If the platform tier uses one of such technologies without sufficient protection/security measures, the attacker can easily target the network and steal or manipulate the sensitive data. Also, it can suffer from DoS and MITM attacks. A DoS attack is an attack to prevent registered users from getting access to devices. This type of attack is done by flooding devices with unwanted and irrelevant requests. This jams the bandwidth and makes registered users from getting access to the devices. An attack where an attacker intercepts and alters the data sent between two nodes is known as man-in-the-middle attack [11]. This is a serious issue as far as cybersecurity is concerned, as it may allow the attacker to capture and modify data in real time.

The enterprise tier deals with the end users. There are many unlawful activities and cyberattack techniques used by the attacker to manipulate or damage the end user's sensitive information/data, for example, by injecting malicious code into the system, an attacker can shut down the complete industrial IoT infrastructure. The attacker can also make the end user access some malicious programming to gain useful information and alter it to malfunction the devices or deny its services. This tier also suffers from cross-site scripting requests. This allows an adversary to inject a script such as JavaScript. Subsequently, the adversary may modify the application and use confidential data and sensitive information illegally.

From the above discussion, it is evident that several vulnerabilities related to the architecture of IIoT systems might have cybersecurity challenges/issues.

The classification of various industrial devices/systems based on vulnerabilities and their vendors has been shown in Table 1. It has also given a number of IIoT devices that may be vulnerable to cyberattacks.

4 Remedial Measures and Best Practices to Mitigate Cyberthreats

Considering the risks and threats already identified, it is clear that safety measures need to be established to mitigate certain vulnerabilities emerging in IIoT area. These best practices need to be followed at all stages from development and operations to implementation and maintenance of IoT technologies.

Security measures and best practices to mitigate threats, vulnerabilities, and defined risks that affect IIoT devices and environments are categorized and summarized below.

4.1 Security Practices for IoT Devices Developers

- Secure software development methodology should be followed in which a step-by-step approach to building secure software from the commencement of the development all the way to its implementation, testing, and deployment.
- Open-source software should be used with care. While selecting the open-source software for development, there is a need to consider the activity level of the community for each open-source component. An obscure and inactive open-source software might not be supported and security issues are not likely to be patched.
- Secure boot and inbuilt cryptographic protocols should be implemented. This will disallow unauthorized access and modification of the boot sequence by executing malicious code.
- Identity-based authentication, attribute-based encryption, and mutual authentication techniques will prevent attacks such as man in the middle (MITM), replay, forgery, impersonation, and eavesdropping.
- Each application should have proper authentication and access control mechanisms to provide security and integrity of the application. The application should include role-based access control for multiuser environments.
- In addition to the role, access control policy should also need to consider geolocation, device type, department, firmware version, date and time, attribute, user type to manage security issues related to unauthorized access.

Table 1 IIoT system, its vulnerabilities, vendors, vulnerable systems, and related CVEs [5, 15–24]

Industrial devices/software	Types of vulnerabilities, which may affect the devices/software	Layer	Vendors	No. of devices/interface at the Internet, which might be vulnerable (approx.)	Related CVEs	Solution
Human–machine interface programming software	1. Memory corruption 2. Credential management 3. Lack of authentication/authorization 4. Cross-site request forgery 5. Code Injection 6. Heap-based buffer overflow	Platform tier	Siemens, Red lion Controls, Advantech, GE, Rockwell Automation, etc	1400	SSA-487246, CVE-2020-16207/11/13/15/29, CVE-2019-10978, CVE-2019-10984	1. Update the software with latest version 2. Update antivirus
Webcam	1. Unauthorized access 2. Remote code execution 3. DoS overflow memory corruption 4. Cross-site scripting 5. Hard-coded credentials	Edge Tier	Cisco, Axis, Shenzhen Neo Electronics, Panasonic, Seyeon	150,000–200,000	CVE-2019-11219/20, CVE-2018-10664/63/62/61/59, CVE-2015-887/88, CVE-2014-8755, CVE-2006-3604	1. Use strong password 2. Use secured network 3. Software should be updated

(continued)

Table 1 (continued)

Industrial devices/software	Types of vulnerabilities, which may affect the devices/software	Layer	Vendors	No. of devices/interface at the Internet, which might be vulnerable (approx.)	Related CVEs	Solution
SCADA system	1. Inadequate encryption strength 2. SQL injection 3. Cross-site scripting 4. Backdoor access 5. Command injection and parameter manipulation 6. Remote code execution 7. Buffer error	Edge tier	Open Enterprises, Laquisscada Schneider Electric, Advantech, Delta Industrial Automation, wecon, circontrol	600,000–700,000	CVE-2020-6970, CVE-2019-6823/24, CVE-2018-12634/35, CVE-2019-10980/94	1. Update the software with latest version 2. Use VPN network 3. Communication between devices must be encrypted

(continued)

Table 1 (continued)

Industrial devices/software	Types of vulnerabilities, which may affect the devices/software	Layer	Vendors	No. of devices/interface at the Internet, which might be vulnerable (approx.)	Related CVEs	Solution
Industrial Ethernet switches/routers	1. Buffer overflow 2. MAC flooding 3. DHCP/ARP spoofing 4. SNMP vulnerability 5. Remote code execution	Platform tier	Siemens, Cisco, Netgear, Fortinet	10,000–20,000	CVE-2020-8597, CVE-2018-18065, CVE-2020-3205/3198	1. In routers passwords must be enabled at both the login mode and the privileged mode 2. Login mode passwords on Console, AUX, and VTY (telnet/ssh) interfaces must be apllied 3. Protect router/switches with a firewall and ACL

(continued)

Table 1 (continued)

Industrial devices/software	Types of vulnerabilities, which may affect the devices/software	Layer	Vendors	No. of devices/interface at the Internet, which might be vulnerable (approx.)	Related CVEs	Solution
RFID Reader	1. Time-of-check time-of-use (TOCTOU) race condition 2. Eavesdropping & Replay 3. Man-in-the-middle attack 4. Cloning or spoofing 5. Clickjacking	Edge tier	Siemens, ABUS Secvest, Impinj Speedway	1000–2000	CVE-2019-15126, CVE-2019-9861, CVE-2018-5304	1. Tag data must be locked permanently 2. Single-source password protection 3. Multipoint password protection
Process control system	1. Unquoted search path 2. Remote code execution 3. Lack of encryption	Edge tier	Siemens, Cisco	15,000–30,000	CVE-2020-7580	1. Update the software with latest version 2. Use VPN network 3. Communication between devices must be encrypted.

(continued)

Table 1 (continued)

Industrial devices/software	Types of vulnerabilities, which may affect the devices/software	Layer	Vendors	No. of devices/interface at the Internet, which might be vulnerable (approx.)	Related CVEs	Solution
Measuring and monitoring system	1. Out-of-bounds read 2. Missing authentication for critical function 3. Lack of encryption 4. Use of password hash with insufficient computational effort 5. Cross-site scripting 6. Classic buffer overflow 7. Authentication bypass by capture–replay	Enterprise tier	Siemens, Cisco	5000–10,000	CVE-2020-10037/38/39/40/41/42/43/44/45	1. Update the software with the latest version 2. Use VPN network 3. Communication between devices must be encrypted 4. Update antivirus

(continued)

Table 1 (continued)

Industrial devices/software	Types of vulnerabilities, which may affect the devices/software	Layer	Vendors	No. of devices/interface at the Internet, which might be vulnerable (approx.)	Related CVEs	Solution
Industrial real-time (IRT) device	1. Improper input validation 2. Remote code execution	Edge tier	Siemens, Erricson	10,000–20,000	CVE-2019-10923	1. Update the firmware 2. Control system networks and remote devices locate behind firewalls and isolate them from the office network 3. Enable access protection and change default credentials for SNMP service

- Device-to-device authentication may be enforced to prevent masquerading of devices by malicious parties and also to provide accountability and forensic analysis of devices.
- Secure key management includes key generation, updation, revocation, and storage of keys to prevent masquerading and device compromises attacks.
- Self-encrypting devices should be preferred to prevent unauthorized disclosure of data.

4.2 Best Security Practices for Communication Network

- Restrict unauthorized access to the network and implement authentication, authorization, and accounting (AAA) systems.
- A pairing protocol may be enforced between the end users and devices to authenticate the communication. In this system, there is no need to share any prior key/password.
- A cryptographic key exchange may be used between the end users and the IoT devices through an auxiliary or out-of-band (OOB) channel to authenticate the communication.
- Implement appropriate access control lists (ACLs) for IP addresses and/or port filters.

4.3 Best Security Practices at the Industry Level

- The perimeter devices should be hardened properly with the use of firewalls, intrusion prevention system (IPS), and demilitarized zone (DMZ), wherever it is necessary.
- Use tamper-proof and trusted/ secure hardware that integrates security at a different level and provide encryption and anonymity.
- To prevent the remote access attack, penetration of the firewall, and routers/switches, a secure virtual private network (VPN) should be used.
- There should be a mechanism that detects vulnerabilities, develops patches to plug the same, and applies patches to the end devices with customer consent.
- There is a need for secure device firmware that could be signed by an irreversible device identifier and securely delivered to the machine over a secure communication channel [25].
- Physical access should be restricted to critical IIoT control systems so that an unauthorized person would not have access to the ICS and safety controllers, peripheral devices, and safety networks.
- All kinds of data exchange with the isolated network such as DVDs and USB drives should be scanned before use in the terminals connected to these networks.

- Physical and logical network separation, segregation, and overlay of security zones and conduits model should be implemented.
- Devices should be updated regularly with new security patches (security at the device level), the latest firewall signatures of new malware (network level), monitoring, and analyzing log files (plant level) [8].
- Standard operating procedures (SOP) should be followed that support the IIoT policies.
- Physical and logical inventory of connected systems should be maintained.
- Integrity measurement architecture (IMA) can be used to devise mechanisms to address the issues with accidental and malicious modification of files [16].
- Hardware/software encryption schemes can be implemented to validate devices, sensors, and other components.
- Vulnerability assessment and penetration testing of IoT-related applications and hardware should be thoroughly conducted to identify potential risks.
- For mission-critical systems, organizations should establish a mechanism and develop a policy for testing of equipment to detect backdoors in firmware code/applications to prevent the supply chain attacks.
- Risk assessment and threat modeling may be done at different levels to identify all possible threats and vulnerabilities of IoT equipment. This will help in developing a mitigation plan and security framework for the organization.

4.4 Best Practices for End Users

- There is a need to create security awareness among end users and employees of the organization through workshops by manufacturers, service providers, and network operators to understand the risks arising out of misconfigured IoT devices.
- End users should follow security measures such as changing default usernames and passwords, using complex passwords, enabling account lock-out policies, and deploying updates/patches provided by the manufactures and developers to the device software.

5 Challenges Related to Cybersecurity

There are several cybersecurity challenges in evolving and expanding Industrial IoT networks such as:

- The high cost of devices related to security features such as firewall, IPS, and DMZ.
- Lack of skills and knowledge about how to use IoT devices in a secure wireless network.
- Cybersecurity researchers have shown an inability to predict threats proactively. We have to build the capabilities to spot potential breaches ahead of time.

- In the market, there are various IoT devices and every device has its configuration and settings that may be a problem for users.
- Lack of universal manufacturing standards/protocols and immaturity of existing standards/protocols.
- There should be a National level Regulation Authority that can design a framework for building devices.
- Industrial management should be held responsible for any data leakage as per the provisions of any regulation like the General Data Protection Regulation (GDPR).
- Non-updation of software by users.

6 Conclusion and Future Work

In this paper, the basics of IIoT systems, their security threats and privacy issue related to the cyber are reviewed in detail. The industrial IoT system enables the industry to ease the industrial processes, but it has to face many cybersecurity challenges that have to deal with. Research work discussed various potential cyberthreats related to the IIoT system along with the countermeasures to overcome these challenges at the developer and industry level. As the next process in the future, IIoT architecture framework can be analyzed in detail, centering on cybersecurity perspectives recognized in this review to secure IIoT ecosystem.

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Eclat_RPGrowth: Finding Rare Patterns Using Vertical Mining and Rare Pattern Tree

Sunitha Vanamala, L. Padma Sree, and S. Durga Bhavani

Abstract Frequent pattern mining is one of the key research areas in the Data Mining (DM) paradigm. There are many algorithms in the literature to identify the frequent itemsets whereas research on rare pattern mining is in the burgeoning stage. Rare items are the infrequent items, where few applications like medical diagnosis, telecommunications, and false alarm detection in industries demand for rare patterns and rare associations with frequent or infrequent items sets in the database. The algorithms that are used to identify frequent items can also be used to identify rare patterns. However, such algorithms suffer from RareItemProblem. Rare Pattern Mining algorithms that are based on Apriori and FP-Growth were designed but Eclat-based rare pattern mining algorithms have not been explored. This paper proposes an Eclat-RPGrowth, algorithm to find rare patterns and the support of itemset is calculated by using intersection of BitSets for corresponding $k - 1$ itemsets. Also, this research work proposes a variant of Eclat_RPGrowth as Eclat_PRPgrowth. Both the algorithms are outperformed in execution time, and with the number of rare items generated.

Keywords Rare items · Rare patterns · Eclat · Prefix based pattern mining · Data mining · FP-Growth

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1 Introduction

Data mining is the approach used for discovering hidden patterns in large databases. Association rule mining and frequent pattern mining is one of important tasks in the data mining [1]. Association rule mining is widely used in different domains like social network analysis, mobile data mining, banking, finance, and stock market data analysis.

Itemsets are categorized as frequent and Rare Itemsets. From the literature, many data mining approaches are available to discover the frequently occurring entities. However, real-world datasets of many applications contain both frequent as well as relatively rare occurring entities. Generally, these rare patterns are pruned by frequent pattern mining algorithms in exceptional cases.

The algorithms that are used to identify frequent items can also be used to identify rare patterns. However, such algorithms suffer from RareItemProblem, i.e., if support value has been set as high then, important rare patterns may be missed and if support is set to low value, many patterns are generated and it is impossible to identify the significance of all generated itemsets or patterns.

Rare association rule mining is the process of identifying associations among rare itemsets that are having low support (rare), but occurs with high confidence, being neglected by association rule mining algorithms.

Rare items are further classified into Rare Item Itemsets, which contains only rare items, these Itemsets are referred to as perfect rare itemsets in literature, imperfect rare itemsets are the itemsets that are combinations of both frequent and Rare Items and whose support is less than the user-defined MinimumFrequentSupport.

Rare patterns are especially useful in applications such as medical diagnosis, fraudulent card usage detection, to identify weak students study behavior and impact of remedial coaching, market basket analysis of rare items such as cooker and pan purchase, like this, rare pattern can be used in many applications and also in collaborative recommendation systems, this kind of patterns plays a vital role to improve sales and profit. Another example, to detect errors in a manufacturing industry like if {Fire = true} is identified as frequent, but {Fire = true, Alarm = Ringing} is rare, indicates that an alarm system is malfunctioning or fault in a device, which is being neglected by all frequent itemset mining algorithms as the stated scenario gives low support.

The objective of the proposed work is to identify perfect rare itemsets and rare item itemsets. The outline of the paper is as follows- Related work is discussed in Sect. 2. Problem formulation and description of algorithm are described in Sects. 3–5. Experimental results and discussion are given in Sect. 6. Section 7 presents the conclusion and future scope of the work.

2 Related Work

In literature, many researchers contributed to find frequent patterns from the database. Basically, data of Transaction Database can be represented in two formats, namely (1) *Horizontal data format*. (2) *Vertical data format*.

Algorithms to find frequent patterns that are based on horizontal data format are Apriori [1] and FP_Growth [2], these are the important and well-known algorithms, the foundation for frequent pattern mining, another algorithm Eclat [3] which is based on vertical data format is one more main algorithm of frequent pattern mining, the performance of Eclat is better when compared to Apriori, all these variations are exclusively for frequent pattern mining and can't be utilized for mining significant rare patterns. Hence, many researchers were proposed variations of Apriori, FPGrowth, and Eclat for finding rare patterns.

2.1 Apriori Based Rare Pattern Mining Techniques

Apriori is based on the level-wise approach that generates k length itemsets by joining $k-1$ itemsets and pruning. Algorithms with single minimum support and multiple minimum supports are the two variations proposed by various authors [4, 5] to find rare itemsets.

Apriori-Inverse proposed by Koh et al. [4] is used to mine perfectly rare itemsets, which are itemsets that only consist of itemsets below the user-specified maximum-supportthreshold (maxSup). As single minimum support is not suitable to find all rare items, authors proposed MSApriori and IMSApriori [6–8], which are two important techniques to find rare items, which are based on multiple minimum support.

Laszlo et al. [9] presented generation of rare association rules by mining of infrequent itemsets. This work describes a method for identifying rare association rules that stay hidden for regular frequent itemset mining algorithms. When compared with other methods, this method finds strong but rare associations that have local regularities in data are found. These associations are referred to as "mRI rules".

2.2 FP-Growth Based Rare Pattern Mining Techniques

Apriori-based variations demonstrated to be ineffective while mining rare item patterns because there will be a significant increase in the number of candidate itemsets at each level, as the rare items are also retained during the itemset generation phase. To overcome the problems of Apriori technique, various rare itemset mining algorithms have used the tree-based technique known as FP-Growth.

CFP-growth [6] and CFP-growth++ [7], an optimized version of [6], these algorithms read the dataset once to build the CFP-tree. Then, they rebuild the CFP tree

using pruning and merging techniques. The tree reconstruction phase in these two algorithms is an expensive step in terms of computation cost, memory usage, and time consumption. Darrab et al. [8] was proposed a technique MISFP-growth, to find frequent itemsets and rare items with MIS. The tree construction in MISFP-growth is efficient.

Ashish Gupta et al. in [10] was presented pattern-growth paradigm to discover minimally infrequent itemsets. It has no subset which is also infrequent. This work uses novel algorithm of IFP min for mining minimally infrequent itemsets. Then the residual tree concept has been incorporated by using a variant of the FP-Tree structure which is known as inverse FP-tree. In order to mine the minimally infrequent itemsets, optimization of Apriori algorithm is performed. Finally, the presented tree is used for mining of frequent itemset.

Tsang et al. [5] developed RP-Tree algorithm, it is an improvement over the existing algorithms. Firstly, RP-Tree, rare pattern mining algorithm based on FP-Tree, to find rare patterns. RP-Tree focuses on rare-item itemsets which generate useful interesting rare association rules and does not waste much time in looking for non-rare-item itemsets, which are to be pruned later. RP-Tree is based on FP-Growth, which is capable of generating long patterns since the task is divided into a smaller sequence of searches for short patterns.

2.3 Eclat Based Rare Pattern Mining Algorithms

Vertical data format initially proposed by Zaki et al. [3], advantage of this method is that it reduces the number of database scans to one. Support of k itemsets can be calculated using intersection of corresponding $(k - 1)$ TidSets.

Sunitha et al. proposed MSApriori_VDB [15] to find frequent and rare patterns, in this algorithm, it uses multiple minimum supports that are obtained based on the frequency of occurrence. Hence, the method reduces the burden of assumption of minimum support threshold. The authors sunitha et al. [16] also developed algorithms to find rare patterns from data stream using vertical mining and bitsets.

MIS-Eclat [11] Darrab, a Vertical pattern mining algorithm for multiple support-based method uses vertical representation of data to mine both frequent and rare itemsets. Although these techniques address the rare itemset problem, they suffer from huge patterns. The problem is that it identifies both frequent as well as rare patterns.

The J. A. Jusoh et al. proposed R-Eclat [12], the vertical data set based technique, is specially used for infrequent pattern generation. The approach is based on Zaki's [3] Eclat algorithm. A DFS is used to achieve a reduced representation of the transactions of the customer database. Support count of k itemsets is calculated through determining support of intersecting tid-lists of its $k - 1$ subsets. In the R-Eclat algorithm, the traditional tidset, diffset and sort-diffset variants are improved to ensure that it is applicable generating infrequent patterns. The data characteristics influence the performance of the algorithm.

All these variations are based on basic Eclat which has the following shortcomings:

(1) In Eclat, candidate itemsets are maintained based on the equivalence class and clipped by using the prior knowledge. (2) Eclat makes the itemset to be very long based on combining the two k itemeset and generate $(k + 1)$ itemset. (3) Processing time will be very high due to the intersection of two different itemsets.

This paper has proposed two new algorithms Eclat_RPGrowth, Eclat_PRPGrowth, which are based on Eclat_Growth. The proposed algorithms are capable of finding rare itemsets and rare-item itemsets: Itemset having at least one rare item. The proposed algorithms have the following benefits:

1. It uses vertical data format, therefore it requires single database scan.
2. It uses Apriori-like pruning strategy based on breadth-first search technique.
3. It generates only interesting rare patterns and avoids generating non-rare-item patterns.

3 Vertical Mining with Rare Pattern Tree

3.1 Basic Concepts and Definitions

The transaction database is a set of transactions denoted as DB $= \{T_1, T_2, T_3, T_4, \ldots, T_n\}$, where T_1, T_2 are the transactions and n is the number of transactions in the database. Each Transaction in the database consists of k items, $k <= m$, Item set $I = \{I_1, I_2, I_3, \ldots, I_m\}$, where m is the distinct items present in the database.

Support: An itemset X $\in$ I, then support of X is defined as the fraction of the transactions in a database that contains itemset X.

Rare Item: An itemset X is a rare item if Supp(X) <= MinFrequentSupportThreshold (MFT) and Supp(X) > MinRareSupportThreshold (MRT).

Frequent Item: An itemset X is frequent item if Supp(X) > = MinFrequentSupport-Threshold (MFT).

Perfect Rare ItemSet: itemset X $\in$ I is called perfect rare ItemSet if all items in the X are rare items.

Rare item itemset: An itemset is called rare item itemset if it has at least one rare item in it.

3.2 Vertical Mining with BitSets

The proposed algorithms are implemented by using vertical data format with BitSet instead of tidset. Each bitset represents transaction ids with bits, the size of bitset is equivalent to the number of transactions in database, and each bit corresponds to

Table 1 Sample database

Tid	Items	Tid	Items	Tid	Items
1	1, 2, 3, 4, 6	5	1, 3, 5, 6	9	9, 12, 11
2	1, 3	6	1, 2, 4, 7	10	9, 2, 12
3	1, 3, 4, 6, 7	7	9, 2, 3, 12, 10	11	9, 13
4	1, 2, 5, 8	8	1, 9, 12	12	9

Table 2 One itemsets

One items (itemname, bitset, support)	Frequent/rare	One items (itemname, bitset, support)	Frequent/rare
[item = 1, bs = {0, 1, 2, 3, 4, 5, 7}, support = 7]	Frequent	[item = 12, bs = {6, 7, 8, 9}, support = 4]	Rare
[item = 9, bs = {6, 7, 8, 9, 10, 11}, support = 6]	Frequent	[item = 4, bs = {0, 2, 5}, support = 3]	Rare
[item = 2, bs = {0, 3, 5, 6, 9}, support = 5]	Frequent	[item = 6, bs = {0, 2, 4}, support = 3]	Rare
[item = 3, bs = {0, 1, 2, 4, 6}, support = 5]	Frequent	[item = 5, bs = {3, 4}, support = 2]	Rare
		[item = 7, bs = {2, 5}, support = 2]	Rare

transaction. Example consider an item {1} in Table 1, [item = 1, bs = {0, 1, 2, 3, 4, 5, 7}, support = 7]. BitSet(bs) of an item 1 represents bit indexes of true bits, a bit is set to true if the corresponding transaction number has item 1. The sample database with vertical data format in bitsets is shown in Table 2. The vertical data format with bitset optimizes the memory usage and reduces the time to perform a intersection in the calculation of support of higher (k) order itemsets from lower order $(k - 1)$ itemsets. E.g. The intersection of item 1 and item 2 from Table 2 is given as Item 1 $\cap$ Item 2 = {{itemset = {1, 2}, bs = {0, 3, 5}, support = 3}, support is equivalent to the number of true bits.

3.3 Structure of a Rare Pattern Tree (RP Tree)

In the proposed algorithm, the tree structure used is similar to the structure in Eclat-Growth [17], consists of the set of levels, depending on the max transaction length or user- specified maximum pattern length.

Each level again is a collection of tree nodes. Each node is a 6 tuple—{itemset(IS), BitSet(BS), ParentNode1(P1), ParentNode2(P2), childNodesPtrList(CPtrs List), isValid(IV). The first node in the first level is the root of a tree. ParentNode1, ParentNode2 represent the references to a parent node, which belongs to

LevelNo (Item-SetLength)	Nodes list of corresponding level													
Level-0(one Itemsets)	IS	BS	P 1	P 2	C Ptrs List	IV		IS	BS	P 1	P 2	CPtrs List	IV	…
Level-1(two Itemsets)	IS	BS	P 1	P 2	CPtrs List	IV		IS	BS	P 1	P 2	CPtrs List	IV	
…	…													

Fig. 1 Rare pattern tree structure

(childNodeLevel-1) level. childNodesPtrList is the reference to its children which are part of (nodeLevel + 1) level, isValid pointer is to reduce the number of invalid candidates generation, which is used to prune unwanted candidate generation.

The tree pattern in Eclat_Growth is constructed with pointers, whereas in this proposed method, the tree is created with arrayList for nodes of each level or itemsets of the same length. Hence, the number of references used in implementation is reduced, which is memory efficient. The structure of a Rare Pattern tree is shown in Fig. 1.

4 Methodology of Eclat_RPGrowth

Two new algorithms are proposed based on Eclat-Growth, First one is Eclat-RPGrowth, to find rareitem itemsets and second is Eclat_PRPGrowth to find perfect rare itemsets.

4.1 Schematic Block Diagram of Algorithm Eclat_RPGrowth

Steps in proposed algorithm—Eclat-RPGrowth (RPTree Building process)

Figure 2 shows the main functional blocks of the algorithm Eclat_RPGrowth. It has two important phases.

1. ***Generate one itemsets List***: The transaction database has to be scanned once to convert the database to vertical representation with BitSet and to find the frequency of each unique item in the database by calculating the cardinality of the bitset and sort the items in descending order of support. Ignore or delete all the items if its support is less than the MRT (items having support less than MRT are assumed as noise and pruned), the remaining items whose support > MRT are used to generate both perfect rare itemsets and rare item itemsets.

2. ***AddItemToRarePattern tree***: For each single item in the oneitemsets list obtained in previous step, call the procedure addItemToRPTree. When the first item is added, the empty tree has to be created. Remaining items are added to RPtree one

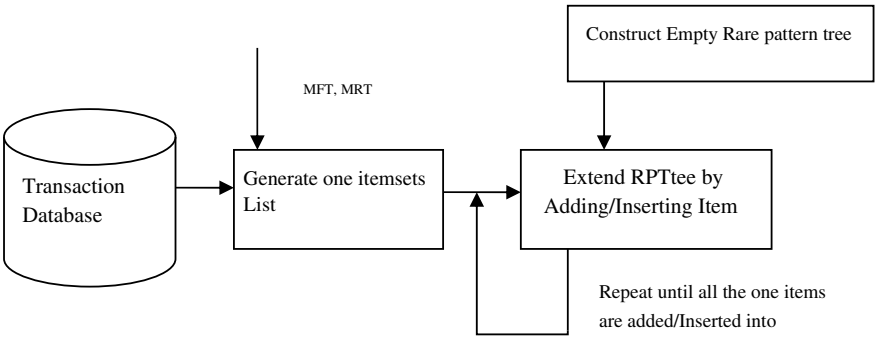


Fig. 2 Diagram showing the major steps in the rare pattern generation

by one and the new patterns are generated row by row by combing new added node with all the nodes already present in RPTree, i.e., itemsets that are available before adding the current oneitem to the tree. Detailed step-by-step process is explained in the example section.

3. Step 2 is repeated until all the items in one itemsets list are added/inserted to tree. Traverse the tree level wise, to display rare itemsets.

Algorithm:EclatRPGrowth
Input: transactionfile/source file, minimumFrequentSupport(MFT), minimumRareSupport(MRT)
Output: EClat_RPTree with rare item Itemsets

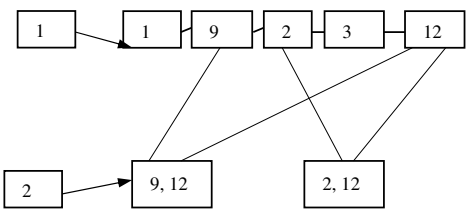
```
begin
    olist • createROneItemVMList();
     for each item sitem in olist
           begin
          if(isRare(sitem))
             begin
              addItemToEclatRPTree(sitem,MFT,MRT);
             end
           end
  end
```

```
Algorithm: addItemToEclatRPTree.
Input: Eclat-RPTree, newItem, minimumFreuentSupport, minimumRareSupport
Output: Updated Eclat-RPTree
Begin
if(eclatRPTree==null)
begin
   createEmptyTreeWithHeight(MaxTransactionLength);
end
   TreeNode newNode←newTreeNode(sItem);
   addNodetoTreeAtLevel(0,newNode);
        if(treeHeight>0)
        begin
                numLevels←treeHeight+1;
                for i in 0 to numLevels
                begin                    //i+1th level nodelist is obtained
 for each node  tempnode in currentLevel
 begin
 if(tempNode.isValid==true)
  begin
       if(isRare(tempNode)||isRare(newNode))
        begin
          newCombineNode←generateLargeItem(newNode,tempNode);
         if(isRare(newCombineNode))
            begin
            addNodetoTreeAtLevel (i+1, newCombineNode)
            else
              setAllChildrenToFalse(tempNode);
            end
          end
else
   tempNode.isValid←true;
end//else of if(tempNode.isValid==true)
end//for tempnode
end//for i
```

4.2 *Eclat_RPGrowth Example*

The RPTree construction procedure with the step-by-step representation is given below. Let us consider the sample transaction database in Table 1. The database has 12 transactions, each transaction has different items represented as numbers 1 to 12, the maximum transaction length in a given database is 5, hence a pattern of maximum length 5 can be detected.

Step 1: In the algorithm, first transactional database in Table 1 is scanned and vertical data format with bitsets is generated, all the items whose support less



Node : Support	True BitSet indexes	IsValid
[1]:7	{0, 1, 2, 3, 4, 5, 7}	True
[9]:6	{6, 7, 8, 9, 10, 11}	True
[2]:5	{0, 3, 5, 6, 9}	True
[3]:5	{0, 1, 2, 4, 6}	True
[12]:4	{6, 7, 8, 9}	True
[9, 12]:4	{6, 7, 8, 9}	True
[2, 12]:2	{6, 9}	True

Fig. 3 Building process of RP Tree, after add/insertion of items 1, 9, 2, 3, 12

than the MRT are excluded as noise and the result is shown in Table 2. Parameter values for MFT is assumed as 4, MRT as 1.

Step 2 (Add/Insert the item to the tree): Items in Table 2 are added to RPtree one by one as given below.

Extending RPTree by Adding item 1 to tree: Initially first node (item = 1) is added to tree.

Extending RPTree by Adding item 9, 2, and 3 to tree: algorithm generates only rare items and rareitem itemsets, therefore a frequent item cannot be combined with another frequent item, the nodes with item = 1, item = 9 both are frequent, these two frequent items can't be combined. Similarly items 2 and 3 are also frequent, as all the items in the list are frequent, these items can't be combined to generate two itemsets. So far no two itemset is generated because all nodes added are frequent; the nodes in the tree after this step are shown in Fig. 3.

Extending RPTree by Adding item 12: the item 12 is a rare item, so it can be combined with a frequent or rare item and then the combined node will be added to list if its calculated support is greater than MRT. Item 12 is combined with item 1, support of {1, 12} is not satisfying MRT, so it is not included in level 2 items. The parent nodes of a node {1, 12} are items 1 and 12. Hence, is Valid entry of all the children of item 1 are set to false, so that they are not combined with item 12, this is an important step and this is the candidate pruning process applied in the proposed algorithm, which reduces number of candidate items, this will improve the performance of algorithm. However, here no children are there for item 1. Similar reasoning applies for item {3, 12} combination. Itemsets {9, 12} and {2, 12} are added to list as these items are satisfying the support. The list of itemsets after this is shown in Fig. 3.

Extending RPTree by Adding item 4: Item 4 is combined with Item9, its support is zero, this node is not included in level 2 list and further invalid entry of children of node 9 is set to false, similarly the combination [4, 12] is also rejected, the invalid

bit of children of node 9, node 12 are set to false. The itemsets [1, 4], [2, 4], [3, 4] are generated and added to RPtree in level 2 items list. The item [4] was not combined with nodes [9, 12] and [2, 12] as the invalid bit is already set to false and when invalid entry is checked for true/false, if it is true, the tempnode (already present in tree) is combined with new newnode otherwise without combining newnode with tempnode, the inValid entry of tempnode is changed to true. The list of nodes generated after adding item 4 are depicted in Table 3.

Extending RPTree by Adding items 6, 5, 7: The list of nodes generated after adding these nodes is shown in Table 4, The total number of Rare items generated after this step are 19 {1—itemsets = 5, 2—itemsets = 11, 3—itemsets = 3}. The corresponding RPTree after final item 7 is being added is shown in Fig. 4. The invalid bit values indicate whether item 7 can be combined with it or not.

Table 3 The list of nodes in RPTree after add item 4

Node:Support	BitSet	IsValid	Node:Support	BitSet	IsValid
[1]:7	{0, 1, 2, 3, 4, 5, 7}	True	[9, 12]:4	{6, 7, 8, 9}	False
[9]:6	{6, 7, 8, 9, 10, 11}	True	[2, 12]:2	{6, 9}	False
[2]:5	{0, 3, 5, 6, 9}	True	[1, 4]:3	{0,2,5}	True
[3]:5	{0, 1, 2, 4, 6}	True	[2, 4]:2	{0, 5}	True
[12]:4	{6, 7, 8, 9}	True	[3, 4]:2	{0, 2}	True
[4]:3	{0, 2, 5}	True			

Table 4 The list of nodes generated after adding an item 7 to RPtree

Node:Support	BitSet	IsValid	Node:Support	BitSet	IsValid
[1]:7	{0, 1, 2, 3, 4, 5, 7}	True	[2, 4]:2	{0, 5}	False
[9]:6	{6, 7, 8, 9, 10, 11}	True	[3, 4]:2	{0, 2}	False
[2]:5	{0, 3, 5, 6, 9}	True	[1, 6]:3	{0, 2, 4}	False
[3]:5	{0, 1, 2, 4, 6}	True	[3, 6]:3	{0, 2, 4}	False
[12]:4	{6, 7, 8, 9}	True	[4, 6]:2	{0, 2}	False
[4]:3	{0, 2, 5}	True	[1, 5]:2	{3,4}	True
[6]:3	{0, 2,4}	True	[1, 7]:2	{2, 5}	True
[5]:2	{3,4}	True	[4, 7]:2	{2, 5}	True
[7]:2	{2,5}	True	[1, 4, 6]:3	{0,2}	True
[9, 12]:4	{6, 7, 8, 9}	False	[3, 4, 6]:3	{0,2}	True
[2, 12]:2	{6, 9}	False	[1, 4, 7]:3	{2, 5}	True
[1, 4]:3	{0, 2, 5}	True			

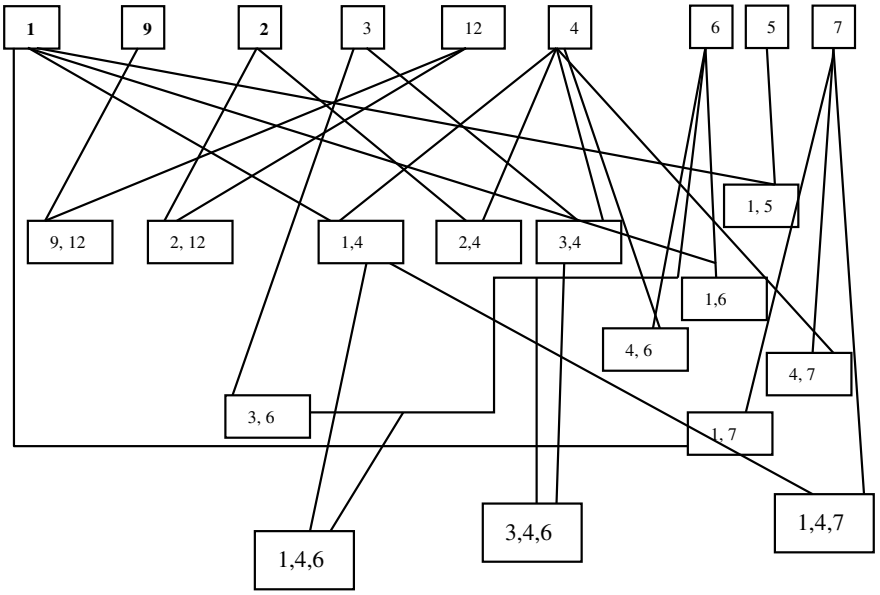


Fig. 4 Tree structure after an item 7 is added to RPTree with 19 rare item itemsets

5 Methodology of EClat_PRPGrowth

The Eclat_PRPGrowth generates only perfect rare items, so the generated items are the combinations of only rare items. So when one itemsets are filtered, all the frequent one items are also filtered and retain rare items. These kinds of patterns are also useful in some critical disease diagnosis where symptoms and their co-occurrences are rare.

Steps in proposed algorithm Eclat_PRPGrowth

1. Scan the database to find the frequency of each unique item in the database and sort the items in descending order of support.
2. Ignore or delete all the items if its support is above the MFT or less than the MRT.
3. Create an empty tree.
4. For each single item, call the procedure addItemToRPTree.
5. Traverse the tree level wise to display rare items.

In Step 2 only rare itemsets are considered for this algorithm, the remaining process is same as EClat_RPGrowth. The list of perfect rare items generated for transactional database in Table 1 are {{12}:4, {4}:3, {6}:3,{5}:2, {7}:2, {4, 6}: 2, {4, 7}:2} with MFT as 4 and MRT as 1 and the resulting tree is shown in Fig. 5.

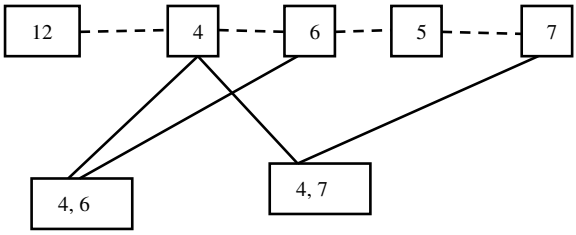


Fig. 5 Perfect rare items generated with EClat_PRPGrowth

6 Experimental Results and Discussion

The proposed section shows the performance of proposed algorithms with different datasets from the UCI machine learning data mining repository [13], Datasets that are used in experiment are shown in Table 5 with their characteristics and FIMI data sets [14], tabulated in Table 6. The performance of algorithm is compared with RP-Tree and R-Eclat. The experiments were conducted on an Intel core i5 2.4 GHz machine running under the Windows 10 Operating system with 8 GB RAM.

6.1 Comparison of Performance

Performance in terms of execution for Eclat-based techniques mainly depends on the number of candidate items generated and methods used to perform the intersection operation of two itemsets. In our approach, the main improvement is the good search strategy and pruning of an invalid candidate itemset generation at very early stages so

Table 5 UCI data sets

Dataset	Number of items	Number of transactions	Max transaction length
Teaching	6	151	6
Adult	15	48,842	15
Zoo	18	100	18
connect	129	67,557	47
Voting	17	435	17
flags	30	194	30
Dermatology	35	366	35

Table 6 FIMI data sets

Dataset	Number of items	Number of transactions	Max transaction length	Database type
Mushroom	8124	120	23	Dense
Chess	3196	76	37	Dense

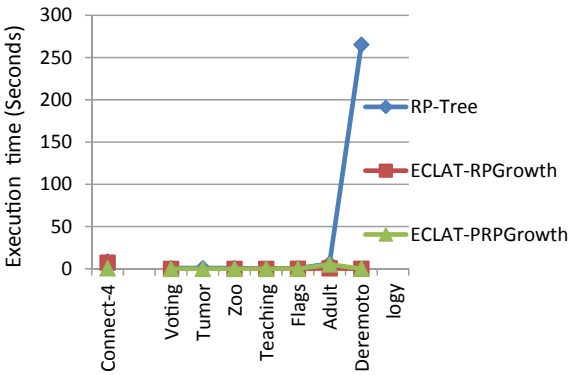


Fig. 6 Comparison of execution time

that numbers of intersections are reduced at each level. The vertical data format uses bitset instead of tidset which reduces intersection time. The proposed algorithms have the advantages of Eclat and also the benefits of breadth-wise pruning like Apriori.

The value of MFT is assumed as 15% and absolute support for MRT as 5 to compare with RPTRee. Performance in terms execution time of three algorithms RPTree, Eclat_RPGrowth, and Eclat-PRP-Growth is shown in Fig. 5. Both the algorithms have improved in execution time compared to RPTree algorithm. A significant improvement has been detected in execution time of adult data set.

The execution time of RP-Tree and proposed algorithms is shown in Fig. 6, significant improvement can be observed in Adult dataset. The number of itemsets generated by our algorithms is also significantly reduced compared to RPTree, the comparison of number of itemsets generated is depicted in Fig. 7, and this is achieved by pruning non-rare itemsets by in the algorithms. Whereas in RPtree algorithm, generated item sets have at least one rare item, but our algorithm has been restricted at most one frequent item in generated rare itemitemsets.

Comparison of R-Eclat (Sorted diffset) with proposed algorithms is shown in Fig. 8. MFT value is assumed as 3% and MRT as 5. The proposed algorithms are better in execution time in case of both chess and mushroom data sets. Significant improvement is observed and is more than 100%. The proposed algorithms are scalable and only limitation is that it requires more memory in case of large datasets as the complete tree has to be in main memory.

7 Conclusion

This research work has presented a new method for finding rare itemsets in large databases using vertical mining and breadth-first rare pattern tree with two variations. This research work has utilized the two user-defined support thresholds MFT and MRT to identify rare itemsets. The first method Eclat_RPGrowth algorithm generates rare item itemsets and, the second method EclatPRP_Growth generates perfect rare

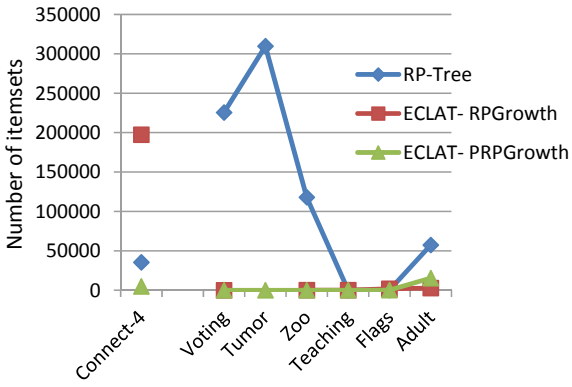


Fig. 7 Comparison of the number of rare itemsets generated

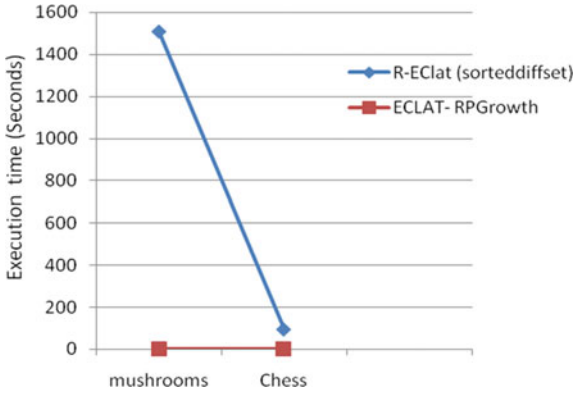


Fig. 8 Comparison execution time of R-Eclat and Eclat-RPGrowth

items only. Two proposed methods are evaluated by comparing the performance associated with execution speed of algorithm against RPTree and R_Eclat algorithms on various datasets from the FIMI and UCI Machine learning repository. We found that in the majority of the datasets, Eclat_RPGrowth generated fewer itemsets, and execution time for our method was less compared to RPTree and R_Eclat. BitSet representation for vertical data format improved the performance of intersection operation and speed of execution. The methods are scalable and the limitation is that it demands more main memory in case of dense datasets having the large number of transactions. In the near future, it has been planned to implement these techniques for incremental databases and data streams and invent methods to generate more interesting rare patterns.

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Research Scholars transferring Scholarly Information through Social Medias and Networks in the Selected State Universities of Tamil Nadu

C. Baskaran and P. Pitchaipandi

Abstract The study analyzes the scholarly information transfering through Social Media and Networks by the respondents in the selected State universities of Tamil Nadu. The study examined that sharing scholarly communication on Web sites that facilitate relationship caters of needs of the researchers in any disciplines varied. This study discusses the total number of 501 respondents have reported from selected state Universities in Tamil Nadu. It determines the results of that male 260 (5.19%) and female 241 (48.1%) of the respondents from the selected eight State Universities. There are eight Universities have been chosen for collecting data from the respondents. The study also attempts to find out that Facebook users are predominant factors in terms of sharing and interacting with peer groups. The respondents highly prefer group sites (Yahoo, Google, and Whatsapp). The research analyses that social media tools for research the majority of the respondents highly preferred Facebook wall for shared the research information by the respondents in the eight Universities in Tamil Nadu.

Keywords Social Medias, Networks · Facebook · Twitter · Blogs · Wiki · Mendeley · Google Scholar · Research Gate

1 Introduction

Internet-based life is the group of online correspondences channels committed to network-based info, connection, content sharing, and coordinated effort. Sites and applications devoted to discussions, miniaturized scale blogging, social bookmarking, and wikis are among various kinds of Internet-based life. It is the best comprehended for gathering new sorts of online media, which share most or the

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entirety of the accompanying qualities such as Web-based life which empowers commitments and input from everybody who is intrigued [1, 2].

Most Social Media services are open to feedback and participation. They encourage voting, comments, and sharing of information. There are some barriers to access and use the content along with the password.

a. To post data about yourself as a profile
b. To post short bits of data as announcements and post photographs and documents
c. To Remark on others' substance
d. To take part in balanced and many-to-numerous discussions.

Make private or open spaces for themed dialogs long-range informal communication administrations, draw together an assortment of apparatuses, and give spaces to a scope of various gatherings to interface, thus it tends to be hard to make speculations regarding how they work. Each help is extraordinary, offers distinctive usefulness, and may be above all has its own way of life. Such societies are to a great extent the result of the individuals who are dynamic members. For instance, numerous clients of Facebook feel that the site ought to be utilized solely for social purposes. Then again, LinkedIn is utilized for the most part for proficient systems administration. In any case, societies develop and change in light of how members utilize the administration [3]. Scholastic and specialists have investigated and analyzed the numerous sides of Web-based social networking over the previous years. Associations take part in online life for the most part with the point of acquiring criticism from partners [4]. While 50 million organizations are dynamic on Facebook business pages, 2,000,000 organizations are utilizing Facebook promoting. Evidently, 88% of organizations use Twitter for promoting purposes [5].

2 Review of Literature

Kreps [6] reports post structuralize study by investigating how intently a person's character is reflected in their online networking profile, for example, Facebook. Garg et al. [7] examined the companion impact in an online music network and found that friends can essentially expand music disclosure. Susarla et al. [8] analyzed that video and client dataset from YouTube and found that the accomplishment of a video immensely relies upon social cooperations, which additionally decide its effect size. Gu et al. [9] explored that despite the advantages of heterophony, financial specialists are charmed by homophiles in their cooperations. Shi et al. [10] emphasized at retweet connections and find that those with feeble ties have a higher likelihood of participating in content sharing. Chiu and Huang [11] investigated the utilization of media correspondence, and the Oriesto shows that client satisfaction from informal communication locales decidedly influences their Web-based life use goal. Zaheer [12] reports the connection between the utilization of Web-based social networking among the university understudied and its consequent effect on the degree of their political interest. People have been seen as progressively dynamic in both

disconnected and online investment. Kalra and Dhingra [13] concentrated on the 46 focal university library site administrations for informal communication apparatuses classifications. When asked to the bookkeeper criticism, recommendations and remarks, contact subtleties/structure/email/telephone, library blog, informing, and so on., Sadowski et al. [14] analyzed the understudies learning advanced education organizations progressively online innovation conveyance for inside learning the executives frameworks (LMS) and outside interpersonal interaction locales means to investigate profundity exertion bunches advanced education understudies sway their instructive experience for features the requirement for steadily estimation of creative instructive activities. Mohammad and Tamimi [15] examined the exploration Imam Mohammad Ibn Saud Islamic University which is situated in Riyadh-Saudi Arabia, and the second is the University of Jordan which is situated in Amman-Jordan University understudies recognitions in regard to utilizing interpersonal interaction sites inside their learning procedure. Adewoyin et al. [16] explored the connection between Internet-based life use and administrations by administrators in government Universities in South-West Nigeria. A large number of the library benefits in university libraries in Nigeria are conveyed physically, and the conveyance of these administrations through conventional methods has been bulky and time squandering. Asnafi and Rahmani [17] surveyed the job of eExploration door in the improvement of logical insightful exercises among employees of University of Tehran's Designing School. The convenience of exploration entryway capacities, which were extricated utilizing writing survey and exploration door site, demonstrated that these abilities influenced on accomplishing researchers' examination objectives. Muscanell and Utz [18] broke down the exploration door (RG) is an Internet-based life stage for researchers, scatter their work, and fabricate their notorieties of the examination. The researchers are transferring and sharing original copies, introductions, and undertaking related materials, and asking and noting research-related inquiries. Baskaran [19] inrestricted the utilization of informal organization and media by the exploration researchers in chosen universities of Tamil Nadu. The most noteworthy 87 (31.9%) of respondents from Annamalai University and (16.8%) and (15%) of the male and female individually out of 273 complete respondents reacted to the examination. The study finds for more respondents (17.2%) of them 26–35. It is followed by (27.1%) of respondents of the executives/trade. The greater part (83.5%) of respondents utilized "Whatsapp". Baskaran [20] investigated the dominant part 73 (32.0%) of the respondents recorded from Alagappa University, though 44 (19.3%) were male and 29 (12.7%) female. The examination exposures that more respondents are 54 (18.8%) of respondents in the age bunch between 26 and 35 at Alagappa University. It is seen that out of 228, respondents were reacted from four Universities, among them significant bit 146 (64.0%) of respondents is unmarried when contrasted with (36.0%) of them wedded class. Wakefield and Wakefield [21] examined the Facebook and Twitter to show that fervor joined with enthusiasm goes about as an ideal factor for expanded online networking commitment. Xu et al. [22] explored the picture and good convictions joined with network arrangements and friend pressure goes about as hindrances to hostility via Web-based networking media. Baskaran [23] investigated those 11,941 records on informal organizations and media recovered from the

Web of Science database during the time of the study. The investigation found that more than ten distributions were contributed by an individual region out of 11,941 records during the period. Liu Y has contributed 37 (0.31%) of the distributions as a top positioned originator in the exploration.

3 Objectives of the Study

1. To know the Gender-wise respondents of concentrate on use social medias and networks in the state universities of Tamil Nadu.
2. To discover the utilization of SNS/Media on the modules for sharing research information by the respondents.
3. To examine the respondents explored towards preference of different type of social Medias in the selected State Universities.
4. To evaluate the exploration on the preference of social Medias tools by the respondents.
5. To analyze the respondent preference of social Medias Research Citration Indexes (RCI) in the selected State Universities of Tamilnadu.

4 Methodology

The examination endeavors to measure the information by appropriation and gathered from the respondents in the selected state Universities in Tamil Nadu. The present investigation incorporates only full-time Ph.D. and examines researchers engaged from chosen state universities in Tamil Nadu. There were eight state universities for conveying the survey and gathering the information. The eight Universities have been accredited with A and A+ by NAAC. The eight universities are University of Madras, Annamalai University, Bharathiar University, Bharathidasan University, Madurai Kamaraj University, Alagappa University, Manonmaniam Sundaranar University, and Periyar University. An aggregate of 520 total questionnaire disttributed among respondents in the eight universities in Tamil Nadu. Further, total number of 501 (96.34%) of the respondents is taken the survey from Social Science Departments in the selected Universities. The investigation takes place for the reason to focuss the carries of the factual dissects with ‘SPSS 20.0’ for Windows to explored and condense information gathered from the respondents. Further, the endeavor to investigate the rate instrument is utilized to discover most of the utility on specific factors, chi-square test, and one way ‘ANOVA’ tests were utilized for analyzing the data.

5 Analysis and Discussion

Table 1 indicated that the respondents were from state universities that are accredited "A" Grade by "NAAC". A total number of 501 respondents were reported in this study. The study analyzed that majority 87 (17.4%) of the respondent are from Annamalai University, whereas 46 (9.2%) of the male and 41 (8.2%) of the female. It can be noticed that more than 14% of the respondents are from Alagappa University (14.6%) and Periyar University (14%), and it followed by Manonmaniam Sundaranar University (13.2%), Bharathiar University (12.4%), Bharathidasan University (10.2%), and Madurai Kamaraj University (10%). The study could notice that very least respondent reported from the University of Madras (8.4%) out of eight Universities in Tamil Nadu. It is concluded that out of 501 respondents 260 (51.9%) of the male, 17.8% of less than that male respondents, the female participants witnessed 241 (48.1%) of them responded from eight state universities in Tamil Nadu (Fig. 1).

The study found from Table 2 that more than 14% of the respondents are from Alagappa University (14.6%) and Periyar University (14%). It was followed by Manonmaniam Sundaranar University (13.2%), Bharathiar University (12.4%), Bharathidasan University (10.2%), and Madurai Kamaraj University (10%). The study could notice that very least respondent reported from the University of Madras (8.4%) out of eight universities in Tamil Nadu. It is concluded that out of 501 respondents 260 (51.9%) of the male, 17.8% of less than that male respondents, and the female participants witnessed 241 (48.1%) of them responded from eight state universities in Tamil Nadu (Fig. 2).

1. **Facebook**: The respondents reported that they used SNs in the selected universities in Tamil Nadu. The study can be witnessed that majority 52 (10.4%) of them used Facebook from Annamalai University and Bharathidasan University. It followed by 50 (10%) of the respondents used Social Networks and Medias from Periyar University.

Table 1 Gender-wise respondents of the state universities of Tamil Nadu

S. No.	Name of the University	No. of the respondents		Total
		Male	Female	
1	Alagappa University	44 (8.8)	29 (5.8)	73 (14.6)
2	Bharathidasan University	29 (5.8)	22 (4.4)	51 (10.2)
3	Bharathiar University	27 (5.4)	35 (7.0)	62 (12.4)
4	University of Madras	23 (4.6)	19 (3.8)	42 (8.4)
5	Periyar University	29 (5.8)	41 (8.2)	70 (14.0)
6	Annamalai University	46 (9.2)	41 (8.2)	87 (17.4)
7	Madurai Kamaraj University	33 (6.6)	17 (3.4)	50 (10.0)
8	Manonmaniam Sundaranar University	29 (5.8)	37 (7.4)	66 (13.2)
	Total	260 (51.9)	241 (48.1)	501 (100.0)

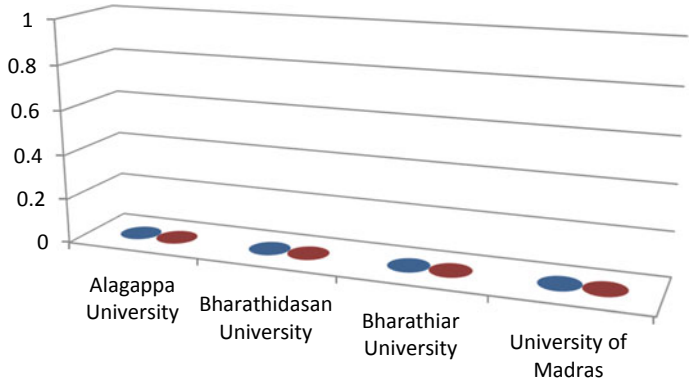

Fig. 1 Gender-wise respondents of the state universities of Tamil Nadu

2. **Twitter**: The majority 21 (4.2%) of the respondents from Alagappa University and Bharathiar University used "Twitter". It has been seen that rest of 103 (20.1) of them utilized "Twitter" by the respondents from Madurai Kamaraj University, Annamalai University, Bharathidasan University, University of Madras, and Manonmaniam Sundaranar University.
3. **YouTube**: The majority 56 (11.2%) of them reported them used from Periyar University, 10.6% of them used from Alagappa University, and 10.2 and 9.8% of them used by the respondents from Bharathiar University and Annamalai University. It is witnessed that
4. **Tumblr/Messenger**: The majority of them reported that "Not use" the social networks of which 45.4% of them higher than predominantly use Tumblr/Messenger. Therefore, this Tumblr/Messenger is a not popular one and shares the information rarely through the social networks.
5. **Whatsapp**: The majority 86.2% of the respondents replied that they were "Use" Whatsapp since this social media is most popular among all category of people, likewise, the respondents disseminate the scholarly information sharing the scholarly contents via this. It is concluded that when to compare the "Non-use" category respondents 72.4% less than that use of Whatsapp by the respondents.
6. **Google+**: The use of Google+ social networks "Use" by 288 (57.5%) respondents is in the state universities of Tamil Nadu. It shows only 15.2% of the respondents are higher than "Non-use" respondents.
7. **Instagram**: The majority 367 (73.3%) of the respondents were not "Use" Instagram, whereas 36.6%. of the "Use" respondents are less than the "Non-use" category.
8. **Others**: Above listed seven social networks are popularly known and used by the respondents in the state universities of Tamil Nadu. The "Others" types of social media are categorized as excluded above described seven social media. It concluded that that majority 86.0% of the respondents are replied the "Non-use" category of Social Media.

Table 2 Usage of different types of SNs among the respondents

S. No.	Name of social medias and networks	Alagappa University	Bharathidasan University	Bharathiar University	University of Madras	Periyar University	Annamalai University	Madurai Kamaraj University	Manonmaniam Sundaranar University	Total
1	Facebook	46 (9.2)	40 (8.0)	52 (10.4)	37 (7.4)	50 (10.0)	52 (10.4)	42 (8.4)	36 (7.2)	355 (70.9)
2	Twitter	21 (4.2)	16 (3.2)	21 (4.2)	16 (3.2)	20 (4.0)	18 (3.6)	19 (3.8)	14 (2.8)	145 (28.9)
3	YouTube	53 (10.6)	37 (7.4)	51 (10.2)	35 (7.0)	56 (11.2)	49 (9.8)	44 (8.8)	45 (9.0)	370 (73.9)
4	Tumblr/Messenger	23 (4.6)	11 (2.2)	25 (5.0)	13 (2.6)	24 (4.8)	18 (3.6)	12 (2.4)	11 (2.2)	137 (27.3)
5	Whatsapp	63 (12.6)	45 (9.0)	55 (11.0)	41 (8.2)	60 (12.0)	67 (13.4)	45 (9.0)	56 (11.2)	432 (86.2)
6	Google +	47 (9.4)	24 (4.8)	41 (8.2)	25 (5.0)	38 (7.6)	53 (10.6)	28 (5.6)	32 (6.4)	288 (57.5)
7	Instagram	17 (3.4)	13 (2.6)	27 (5.4)	19 (3.8)	17 (3.4)	17 (3.4)	15 (3.0)	9 (1.8)	134 (26.7)
8	Others	18 (3.6)	4 (0.8)	9 (1.8)	8 (1.6)	8 (1.6)	5 (1.0)	10 (2.0)	8 (1.8)	70 (14.0)

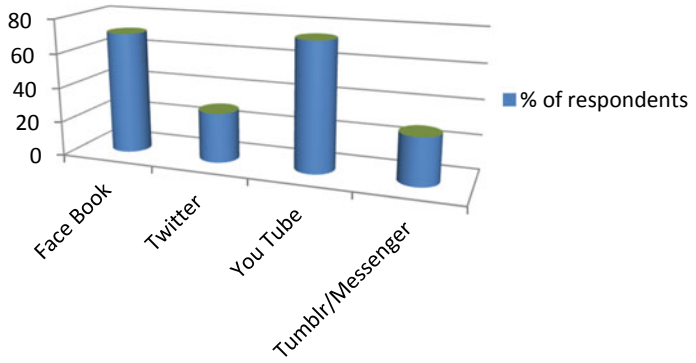

Fig. 2 Usage of different types of SNs among the respondents

The study discussed that SNs modules used by respondents from the selected state university of Tamil Nadu. Table 3 analyzed that above 50% of the respondents, among them, 339 (67.7%) of the respondents preferred "Group sites" (e.g., Yahoo Group, Google Group and Whatsapp group, etc.), followed by 285 (56.9%) of them preferred "Instant messaging sites" (Whatsapp). The study witnessed that below (50%) of respondents preferred, out of the 149 (29.7%), 87 (17.4%) 76 (15.2%), and 63 (12.6%) of them noticed "Profile-based multi-dimensional site", "discussion forms", short messaging services, and blogs, respectively. Further, the study could be witnessed from Fig. 3, the other SNs modules preferred by the respondents to share the scholarly information, only 41 (8.2%) of them recorded for preferred besides six modules by the respondents of the study (Fig. 4).

The respondents do prefer tools for sharing contents/texts related to scholarly information share through SNs in the state universities in Tamil Nadu. Table 4 analyzed that there are seven tools as given. The majority 211 (42.1%) of the respondents prefer "Facebook walls" for sharing research contents/texts. It followed that 201 (40.1%) of them preferred "Yahoo/Google+" which is less than only 2% to "Facebook walls".

It is discussed that 157 (31.3%), 42 (22.4%), and 92 (18.4%) of them witnessed that preferred tools for sharing scholarly information on "YouTube comments", "Blogs/wiki articles," and "other tools." Further, the study can be reported that less than 10% of the respondents given their opinion for them sharing scholarly information through SNs, among them "Tweets" (128%), "Delicious Book marks" (7.6%), and "Flickr Comments and Tags" (3.3%).

The social science research scholars concentrate to publish the papers in various journals, whereas they do expect and try to get more citation counts and their h-Index. Table 5 depicts that respondents preferring social media are to share research citation indexes (RCI) in the state universities of Tamil Nadu. The study has been witnessed that there have been listed six "Research citation Index". More than 80% of the respondents among 492 (98.2%) and 431 (86.0%) stated "Get CITED" and

Table 3 Use of SNS/medias modules by the respondents

S. No.	Types of modules	Name of the Universities								Total
		Alagappa University	Bharathidasan University	Bharathiar University	University of Madras	Periyar University	Annamalai University	Madurai Kamaraj University	Manonmaniam Sundaranar University	
1	Group sites (e.g., Yahoo, Google, and Whatsapp, etc.)	47 (9.4)	31 (6.2)	47 (9.4)	30 (6.0)	52 (10.4)	57 (11.4)	32 (6.4)	43 (8.6)	339 (67.7)
2	Blogs	8 (1.6)	6 (1.2)	7 (1.4)	11 (2.2)	10 (2.0)	6 (1.2)	6 (1.2)	9 (1.8)	63 (12.6)
3	Discussion forms	13 (2.6)	13 (2.6)	13 (2.6)	11 (2.2)	16 (3.2)	7 (1.4)	6 (1.2)	8 (1.6)	87 (17.4)
4	Instant message sites	43 (8.6)	29 (5.8)	39 (7.8)	31 (6.2)	41 (8.2)	43 (8.6)	29 (5.8)	30 (6.0)	285 (56.9)
5	Short message services (Twitter)	14 (2.8)	6 (1.2)	11 (2.2)	10 (2.0)	9 (1.8)	6 (1.2)	10 (2.0)	10 (2.0)	76 (15.2)
6	Profile -based multi-dimensional sites (e.g., Friender and Facebook)	16 (3.2)	16 (3.2)	27 (5.4)	19 (3.8)	20 (4.0)	23 (4.6)	13 (2.6)	15 (3.0)	149 (29.7)
7	Other modules	11 (2.2)	2 (0.4)	3 (0.6)	4 (0.8)	4 (0.8)	6 (1.2)	5 (1.0)	6 (1.2)	41 (8.2)

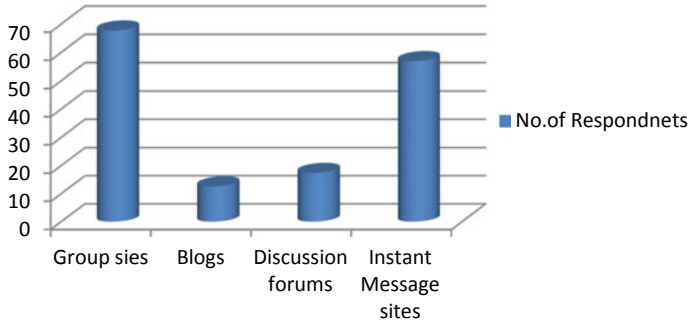

Fig. 3 Use of SNS/Medias modules by the respondents

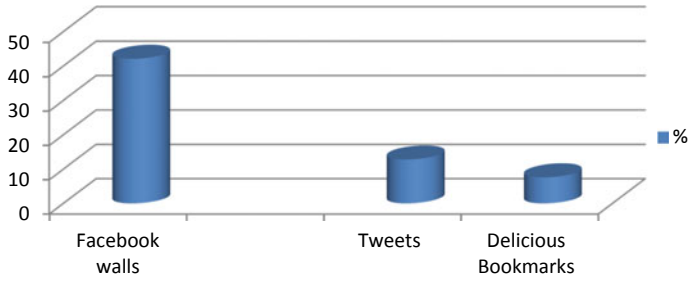

Fig. 4 Tools preference for sharing contents and texts through SNs

"Google Scholar", respectively. More than 20% of the 146 (29.1%) and 115 (23.0%) of the respondents recorded "Scopus" and "Web of science", respectively.

Table 6 analyzed the respondents of the study in the selected state universities in Tamil Nadu. The study finds that the respondents used social media to find out research citations for the publications. The study has been witnessed from the analysis that FR is 3.973 and FP is 0.0003. It has been analyzed that "Null Hypothesis" is rejected from the above analysis. Further, the study has been discussed that there is a critical contrast between the respondents from selected state universities, and they utilized citations of research publications and subject references.

Table 7 discussed the analysis made from the study of the respondents from selected state universities in Tamil Nadu. The respondents preferred social media for other than research activities. The study has been witnessed that FR is 1.6154 and FP is 0.1286. Further, it is witnessed that "Null Hypothesis" is accepted in the analysis. It has inferred that there is no difference between the respondents from selected state universities in Tamil Nadu, and they have been used social media for other than research activities.

Table 4 Tools preference for sharing contents and texts through SNs

S. No.	Types of tools	Name of the Universities								Total
		Alagappa University	Bharathidasan University	Bharathiar University	University of Madras	Periyar University	Annamalai University	Madurai Kamaraj University	Manonmaniam Sundaranar University	
1	Facebook walls	31 (6.2)	25 (5.0)	38 (7.6)	19 (3.8)	32 (6.4)	23 (4.6)	29 (5.8)	14 (2.8)	211 (42.1)
2	Tweets	12 (2.4)	4 (0.8)	10 (2.0)	5 (1.0)	8 (1.6)	8 (1.6)	9 (1.8)	8 (1.6)	64 (12.8)
3	Delicious Bookmarks	5 (1.0)	5 (1.0)	7 (1.4)	3 (0.6)	4 (0.8)	3 (0.6)	4 (0.8)	7 (1.4)	38 (7.6)
4	YouTube comments	25 (5.0)	14 (2.8)	23 (4.6)	10 (2.0)	22 (4.4)	22 (4.4)	28 (5.6)	13 (2.6)	157 (31.3)
5	Flickr comments/tags	3 (0.6)	1 (0.2)	3 (0.6)	–	2 (0.4)	3 (0.6)	2 (0.4)	3 (0.6)	17 (3.39)
6	Yahoo/Google+	42 (8.4)	11 (2.2)	20 (4.0)	14 (2.8)	28 (5.6)	42 (8.4)	17 (3.4)	27 (5.4)	201 (40.1)
7	Blogs/wiki articles	14 (2.8)	13 (2.6)	11 (2.2)	13 (2.6)	14 (2.8)	17 (3.4)	14 (2.8)	16 (3.2)	112 (22.4)
8	Any others	11 (2.2)	7 (1.4)	18 (3.6)	10 (2.0)	16 (3.2)	8 (1.6)	9 (1.8)	13 (2.6)	92 (18.4)

Table 5 Preference of social medias on research citation indexes (RCI)

S. No.	Research citation indexes	Name of the universities								Total
		Alagappa University	Bharathidasan University	Bharathiar University	University of Madras	Periyar University	Annamalai University	Madurai Kamaraj University	Manonmaniam Sundaranar University	
1	Google Scholar	68 (13.6)	45 (9.0)	57 (11.4)	36 (7.2)	66 (13.2)	65 (13.0)	42 (8.4)	52 (10.4)	431 (86.0)
2	Cite Seer	6 (1.2)	1 (0.2)	2 (0.4)	2 (0.4)	3 (0.6)	1 (0.2)	1 (0.2)	5 (1.0)	21 (4.2)
3	Get CITED	1 (0.2)	1 (0.2)	2 (0.4)	–	1 (0.2)	87 (17.4)	50 (10.0)	62 (12.4)	492 (98.2)
4	Math Scinet	1 (0.2)	–	2 (0.4)	–	1 (0.2)	2 (0.4)	2 (0.4)	1 (0.2)	9 (1.8)
5	Scopus	19 (3.8)	18 (3.6)	18 (3.6)	15 (3.0)	30 (6.0)	19 (3.8)	10 (2.0)	17 (3.4)	146 (29.1)
6	Web of science	16 (3.2)	16 (3.2)	11 (2.2)	10 (2.0)	16 (3.2)	19 (3.8)	10 (2.0)	17 (3.4)	115 (23.0)
7	EBSCO	1 (0.2)	4 (0.8)	7 (1.4)	1 (0.2)	3 (0.6)	–	5 (1.0)	3 (0.6)	24 (4.8)
8	Pro Quest	4 (0.8)	5 (1.0)	14 (2.8)	6 (1.2)	8 (1.6)	8 (1.6)	4 (0.8)	4 (0.8)	53 (10.6)
9	Others	10 (2.0)	3 (0.6)	17 (3.4)	9 (1.8)	11 (2.2)	18 (3.6)	9 (1.8)	13 (2.6)	90 (18.0)

Table 6 Respondents Vs. used SNs for tweeting for research ideas

Variable groups	D.F	Sum of squares	Mean squares	*F* ratio	*F* prob.
Between	7	62.0412	8.8630	4.9909	0.0000
Within	493	875.4958	1.7759		
Total	500	937.5369			

Table 7 Respondents Vs. prefer SNs/medias for other than research activities

Variable groups	D.F	Sum of squares	Mean squares	*F* ratio	*F* prob.
Between	7	19.2503	2.7500	1.6154	0.1286
Within	493	839.2926	1.7024		
Total	500	858.5429			

6 Conclusion

The study considered the quantitative data from the respondents in the selected state universities in Tamil Nadu. In the proposed work, the majority of respondents reported from Annamalai University. Now, considering Whatsapp and Facebook is highly preferable to share the research information with others. Likewise, the study witnessed the majority of the respondents preferred Facebook to share the research information. Presently, the researchers are more interested to count their citations on their research work, and h-Index on the purpose of Google Scholar is the primary one it can be registered easily by every researcher. The study analyzed that more respondents highly preferred Google scholar for analyses of their h-Index, citations, and research impact of the publications of social science scholars. The present context of research to an individual depends on the research information and communication disseminated by the social media which is twitted, and Mendeley on the research publications score can be counted to Altmetrics score which will be distinct to the researchers. Social media plays the most vibrant information communication sharing devices in the present context. Research on such networks ought to extend to consider the interaction among the researchers for searching needful information against reviews collecting, fact finding, and an innovative concept on the research. The researcher attempts to seek the methods of research, in terms of origin to develop and support clients "Natural Inspirations". From a hierarchical point of view, examination via Web-based networking media should move past the ordinary dyadic perspective on the connection between an online network and a firm, and the scientists get the insightful correspondences in expanding research spaces, which centers around re-conceptualizing on the Web clients as an eco-arrangement of partners. Online networking has restored the elements between associations, representatives, customers, and academic networks of the information society.

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Twitter-Based Disaster Management System Using Data Mining

V. G. Dhanya, Minu Susan Jacob, and R. Dhanalakshmi

Abstract Social media is an essential part of life for most people around. No wonder even during emergencies like flood or cyclone, more and more people look up to Twitter, Facebook, WhatsApp groups, etc., for immediate assistance. This helps to get data from even remote places and from small groups which will be difficult to reach. This sheer amount of data generated during a short span of time is also the challenge in this approach. Even when there are resources available for help, many requests could go unnoticed. This paper addresses above-mentioned problem by collecting the generated requests for help and resource availability and plot the location in the map. Request data shall be analysed using three machine learning algorithms called linear ridge regression, SGD classifier and Naive Bayes algorithm for the initial filtering and will be passed through natural language processing to match needs and offers within a given geographic boundary. The system is working with 96% accuracy for linear ridge regression and Naive Bayes classifier and 95% accuracy for SGD classifier. The report shall be published to provide a centralized status of requests. This brings more efficient management of disaster situations.

Keywords Twitter · Machine learning · Disaster · Datamining

1 Introduction

Humans are exploiting nature in many ways. Now humans are paying for that. Currently, the world is facing so many natural disasters. In 2018–19, Kerala witnessed drastic flood, and more than 100,000 people had been evacuated from their home. In

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2015, heavy flood due to heavy rain fall happened in Chennai, more than 500 people were killed, and over 18 lakh people were displaced. This all shows how natural disasters make human life difficult.

Nowadays, people depend on social media in a wide range for information sharing around the world. The social media is being considered as a medium for emergency communication because of its growing ubiquity, communications rapidity and cross-platform accessibility [1]. Twitter and Facebook are the major ones among this. Twitter is one microblogging service that allows its subscribers to broadcast short messages, called tweets, of up to 140 characters. These tweets are used to share relevant information and report news [1]. Twitter is taken here for data analysis. For recent years, several data analysis is done on Twitter than the other social media. In other social media like Facebook, messages are coming in many ways in different word length and pattern. The uniqueness of Twitter is tweets coming in structured and precise manner. So, the analysis of data is comparatively easy. Twitter provides excellent APIs for analysing and understanding data. This makes Twitter as a wide range platform for the data analyst. So many requests are coming in Twitter at the time of natural disasters in the form of help request and willing to give help for the victims. But this request is unnoticed because of the immense number of tweets coming at the time of natural disasters. This paper addresses that problem efficiently with the three machine learning algorithms. Linear ridge regression, SGD classifier and Naïve Bayes algorithm are used here, and the performance is calculated with respect to accuracy, precision and recall.

The aim of the proposed system is to identify the help request tweet and tweets coming with the information of the resource availability. So many junk tweets are coming under the same hash tag, so a data set is trained to find the required tweets. Identifying the location of the tweets is an important factor in the disaster management. Some tweets are help request for some other persons in a different location. The location with the tweets will not help here to identify the exact location. This model aims to identify such location with the help of machine learning algorithms and plot the location in the map. So, the rescue operators can easily find the location. This will improve the efficiency of the disaster management in terms of time and resources.

2 Related Works

Nguyen et al. [2] present reinforcement algorithm called ResQ, algorithm designed to develop for coordinating the request from the victims and volunteers providing various assistance in Hurricane Harvey in 2017. Hurricane Harvey was a category 4 hurricane that made landfall on Texas, causing catastrophic flooding and many deaths. The model works for identifying trapped victims and rescuing volunteers and makes use of volunteers rescue strategy at its best and in time-sensitive manner. The effectiveness of this method is validated using the data set collected from social media at the time of Hurricane Harvey held at Texas in August 2017. The significance of this model is that it can schedule multiple volunteers simultaneously for the rescue

operation. This model can work with constantly changing data and achieve best performance over space and time. Alam et al. [3] apart from the analysis of textual content study about how image contents are helping in disaster response which was done. This paper presents human-labelled multimodal data set collected from Twitter at the time of seven natural disasters including wildfire, earthquakes, hurricanes and flood. Lacking labelled imaginary data is one of the issues. In this, this issue is addressed by introducing CrisisMMD, multimodal Twitter corpora consisting of lots of manually annotated tweets and images fetched at the time of seven major natural disasters like hurricanes, earthquake, wildfires and floods that happened in the year 2017 across different parts of the world. The data sets contain three types of annotations: informative versus not informative, humanitarian categories and damage severity categories. Singh et al. [2] propose a tweet classification system to support the victims in disaster. The objective of the system is to classify the high priority and low priority tweets. For these, three algorithms are used, namely (a) random forest, (b) support vector machine and (c) gradient boosting. Very poor result was shown by SVM algorithm than the other two. The classification accuracy of the system is 80%. The location of the user is evaluated from the old tweets if there is no location available in the current tweet. Markov chain method is used for finding the location. For categorizing the tweets here, only the textual contents were taken, and Internet links are not considered. The drawback here is that these Internet links will give information about some other website, in which we can gather more information about the affected area. The system identifies tweets which are related to flood in English and Hindi.

3 Methodology

The data set available in this work is the Chennai flood data set obtained in the year of 2015 November–December. About 40,000 tweets are taken for evaluation. Here it used a customized Twitter script for extracting backdated data by using the key word 'Chennai flood'. So many tweets are coming under this key word which is unwanted like sympathizing the situation or showing emotions. So, pre-processing of data is needed to extract tweets for requesting help and tweets for resource availability. Since it is a large data set, 20% of the data is used for training and 80% used for testing. Tweets collected have been classified using three machine learning algorithms such as linear ridge regression, SGD classifier and Naïve Bayes algorithm, and performances of three are compared with respect of accuracy, precision and recall (Fig. 1).

The methods used for study are classification and regression. Simple linear regression is an effective algorithm for the prediction of valid tweets. Linear regression is a statistical model that shows the relationship between two variables using a linear equation in which X is the explanatory variable which explains the value of the other variable and it is independent. Y is the dependent variable. The motive of the linear regression is to plot the straight line that is best fit for the data.

Equation of the straight line:

	text
4788	This baby was lost in # chennaiflood share this photo ... http://fb.me/6YsuB3oFb
6277	Wishing you strength for today and hope for tomorrow. # ChennaiFlood http://fb.me/4U5Ts1RrE
221	Sathees_offl: RT ishafoundation: DEC 10 - Today's Medical Camps for # ChennaiRainsHelp # ChennaiFlooods vp_offl PremÃ...pic.twitter.com/rMngfapl
5665	Helicopter,Boat rescue by NDRF Tambaram 9445051077 Alandur 9445190012 Adyar 9445190013 Perungudi 9445190014 # ChennaiFlood @ selvaraghav
1917	Great tribute by @ arrahman ji for TN # ChennaiFlood # ChennaiMicro https://www.youtube.com/watch?time_continue=87&v=KwUaTVZPs4M Â...
3526	10 # Selfless celebrities from # India united as one in aid to all the # ChennaiFlood victims! http://bit.ly/1SNONwd pic.twitter.com/RCAsshOOHo
2047	@ HyundaiIndia @ Hyundai_Global : # ChennaiFlood affected cars totaled.. Help us replacing with New car, with discount price.. Mine is 2mth old
6921	??????? ?????????? ????? ???????? ????? ???, ??????? ??? http://eisamay.indiatimes.com/nation/flooded-chennai-traumatized-by-stray-snakes-d
2917	# BackToSchool from # ChennaiFlood # chennairain
5170	Emergency (Medical Help : Call at 044-23452338 & 9840630903) # ChennaiRainHelp # ChennaiFlood # ChennaiRains
3004	Chennai floods: Madras HC seeks state report on Ã'lack of relief coordinationÃ' https://shar.es/1GgriK # ChennaiFlood # Jayafails
6671	# chennaiflood
6467	# ChennaiFlood disaster unprecedented: Venkaiah Naidu http://bit.ly/1I77tMO
6314	RT Verified- Food for 200 people available i KKNagar. Those in need please contact FESTUS - 9791183785 # ChennaiFlood # ChennaiDrowning
5254	# chennaiflood @ ArvindKejriwal JI AAPNE MLA KI BAJAY INKA VETAN BADHANE KA FESALA LIYA HOTA. INSAN K ROOP ME BHAGWANpic.twitter.com
4285	Why is Chennai Under Water http://helloexcuseme.net/chennai-flood/ # ChennaiRain # ChennaiFlood # ChennaiRainsHelppic.twitter.com/NNE0i8i
6207	# crowdsourced # ChennaiFlood map http://osm-in.github.io/flood-map/chennai.html#9.32/13.0288/80.1589/-7.9 Â... # BigData
5858	To call helicopter for help raise ur hand in Y Shape.. it will be understood by PILOT # ChennaiFlood # ChennaiRainsHelp
4720	# chennaiflood I only came to chennai with rescue team for helping flood victim .
4210	???? ?? ??? ???? ??? ??????? ?? ??? ???? ?? # ChennaiFlood ??? ???? ?? ??????? ?? ??????? ?? ????? ???? ???? @ ISapnaMishra # helpingsouls

Fig. 1 Sample data set

$$Y = mx + c \tag{1}$$

so that it finds the best value for m and c so as to reduce error between actual value and predicted value. The line with least error is line of regression and the best fit line. The attributes considered in this work are set of tweets as input and set of valid tweets with respect to scope of analysis (in this case, flood) as target. Regressive analysis of data was done, and here linear ridge regression model is used for data analysis.

3.1 Linear Ridge Regression (LRR)

Linear ridge regression is employed in scenarios where there is high variance of data points as compared to the data which is used to train the model. It uses the regularization technique to penalize the model. By adding a bias, it creates a new line with low variance. Thus, applying ridge regression technique, the penalty is reduced and thereby variance.

$$\min(||y - x(\theta)||_2^2 + \lambda||\theta||_2^2 \tag{2}$$

3.2 SGD Classifier

Other than gradient descent, stochastic gradient descent selects some random samples for each iteration from the whole data set. The path taken to reach the minima is nosier than GD algorithm but SGD algorithm is computationally low expensive. For

performing the iteration, the sample is shuffled and randomly selected.

$$\theta_j = \theta_j - \alpha\left(\bar{y}^i - y^i\right)x_j^i \tag{3}$$

3.3 *Naive Bayes Classifier*

Naive Bayes is a problematic machine learning algorithm which states the conditional independency of the features in a model. This is widely used in the classification task. The theorem assumes that the features in the model are independent to each other. That is, a given change in one feature does not make any change to other feature(s) which is used in the algorithm. Naive Bayes classifier works on the basis of Bayes theorem.

Bayes theorem:

$$P\left(\frac{A}{B}\right) = P\left(\frac{B}{A}\right)P(A)/P(B) \tag{4}$$

Here B is the instance, and A is the hypothesis. Using this theorem, we can find the probability of A happening, given that B has occurred (Fig. 2).

Finding the location of the tweet

Tweet information filtered through machine learning model shall be passed through natural language processing algorithm to understand type of requirements/resources

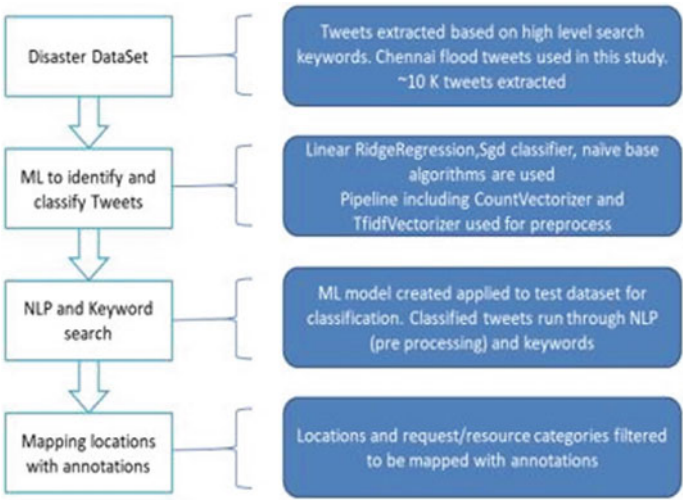


Fig. 2 Methodology structure

and identify location in the tweet. Tweet locations from Twitter may not be always helping here as the request could be made from a different Twitter account, not the actual victim or volunteer. Also, the type and nature of request could be dependent on disaster hit area. So, these two information shall be kept as configurable so as authorities can set it as per the ground requirements.

Once analysed result is ready, geo positioning information shall be generated for the identified locations. This is achieved using module geopy, geocoders and geolocator methods.

For a given location, it shall return the latitude and longitude information. Geo locating information generated shall be then used to create maps. Mapping is done using folium module.

4 Implementation

Training and test data sets are converted to Pandas database for ease of processing. 20% of data set is used as training data set and is trained manually labelling tweets related to Chennai floods (true positive) as 1 and others as 0. Both trained and test data are then converted to matrix of token counts. A sparse data set is created which is then converted to dense to save memory and to improve performance. Original data will be pre-processed to further filter out random data during digitizing. Three machine learning algorithms are used to process data. Digitized train data are then fed to the machine learning model to fit the model for specific input requirements. Cross-validation methods are used to check the effectiveness of the model. Accuracy rates around 70% were achieved in the initial phase.

Tweets identified from the machine learning module are further moved through natural language processing to identify keywords in the given data set and location from where the request/response a given tweet is referring to. Depending on the nature of emergency and location, data set shall be created for filtering process. Filtering of data to a desired level is achieved with pre-processing itself.

Filtered data shall be validated against a set of preset keywords to identify nature of request and preset location to identify the exact location where assistance is required.

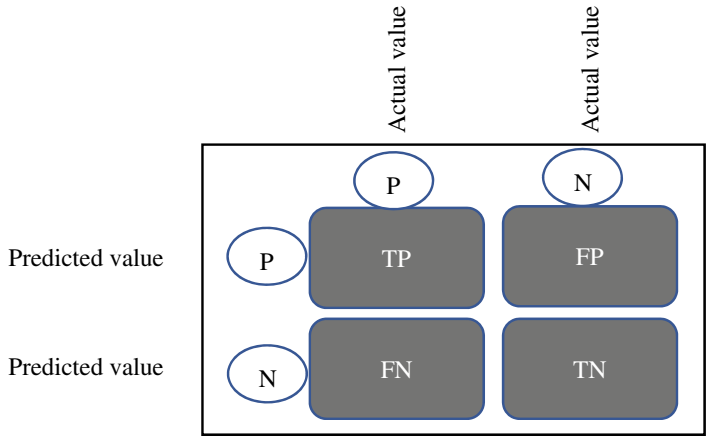
5 Result and Discussion

The performance of a classification model can be described using a confusion matrix. Here it used three machine learning algorithms for classification. Confusion matrix allows the visualization of the performance of an algorithm.

Evaluation matrix is defined according to the confusion matrix (Table 1).

Accuracy is the ability of the model to predict correct instance for the given observation. Precision is the fraction of the relevant instance among the retrieved

Table 1 Confusion matrix



TP = observation and prediction positive
FN = observation positive, prediction negative
TN = observation negative, prediction is also negative
FP = observation negative, prediction positive

instance. Recall is the total amount of relevant instance that are actually retrieved (Table 2).

Validate the model with the 20% of data which kept aside. The predicted result is again analysed, and the number of true positive cases is identified. Thousand eight hundred and seven tweets got as the predicted data and in these 40 data are true positives, that means, tweets related to help offerings or tweets for help request. Fifteen data are false negative, that means, tweets related to request for help or

Table 2 Evaluation matrix

Accuracy	$(TP + TN)/(TP + TN + FP + FN)$
Precision	$TP/(TP + FP)$
Recall	$TP/(TP + FN)$

Table 3 Confusion matrix for the three algorithms

R. R		SGD		N. B	
TP	FP	TP	FP	TP	FP
40	0	37	0	38	0
TN	FN	TN		TN	FN
1719	15	1716	17	1717	14

resource availability but it is predicted as negative. This can be improved by giving more specific keywords and adding more filters in the trained data set. Thousand seven hundred and nineteen tweets are true negative means tweets which are not related to our requirement category. But that are coming with a hash tag of Chennai flood. Tweets are related to some personal statements, sympathizing situations, donations given by actors or political leaders, free performance of celebrities to raise the fund. Like this so many tweets come under the hash tag of Chennai flood or Chennai rains. So, finding the required tweets from this large amount of junk tweets is really challenging. But it is effectively done with the three machine learning algorithms. No false positive case is identified. It shows the efficiency of the model. There is a slight difference in the numbers of result by using three algorithms. It is shown under the table given (Table 4). validate the model with 20% of data so the number of data in the result is very less (Table 3).

Entire data set is divided into 20 folds for evaluation. Here performance of the system is calculated with 20-fold cross-validation. Each fold is verified using this cross-validation. The difference with respect to performance in each fold for the three algorithms is evaluated (Table 3).

The accuracy, precision and recall of the system using the three different algorithms are given below. Accuracy of the model using the three algorithm is plotted below (Figs. 3, 4, and 5). Values of the first tenfold are taken.

It is clear in the graph that accuracy is gradually increasing over folds. Above 97% accuracy is shown with linear ridge regression.

For SGD classifier and Naïve Bayes algorithm, it got only 96% accuracy. So, it is showing that linear ridge algorithm is best for this model (Figs. 6 and 7).

Table 4 Performance comparison table (first tenfolds)

Folds	LRR			SGD			Naïve Bayes		
	Accuracy	Precision	Recall	Accuracy	Precision	Recall	Accuracy	Precision	Recall
1	0.954	0.946	0.962	0.957	0.958	0.966	0.96	0.926	0.962
2	0.963	0.946	0.962	0.957	0.958	0.966	0.96	0.926	0.962
3	0.957	0.946	0.962	0.96	0.958	0.966	0.96	0.926	0.962
4	0.969	0.946	0.962	0.96	0.958	0.966	0.960	0.926	0.962
5	0.963	0.946	0.962	0.96	0.958	0.966	0.96	0.926	0.962
6	0.963	0.946	0.962	0.957	0.958	0.966	0.963	0.926	0.962
7	0.96	0.946	0.962	0.96	0.958	0.966	0.963	0.926	0.962
8	0.967	0.946	0.962	0.963	0.958	0.966	0.963	0.926	0.962
9	0.972	0.946	0.962	0.963	0.958	0.966	0.963	0.926	0.962
10	0.972	0.946	0.962	0.963	0.958	0.966	0.966	0.926	0.962

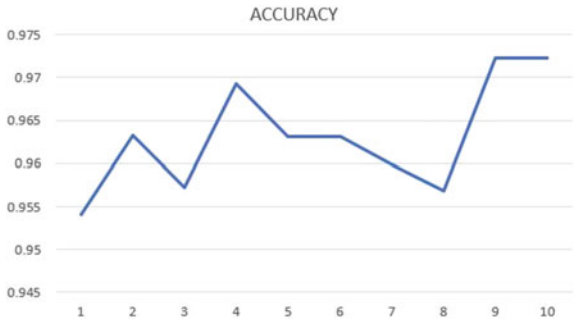


Fig. 3 Accuracy over tenfolds using linear regression

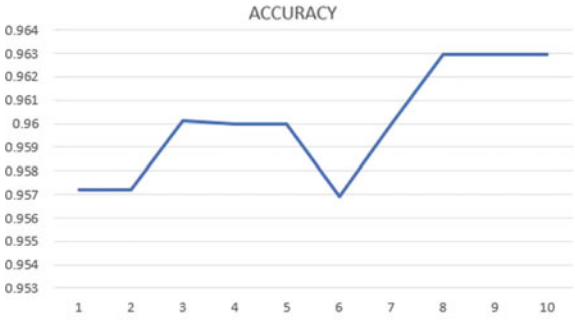


Fig. 4 SGD classifier accuracy over tenfolds

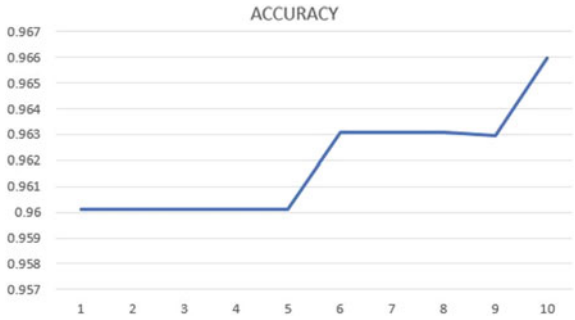


Fig. 5 Naive Bayes algorithm accuracy over tenfolds

6 Conclusion

In case of emergencies, people are making use of social media platforms, and the trend is increasing as it can be observed from the recent situations faced in India. Utilizing the advancement in AI and machine learning, request in Twitter can be tracked and channelled for assistance, and the same is demonstrated in this paper. This paper proposes a model using linear ridge regression, SGD classifier and Naive Bayes algorithm to identify the valid tweets. The system is working with an accuracy of 97% accuracy for linear ridge regression and 95% for SGD classifier and Naive

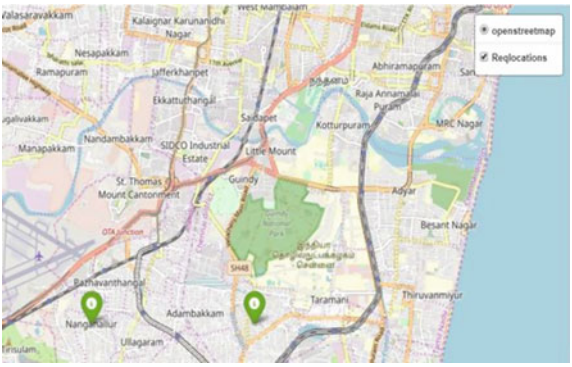


Fig. 6 Request location

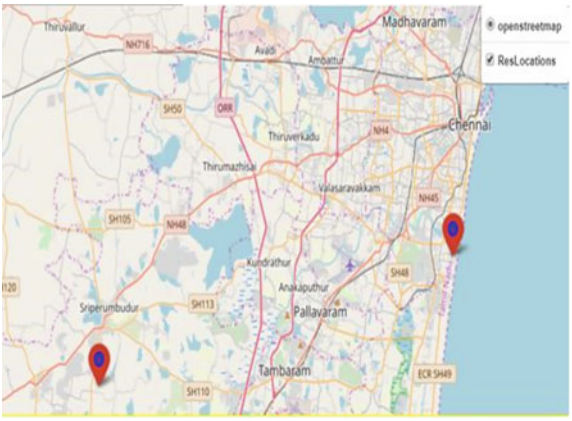


Fig. 7 Resource location

Bayes. Anybody can easily identify the location of the help request and resource availability through this system. This system helps the efficient management of time and resources at the time of disaster. The future work is planning to map the requirement request and the resource availability according to the nearest location. The mapped result is published in other social media platform or conventional media, so that there is better access of data to the people of all walks of society. Working together with government entities for data sharing will also come in future scope.

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Sentimental Analysis on Twitter Data of Political Domain

Seenaiah Pedipina, S. Sankar, and R. Dhanalakshmi

Abstract The arrival of social media has initiated the platform for the public to express their views and to share their emotions. In addition to this, smart phones and mobile communication technologies have emerged and become as a tool to spend more time than earlier on social media to be in touch with their friends. The way of expressing the thoughts, attitude, and feelings is changed drastically due to that short messages and emoticons utilization has been increased through social media. There have been no constraints in using the micro blogging services like Facebook, Twitter, etc. Thus, these messages are the views of people used to describe their behavior. Nowadays political party workers and leaders also started spending more time on Twitter, Facebook, and blogs to be in touch with the public. Hence, political parties or social media campaigners started analyzing for the solutions to utilize the public opinions or views about their own political party. A program is developed which collects the reviews or text posts of people and transfer it to the next module called pre-processing or cleansing. This module is to remove URLs, special symbols, Junk text, stop words, and tokenize the sentences and to perform the stemming process. Word2vec model is used to perform the word embedding to convert the text data into numerical vector format to transfer it to Recurrent Neural Network. The sigmoid function is used as an activation function to classify and polarity of positive and negative sentiments have been evaluated. The effectiveness of the proposed system has been proved through experimental analysis in this paper. This proposed system will be used to understand the winning chances of political party and to analyze the response of the public on particular political decision during election campaign.

Keywords Sentiment mining · Sentiment analysis · Word2vec · Artificial neural network · Classification

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1 Introduction

The utilization of the internet has got increased rapidly and social media has a major contribution to users. Social media has created the platform for the users to share their feelings, status, and emotions; this includes feedback about a particular product or movie, experience of a particular service, opinion on the government reaction over social issues, etc. Users post their opinions through microblogging sites or social media as their expression. As the usage of social media is high, hence it generates a huge amount of data, which can be used to identify the collective sentiment of people. Thus, it has become the best option for taking important decisions related to their business, to run the political campaign according to the people's interest, and for good product consumption.

Earlier political parties used to conduct surveys collecting sample opinions in person to understand public satisfaction on government but the consumption of time and cost is high in this approach. In these days, even politicians are creating their official pages on the social media especially on Twitter to stay in touch with the people. Public also responds in social media over the government performance, social welfare schemes implementation and public sector services. Thus, political parties started leveraging the social media platforms by extracting the data from the micro blogging services, which is easy and more effective way. Data also trustworthy to analyze as the social media users share their genuine feelings, feedbacks, and emotions. In addition, there are many effective tools available to collect, the data from these sites, which provides by same sites or third-party vendors.

As everyone knows that Twitter provides the access to the raw format of the tweets text data, it is essentials for the analyzer to evaluate and analyze the data accurately. Data is collected from different sources, chances are more to have junk or irrelevant data [1]. Thus, to remove this effective data cleansing and pre-processing should be applied for removing bad data. Sometimes data would be good but it does not help us in classifying the sentiment polarity. More the data is clean more the accuracy would come from machine learning algorithms. Hence, there is very much need in design to have effective data cleansing techniques while pre-processing the data.

1.1 Sentiment Analysis

Sentimental analysis has become the buzzword in the natural language processing as the utilization of this analysis has got spread widely to different domains. This is a process to evaluate the text data and extract the opinion polarity out of the text, and hence this process is called opinion mining. There are three main opinion polarities called positive, negative, and neutral that can be extracted from the text user interested in. This process is used to understand the opinion of the writer or speaker with respect to the subject text [2]. Sentiment analysis is categorized into three levels depends on the text data to which sentiment should be matched.

If the sentiment is assigned to a document, evaluating the whole text belongs to that document then it is called sentiment analysis at document level. For example, if the data is extracted from an internet blog and if the the user needs to identify the polarity of the whole text then this type of sentiment analysis can be used.

If the sentiment is assigned to each sentence in multi-sentenced document then it is called sentiment analysis in sentence level. For example when user wants to assign a opinion polarity for each tweet extracted from twitter belongs to a particular domain (political domain in this paper) then this type of analysis can be used.

If the sentiment is assigned to each phrase in a text then it is called phrase level or aspect level sentiment analysis. In this level, every word is evaluated and assigned the sentiment. When user wants to count the number of positive or negative words present in text then this process can be used.

There are legacy and modern techniques available to perform sentiment analysis. The lexicon-based approach is the legacy technique in which scores are assigned to each lexicon of words or terms. Further, the sentiments can be assigned to text or words using the pre-assigned scores. In lexicon-based, we have dictionary-based and corpus-based techniques. In dictionary-based approach, sentiment is assigned by identifying the presence of signaling sentiment words. The corpus based is data-driven approach where sentiments are labeled based on the contexts.

In this proposed system, a recurrent neural network model is used along with Long Shor Term Memory (LSTM) layer to train and classify the political tweets data with positive, neutral, and negative polarities.

2 Review of Literature

The sentimental analysis has got the huge attention from different domains like marketing, entertainment, digital and political which are actively related to social media messages. IT department has become essential for every company or party to publish messages to their followers and analyze the response. Hence Sentimental analysis is playing a very important role in helping the sources to understand the public response on particular products of a brand or tweets that are posted by a political leader. The different conclusions or insights that companies can understand in this are a mobile company can predict the demand for their upcoming mobile by understanding the positive comments posted on Facebook or Twitter for their posts or advertisements. Audience can understand the product reviews by analyzing the sentiments behind the reviews that are posted for that particular product or a political leader can understand how well the public is satisfied on the new government policy by collecting and predicting the sentiments of their tweets. As such there are many problem statements in which sentimental analysis is helping in different sectors. Hence, there is a lot of scope to research and identify the better solutions than the existing to classify and predict the sentiments. There are different methods and lexical based methods to analyze sentiments from tweets that are in natural language format in order to identify the polarity: positive, neutral, and negative and it. The

lexicon-based method [4], refers two dictionaries; one for bag of words and other for emoticons.

In dictionary approach, list of words has to be built manually and it is a time-consuming process and also requires frequent alterations. The disadvantage of this model is that it cannot assign the polarity for the word which is out of the pre-defined dictionary which leads to bad accuracy of the model. This makes the programmers look for different approaches that are using machine learning. Comparing the accuracy of sentiment analysis using this traditional approach and supervised machine learning approach [5] of Naive Bayes for assigning the positive and negative polarities to tweets data. Existing researches have proved that machine-learning approach is better accurate than lexicon-based method. However, there are disadvantages in machine learning approach as well. The accuracy of naive Baye's model is always proportional to the dictionary size, so the word count should always be high [6] to increase the model accuracy. The other mostly used algorithm in text classification is support vector machines which gives more accuracy than Naïve Bayes but developing SVM model is not easy compared to Naïve Baye's and this requires large amount of training data, at the same time testing the model is also slow. This model also finds difficulty in identifying important words for classification [5]. In natural language processing, each input item may contain multiple sentences, which gives the exact meaning only if they are processed together. So maintaining the context between these kinds of sentences is very much important to get the better accuracy. Traditional machine learning algorithms that are support vector machines, Naïve Bayes are failing to maintain the meaning when they face these data items in input. To get rid of these problems, in this proposed system, recurrent neural network deep learning algorithm is used.

The text data has to be transformed into numerical vector format as input to deep neural network, to accomplish this there are several word embedding techniques. One-hot encoder approach is one of them used mostly for vector representation. In this approach binary values 0 or 1 are assigned for all the elements. 1 is assigned to the index of the integer and remaining all the values would be 0. However, drawback of this method is that context cannot be maintained between the words present in the same sentence. Word2vec is the most widely used word embedding technique and so it is used in this proposed system as well to convert the text data into numerical vector with the dimension of 200.

The following existing experiments have been evaluated to select the effective techniques in pre-processing, word embedding, deep neural network model in different modules in the proposed system.

Kumar et al., proposed a machine learning approach to analyze customer satisfaction from airline tweets [7] which is about investigation of twitter data collected for airline business. Some regular main airline corporations have been chosen across the world based on their number of tweets and followers on the Twitter. Twitter data has been collected, cleansed and transformed into numerical vector format using *n*-gram approach for further analysis. Initially, numerous artificial neural network models were applied and performed testing along with support vector machines on hybrid word embedding, trained and pre-trained datasets. Artificial neural network4 model

has given more accuracy compared to all other developed SVM and ANN architectures models. Further, SVM and ANN4 have been also analyzed using different *n*-gram representation of Twitter data. It has been identified that *n*-gram model with $n = 4$, gives better accuracy for both SVM and ANN4 models. At the end, the convolution neural network model has been developed to predict the sentiments polarity behind the tweets data even though CNN models are mostly used for image classification and it provides a drastic development in sentiment prediction of text classification model performance.

Chen et al., has proposed a system for classifying the sentiments using intensive sentiment supplement information [8] and negative meaning data. This system has addressed the semantic composition problem of current deep neural network related models in sentiment classification. Particularly, this is designed for the major impacts of intensive and negative words through a GRU or LSTM network, that are modeling negative expression and intensive expression. The effect to the sentiment reversing on succeeding expression due to the negative words like "not" and "never" is analyzed in this system by using backward LSTM model. These models are integrated into three neural networks as LSTM, CNN, and Char SCNN to evaluate the efficiency of the above operations, and denoted these new models as NIM-LSTM, NIM-CNN, and NIM-Char SCNN, where "NIM" means "Negative and Intensive Modeling."

Namugera et al. [9] proposed a system to mine the text data and determining the sentiments. This system explores the social media sites like Twitter and Facebook usage by Uganda media houses. This system has examined the tweets data belongs to print and digital media companies in Uganda from Twitter to form the sensible insights using text data mining approaches. The study had proved that tweets with negative sentiment are highly engaged with users. This study has also analyzed the rate at which retweet count or mentions has increased for tweets with negative and positive sentiments and proved that tweets with negative polarity spread faster than the positive tweets. Thus, there is very much need to monitor these negative spreads closely to control the fake news propagation. This study has also recommended to extend the proposed model using beg data analytics for sentiment prediction.

After the study, it is understood that in the social media domain, sentiment analysis has more scope to research in this area. There has been already sentiment analysis is done on the user reviews related to political domain with respect to the government decisions and political issues. As we got the ability to collect and label the huge amount of data, we can leverage the deep neural network models that are recurrent neural network and convolutional neural network. Convolutions networks are best suited for image data analysis. Hence RNN has been selected in this proposed system in addition LSTM layer also provides the capability of maintaining the context between sentences in order to train and predict the sentiment polarity more accurately.

3 System Architecture

This section explains the different modules available in the proposed approach. The proposed system architecture is shown in Fig. 1. This approach has designed to extract the messages posted by users related to political parties, government policies, and political diplomats from the social network sites like Facebook or Twitter and then perform pre-processing by removing the unwanted and junk data, which does not carry any information related to opinion polarity along with the tweets from extracted data. This process is also called cleansing. After performing cleansing, Recurrent Neural Network with LSTM model is analyzed and then the sentiment behind each tweet is predicted. There major steps are followed during the architecture implementation:

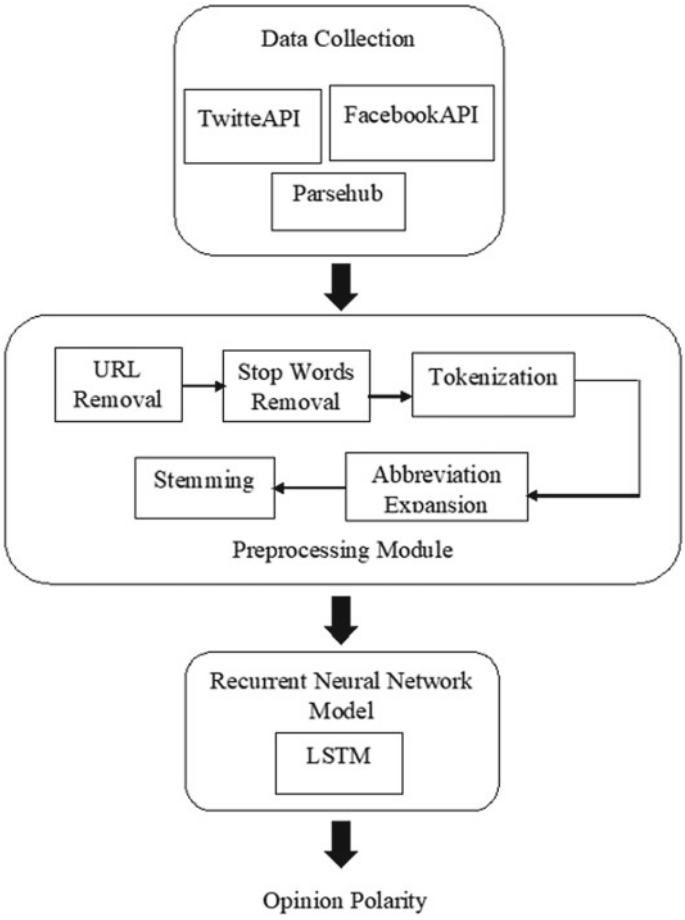

Fig. 1 Proposed system architecture

1. Data Collection using Python API
2. Preprocessing
3. Classify each tweet as positive, negative or neutral using RNN with LSTM.

3.1 Data Collection

The very first step in the architecture is that collecting the twitter data that is posted by public related to political domain. There are several tools and APIs available in order to study the sentiments of the user. Web scraping or web crawling is the technique for extracting the data from web blogs, feeds. Data has been extracted from the widely used social media web sites like Facebook and Twitter. Tweepy OAuth API has been used to import the Twitter data. Facebook's Graph API is used to gather the user posts from Facebook. Data is also collected from public domains sites and different blogs using web crawling API called ScraPy using Python.

3.2 Preprocessing

The data that is collected in the Data Collection step is not structured or semistructured as it contains unusable parts such as web URLs, advertisements, HTML tags, stop words, scripts, and junk characters. The processes of removing all these uninformative parts for sentiment analysis are called pre-processing. In this process, data is cleaned and passed as input to the upcoming steps in the system. The data dimensionality plays important role in classification process, words that are presented in the data is represented as one dimension. The dimensionality also will be increased due to inappropriate words. Hence, the preprocessing or cleansing process is very much essential to get better accuracy out of any Neural Network model.

There are different Python libraries available to perform cleansing process. NLTK is the most used Python library in pre-processing the data. Python regular expressions (re library) can also be used by passing the text patterns to replace the bad data.

Regular expression package is used to delete special characters, URLs and other junk data. NLTK library is used to perform Tokenization, Stop word removal, abbreviation expansion and stemming. The complete preprocessing procedure contains numerous steps: Removal of URL, white space and special characters, removing other words which doesn't help in sentiment classification, tokenization, and parts of speech tagging.

The sequence of steps given as below in preprocessing:

Step 1: Removing junk characters and URLs
Step 2: Removing special characters and numbers
Step 3: Removing stop words from text
Step 4: Tokenizing the tweets into sequence of words.

3.3 Word Embedding

Usually, neural network models accept the input in numerical vector format. Word embedding is the process of converting the text data into multi-dimensional numerical vector format. In this process, 200 dimension input vector is used. After performing preprocessing to remove all the unrelated data from the collected data, this text data needs to be transformed into numerical format in order to pass it to the recurrent neural network for the sentiment polarity mapping process. There are many approaches to perform word embedding. One-hot encoding is the legacy approach which is widely used method for performing word In this method the number of words equals the array of size in the document is preserved. Every word has been mapped to 0 or 1 is characterized by transforming bit from 0 to 1 in the position of that word in the array. The disadvantage of this model is that it cannot maintain the context between multiple sentences when there is dependency between them. The context should be maintained between all the words to understand the correct meaning lying in the text, while converting the text into numerical vector format. The word2vec model is used to avoid this problem in word embedding. This is a shallow and two-layer neural network model designed and mostly contributed byGoogle. These models can be trained to reconstruct the linguistic contexts and meaning of words in between the sentences [10].

Word2vec model can be trained using dataset of textual tweets and posts that are extracted from Twitter and Facebook. Each word in text message is characterized to numerical vector with the dimension of 200. These vectors are further passed to the proposed model recurrent neural network as input. The input tokenized sentences are further converted to order of vectors from order of words with the dimension of 200.

$$-\frac{1}{T}\sum_{t=1}^{T}\sum_{\substack{-c \le j \le c \\ f \ne 0}} \log p\left(w_{t+j}|w_t\right) \tag{1}$$

There are different techniques to perform word embedding in word2vec itself. Here Skip-gram model is used in this proposed model. The word's probability and its context can be increased by using skip-gram model. In Eq. (1), 'w' represents the centered (at t) word and 'c' represents the training context size. The high number of vectors also affects in training phase where there are more words, which does not help in assigning the sentiment polarity. To avoid this, TF-IDF technique is used to reduce the irrelevant vectors while maintaining the each word weightage. This method also evaluates the average weight of the vectors of all the words. Hence, every input sequence is now transformed to vector representation with the dimension of 200 along with the meaning within the sequence.

3.4 *Recurrent Neural Network (ANN)*

Recurrent Neural Networks (RNN) is multi-layer fully connected deep neural networks. This model is used for text classification process. This model has a capacity to evaluate the relation between input data and target variables to identify the patterns associated. There are different factors that plays important role in behavior of the recurrent neural network. They are input data, weights, loss and activation functions. Sigmoid activation function has been used in this model to describe the output of every neuron [11]. Once after text data is represented by the numerical vectors format; these numerical vectors are later passed to feed the Recurrent Neural Network model in training phase. RNN leverages the Long Short Term Memory (LSTM) layer to store the data in memory when there is dependency between multiple sentences to maintain the context of the text while processing is in progress.

RNN contains of 200 inputs, since every sentence is represented using 200 vectors. These inputs are then moved to hidden layer, which is consisting of 100 neurons. Final result is evaluated by the activation function (sigmoid function in this case), which gives output in the form of 0 or 1 (Fig. 2).

The sequence of steps given as below in Artificial Neural Network phase:

1. *Input: Numerical vector of size 200*
2. *Output: Sentiment Polarity*
3. *Initializing weights randomly to the inputs,*

Input layer evaluates total input by

$$I = \sum_{i=1}^{n} W_i X_i \tag{2}$$

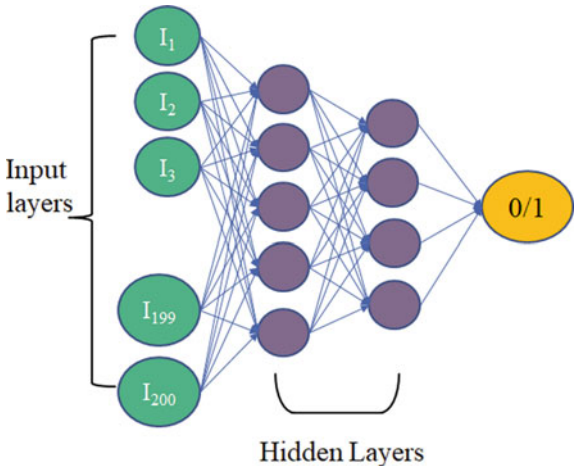

Fig. 2 Recurrent neural network with 200 inputs, 2 hidden layers, and 1 output and single neuron with activation function

4. *Hidden layers perform processing & backward propagation algorithm attempts to decrease the error, the error function is given below*

$$E = \frac{1}{2}\left(\sum_{k=1}^{m}(y_k - d_k)^2\right) \tag{3}$$

5. *Sigmoid function is used as an activation function to produce the output*

$$\text{Sigmoid}(x) = \frac{1}{1 + e^{-x}} \tag{4}$$

4 Results and Discussion

This phase is about discussing the results of the proposed model. Usually, Recurrent Neural Network is suitable for text processing for example predictions and word generation. And also prior studies prove that RNN performs well on text classification.

To train the model a dataset that has 4400 tweets of Indonesia politics has been downloaded and performed pre-processing, word embedding, and passed the numerical vector data to the model. Model has given the accuracy of 85%.

In order to predict the sentiments of the users for the specific political party, around 2350 were collected from Twitter related to Indian Prime Minister Narendra Modi. The collected data is Pre-processed, transformed into numerical vector, and then passed to the trained recurrent neural network model to perform the prediction. After predicting the underlying sentiments positive, neutral, and negative, the count of each sentiment has been represented in Fig. 3. The Sigmoid activation function has given the output with the score between 0 and 1. The tweet that has the prediction

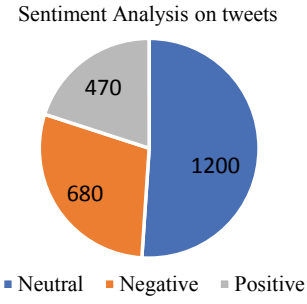

Fig. 3 Count of positive, negative, and neutral tweets

score close to 0 is categorized as Negative sentiment, tweet that has the score close to 1 is categorized as positive sentiment and to classify the neutral sentiment, the scores for few tweets have been evaluated in the middle range and classified them as neutral.

5 Conclusion and Future Scope

Social media has become the platform for public to share views and opinions genuinely. So, political parties can consider it as feedback of the users for their decisions with respect to the government or their own political party. Extracting and evaluating the text to understand the sentiments always help them to take better decisions in attracting the public. The major social media platforms like Facebook, Twitter are providing the access to the users data and tools to collect the data for analysis. The existing proposed systems have been classifying the sentiments by using legacy approaches that are support vector machines, naïve Bayes machine learning algorithms. This paper has extended the analysis using deep learning models like recurrent neural network and LSTM neural network models. The same data has been used for all the above-mentioned models and classified the opinion polarity and all the performance metrics have been analyzed. This proposed model with LSTM layer has outperformed all the legacy algorithms. Different word embedding techniques one hot encoding and word2vec models are used to convert the text data into numerical vectors to pass as input to the model and model has given better accuracy with Word2vec embedding technique. In the future, better data cleansing techniques can be used. Increasing the hidden layers and data size also can increase the accuracy of the model. There are different state of art word embedding techniques like Glove and BERT available to try in the convolutional neural network to leverage the best of deep learning techniques to train and predict the sentiments. Once the model is ready with highest possible accuracy then this helps the political parties to perform sentiment analysis in real time to plan election campaigning to increase the winning chances in the elections.

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Cloud-Based Smart Environment Using Internet of Things (IoT)

E. Laxmi Lydia, Jose Moses Gummadi, Sharmili Nukapeyi, Sumalatha Lingamgunta, A. Krishna Mohan, and Ravuri Daniel

Abstract Internet of things (IoT) is a primary computational paradigm to develop a smart environment in every area of health, city, factory, and home in our daily lives. It incorporates wireless transmissions to all sensor devices through the internet. Equipping a smart environment to the society, IoT as the primary source provides alternative diversified communicating characteristics. Its ecosystem is the solution to all communication technologies as well as designed architectures. This paper deals with distinct core requirements to generate reusable features and technologies to develop a smart environment. Technological architectures like Radio Frequency Identification (RFID) and Constrained Node Network (CNN) are identified to enhance the Internet of things. This paper also describes the necessity of having smart environment sensors with the Internet of Things (IoT). This shows the involvement of a smart environment crossing all communicative disputes from the technical and informative perspective that desires to fulfill the efforts of the people in the coming years.

Keywords IoT · Smart environment · Cloud computing · RFID · CNN

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1 Introduction

The measures of IoT computations and prototypes for communication transmission on connecting frequent objects to the internet are sustained by the establishment of resource-constrain tools. These incorporate and facilitate intelligent systems using sensors and actuators. Intelligent systems gather physical world information to perform actions subsequently. Most of the efficient advantages of IoT have resource management, upgraded productivity, and elevated quality of life for the smart environment of the large human population. The beginning of a smart environment starts with enhancing smart homes, cities, factories, and surrounding areas that relate to our daily activities. IoT tools make possible multiple transmissions of data through Radio Frequency Identification and Constrained node network technologies. These technologies have various features and plenty of heterogeneous solutions for IoT communications. Smart environments gather information from different sources based on different scales with disparate prerequisites. Therefore, information is retrieved depending upon unique domain connectives.

IoT appliances demand maintenance and assist the sensors to handle data for storing, managing, and processing. The various data flow through consistent approaches like cloud computing and Fog computing exist.

The influence of the internet on remote areas comprises scalable solutions with low latency for more number of devices are connected uses fog computing. Real-time interactions for smart monitoring intend to have smart homes through cloud computing. This allows us to control complementary data processing and storage operations but not absolute to the latency such as operating television, turning on the bulb, AC so on through remote control. For explicit interaction of devices, it is mandatory to have either cloud computing or fog computing. Smart cities were operated through cloud and fog techniques. Low latency helps us to have more number of IoT tools with potential information within the city. Production of smart factories invokes advanced sensors and actuators for the internet connectivity among large administration systems and companies through gateway using stream of data. Smart factory applications like Enterprise Resource planning, manufacturing execution systems develop smart products by monitoring machine-health parameters.

To aid all smart applicational manufacturing products, computing analytics help to process data in real-time with capability apprehension. The waiting time of the data processing is the primary concept to progress manufacturing applications as it ranges within milliseconds. Instead of continuous execution of all jobs in cloud computing, smart technologies make use of fog computing to offload some of the data processing jobs. This results in introducing low latency and low operational investment i.e., a smart manufacturing company. Industry 4.0 realize to have cloud computing to share the data from the internet to all enterprise and suppliers which hold manufacturing process using cloud services. The major intention of the expanded transparency through the supply chain and procedural networks lead to the automated production environment.

2 Literature Survey

The dominance to empower users in smart cities reduces the deployment rate and enhances the development of the capillary sensory apparatus. Nevertheless, the beginning of the smart cities uses these mechanisms uniformly to progress and test at many distinct exploratory platforms. Along with the frequent mechanisms the emerging edge computing allows different forms of network organization to sense the environment [2].

Some of the political issues in the cities obstruct the formation of the smart city due to an assortment of technical problems and lack of technologies [1]. The interoperability of high-tech solutions in the area of the Internet of Things extensively identifies the basic technological promoter of smart cities. The modernized progression of evolution uses mobile applications to sense models associate with valuable functionality to sense information from the cities for intimate smartphones [3].

Smart homes provide smart services that vary extensively. Assistive services and management services are the services that help to meet the needs of user mostly elderly people, disabled. These satisfy to furnish the e-health services [4]. The frequent explosion of technological modifications has led to the evolution of smart sensors, advanced computing approaches (cloud computing, big data analytics), internet of things possibly correlated to smart home healthcare projects. These smart home-based projects were carried out in research and commercial systems using two primary real-time telemonitoring methods like video examinations/consultations and also diverse bio-signals [7].

Collection of information from many systems as input, for example, computer vision frame smart environments. The obligation of the entire process acknowledges the smart environment from a human perspective directly or indirectly [5]. According to ICT, mostly contradict to all fields and challenges, and point schemes of smart cities, some precisely extend to smart energy [12], e-government [11], e-health [6],e-culture, smart mobility, e-tourism [16].

Electro-Mechanical Systems (MEMS) use inertial sensors as the most unique measures for better human observations. Depth cameras give more intelligence and evaluate more efficiently [7].

The moderate potential wireless networking is to describe instability as a concern of hasty improvement of ingenious IoT resolutions that unfold the restricted modern technologies. The eventual consideration and the work across the major improvement in limited issues. IoT technologies and systems acknowledge the exchange of data to initiate a smart environment astounded by artificial and enveloping intelligence [8].

For the entire population, quality-of-life is increased through the assistance of adequate resource management, complemented productivity IoT [9]. Later on, the applications are encouraged to enterprise the precision of endemic diseases and deterioration [10]. This can enhance the living standard of smart cities and their reparations.

Intelligent systems [13] for the smart environment include smart remote driving technologies for the benefit of the materialized business standard of Industry 4.0.

Smart homes, manufactured systems, working offices acquire the assistance of common application with the process of acquiring data and dealing with disparate compatible context information.

One of the most complex scheme to develop smart cities and smart environment come across many dominions [14, 15] that incorporate the economy, energy, mobility, governance of a huge number of correlated disputes and implicate collective actors such as city service providers, administrators, operators, citizens with conceivable challenging objectives.

3 Methodology

3.1 RFID Technology

Radio Frequency Identification is a noticeable technology that implements a selection of the immense range of frequencies, merge with multiple device types and communication protocols. It is a standardized model to large international organizations like ISO (International Organization for Standardization), ITU (International Telecommunication Union), IEC (International Electrotechnical Commission), and also national wide organizations like DIN (Deutsches Institut for Normung), JIS (Japanese Industrial Standards) and SINIAV (National Vehicle Identification System). A trivial method is been accepted by all technologies that are equivalent to the Frequency band.

RFID technologies have a low-frequency band with 125–134.5 kHz, a high-frequency band with 13.553–13.567 MHz, and Ultra-high frequency band with 433 MHz and 858–960 MHz, Microwave with 2.4–2.454 GHz 5.725–50,875 GHz. RFID technologies have Passive, semi-Passive, Active, Sensor Tag chip type for transmission, signal modulations, and Chipless time-domain frequency. RFID technologies that are used by the IoT are ISO 14443 (13.56 MHz), ISO 18000-63 (858–960 MHz), ISO 18000-7 (433 MHz), EN 300 220-2007 for different applications such as personal identification, Online Payments, ticket booking, Access control, and security, tracking logistics, retail/consumer applications, real-time location tracking.

Most of the IoT applications utilize any three of the shared types of RFID technologies that match the number of collaborating devices at the same location with supported speed by preventing collisions.

- **Radio Frequency Identification (Identifier schemes)**

The expansion of the open IoT systems consolidate any number of stakeholders with the scalable operation. These RFID identifiers retrieve tags by interpreting them in a general way. Use of widespread standard identifier schemes requests to have RFID among the mixture of material objects, digital artifacts, and their locations with a feasible point of view. SG-1 has matured Electronic Product codes globally through object identifiers at ISO/ITU Organizations. Identifiers from Japan use Ubiquitous

IDs to employ RFID technology. Industries classify tagged billions of objects using barcode encodings. Patterns and codes of the individual scheme may not have the same for all identifiers. EPC system follows a specified prefix code for all its users i.e., 00110000. The remainder of the code generates 96 bit length as Serialized Global Trade Item Number which is always ordered in a stratified process that enables the code within the organizations with allotted authorization.

- **Radio Frequency Identification (Identifier resolution systems)**

Internet of Things (IoT) system integrates with RFID. It tags the existence of individual entities to analyze the information related to the identifier, privacy protection, and secured operations provided by the control access. This capacity and the effectiveness of the system is indicated as Identifier Resolution Service. The ongoing scheme specifications for services use Identifier Resolution Service. Contradiction to the IoT applications, they need to be open and comprehensive.

3.2 Constrained Node Network (CNN) Technology

Technologies like RFID refer to communicate with other objects, but CNN is preferably used to communicate with the physical world. These are the sensing computer tiny devices with a max 16-bit processor and ~10 KB RAM with some computational constraints, energy constraints (for example batteries with limited energy source). The communication transmission can be done through wired or wireless technologies. CNN technology mostly works under MAC and physical layer functionalities. Every innovation may have explicit qualities and might be more qualified for a restricted arrangement of situations. The arrangement of technological advancement consists of

- ***IEEE 802.15.4*** is a wireless technology meant to allow tracking and manipulating various applications for WPAN. Its first publication point to standardized low-rate transmissions and low energy consumption. It was not produced to work for only a particular domain, rather preferred as universal technology with significant protocol architectures by upholding Ipv6 and protocol architecture with non-IP-based protocol architectures. Smart environments with optimized technology like IEEE 802.15.4 were designed to neglect destructions in Industrial environments. This mode of implementation is referred to as Time slotted channel hopping a specified protocol.
- ***BLE*** was launched in 2010 with a very low-electricity variant of conventional Bluetooth. About the partial use of hardware, a tool that is supported by the conventional Bluetooth also supports the low additional price of BLE. Consequently, this will leverage its large existence in smartphones, possibly accumulated information can be sent to nearby sensing devices and actuators. Smartphones that interact using tools, actuators over the Internet have a gateway. This can be further designed for most of electronic devices, wearable.

- ***ITU-T G.9959*** is a wireless Z-wave technology that clarifies the stack protocol mostly innovated to model smart homes i.e., home automation.
- ***DECT-ULE*** is a technology meant for voice and data transmissions through the gateway. It generates low-energy and enables communications for indoor cordless telephony connected to all sensors, actuators by manipulating the robust latency of DECT appliances in the home.
- ***NFC*** is a wireless technology that implements reader mode, peer to peer communications and satisfies multiple communication modes of data communication within a short range of ~10 cm. The intrinsic security properties of NFC provide maximum rejection of unauthorized devices that intend to grab transmitted data.
- ***IEEE 802.11*** is referred to as WLAN wireless communication, designed to have various power-saving techniques with low power consumption, energy-constrained tools. It also enables multiple compilations of sensor devices for data collection namely smart grid.
- ***LoRaWAN*** is a wireless technology referred to LPWAN. Its communication through the physical layer transmits data within 10s of km. It follows star topology as it transfers data between hundreds of communicating devices with low-cost infrastructure, low bit rate limitations through gateway implementing LoRa technology at the layer.
- ***Sigfox*** is similar to LoRaWAN, the wireless technology with reduced bitrate and low-cost infrastructure reflects LPWAN technology. It connects devices of large distances by using star topology. This technology functions under unlicensed frequency bands, managed by the organization.
- ***Narrowband IoT (NB-IoT)*** is one of the advancing wireless technology, categorized as LPWAN. It offers many numbers of systems with a licensed spectrum with a low bit rate of specified 3GPP under the single base station.
- ***Power Line Communication (PLC)*** represents a smart grid framework. It is a wired technology that tampered with the impairments related to the wireless media. Its applications are applied to have an innovative smart home living with a low bit rate. IEEE 1901.2 or ITC-TG.9903 are the variants of PLC.
- ***Master-Slave/Token Passing (MS/TP)*** determines the wired technology usually related to the BAC net. This technology is mostly designed based on grid-powered to develop automated features in the physical layer. These are constrained to RS-485 requirements at low bit rates.

Protocol Architecture for Constrained Node Network (CNN)

Constrained node network architectures were classified into IP-based architectures and non-IP-based architectures. The main protocol and connections were generated and based on the physical layer.

IP-based architectures are interoperable and flexible to communicate remotely with many devices, sensors, internet connectivities, and actuators. The data that has been shared between devices are secure by providing address names. Any connections to the constrained devices use running IP to obtained efficient internet connectivity. It is an open protocol modeled to have underlying technologies and stack protocols

like HTTP, TCP, IP as frequent network interfaces. This can be mostly observed with grid-powered devices. Some devices with insufficient computational power cannot afford to use traditional protocol stack as it is energy-constrained. To advance more in technology IP based architectures added Ipv4 and then later Ipv6 for system self-configuration. IoT stack-based protocol composes of adaption layer down to IPv6, Low powered routing protocol, Constrained Application protocol, and RPL. This also supports IEEE 802.15.4 networks.

Network Topology of CNN
Cities that are developed as smart environment cities adopt mesh network topology. Network with mesh topology is a sophisticated network similar to star topology connections. CNN implements dynamic routing protocol which enables the paths of the network through routers for real-time logical networks. The foremost prominent preferences of the mesh topology of CNN has two advantages. It overcomes the limitations of star topology by reducing the link range. It provides path diversity and avoids star topology single-point failure issues. Due to multiple network connections and path propagation, this will improve the wireless network functionality. This can be applied to develop both smart homes and smart factories with advanced sensors and also with low infrastructure costs. In some cases, LPWAN technologies were also implemented for innovative smart cities.

3.3 Smart Environment Sensors with the Internet of Things (IoT)

The following are the different categories of sensors, technologies that are used to invoke a smart environment using IoT-based Systems. Specialized sensors for smart environments adapt to physical parameters. These sensors are placed for the automatic generation of the information ordered at locations such as homes, body, factory, city, etc. Despite the exploitation of the user information through a smartphone, sensors provide information even though the sensors have not been intended for an unambiguous use case that implicates many disputes.

Specified systems for developing authentic, robustness, and analyzed management of smart factory always encourage to have more sensing effectiveness of the environment, mostly smartphones.

The development of smart homes influences the existence of smartphones. Smart manufacturing devices offer both analog and digital sensors to have quick look over work status. Some of the most implemented manufacturing applications are Industry 4.0 automation. Anticipates the operations that supply information from the device or production of the analyzing process generates a high quality of sensors. Which allows us to have smart homes. Some of the privacy preservations for sensors are considered to come against environmental disputes and performance such as a change in the moisture, the existence of chemicals, vibrations, changes in temperature, dust.

Smart environments mostly reflect the design of smart homes and also overcome the changes affected by nature, i.e., high temperatures, and shocks using a large number of available technologies. Smart homes use ITUTG.9959, infrastructure uses PLC and DECT-ULE. Commonly used technologies are IEEEc802.15.4, BLE. Smart factories use IEEE 802.15.4e TSCH technologies leads to having primary settings. Emerging technologies of LPWAN uses LoRaWaN, NB-IoT, Sigfox. Eventually, the physical environment carries e-health smart applications as home-centric connected to smartphones.

4 Conclusion

Remote operations using IoT-enabled keen cloud computing frameworks provide smart homes, advanced healthcare, smart manufacturing factories, and cities. However, selecting the correct innovative technology reaches the best prerequisites of a particular framework with a challenging errand and produces the best framework modeler due to the huge differing qualities of preferences. The trade of information permitted by IoT innovations and frameworks could be the beginning state for enhancing smart environments encouraged by manufactured and encompassing insights. This paper concludes to design the core requirements that generate reusable features and technologies to develop a smart environment. Two technological architectures like Radio Frequency Identification (RFID) and Constrained Node Network (CNN) are described to enhance the Internet of things. Thus the process of inventing a smart environment for the social changes the style of living to advanced good health and safe life.

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A Review of Healthcare Applications on Internet of Things

S. Chitra and V. Jayalakshmi

Abstract Internet of Things (IoT) is rapidly advancing as a most recent exploration point in various academic and industrial controls, especially in medical care, as the flow transformation of the Internet. Due to the rapid proliferation of wearable devices and smartphones, innovation facilitated by the Internet of Things is evolving medical treatment from the conventional center-based setting to a more Personalized Healthcare System (PHS). Nevertheless, making the use of cutting-edge IoT innovation in PHS remains essentially testing within the area thinking about various problems, such as lack of functional and accurate clinical sensors, unstandardized IoT system models, heterogeneity of related wearable gadgets, multi-dimensionality of generated knowledge, and interoperability popularity. This paper offers a description of the IoT of various diseases in healthcare systems.

Keywords Internet of things · Personalized healthcare · Big data · Sensors · Algorithms

1 Introduction

Internet of Things (IoT) has evolved as another data innovation worldview aimed at creating a specific global organizational system by integrating a variety of physical and virtual 'things' with flexible and sensor growth. At first, IoT was suggested to refer to extremely recognizable articles (things) and their interactive portrayals in a web-like framework, with the use of creativity in radio-frequency identification (RFID). Later on, with a range of sensors, such as actuators, global situating framework gadgets, and smartphones, the concept of IoT was reached out to cover more kinds of 'things'. At an Internet-related point, the consistent mix and efficient outfit

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of these sensors has posed a large number of exploration problems, from framework design, knowledge preparation to applications [1].

The inspiration for the use of current Information and Communication Technologies (ICT) in the medical services context is typically to provide promising responses to the proficient transmission to patients of a wide range of clinical medical care administrations, called e-wellbeing, such as electronic record frameworks, telemedicine frameworks, personalized determination gadgets, etc.

An ordinary case of medical care IoT arrangements is the estimation of vital signs through far-off sensors and the implementation of nonstop and continuous information through cloud administration to the considered expert. Through IoT execution, medical attendants and specialists don't get the chance to stroll around the wards to follow the states of patients. Rather, a point of interest or irregular sign distinguished from the patients may be followed right away. Other than that, the gadgets with wellbeing observing and action following capacities are encountering expanded prevalence, as they permit clients to turn out to be more mindful of their wellbeing related conduct [2].

IoT offers suitable technologies for numerous applications covering all facets of life, such as smart cities [3], smart traffic management, waste management, control of systemic health, protection, emergency response, supply chain, retail, industrial management [4–7] and healthcare. By 2030, 500 billion devices will be connected, which is roughly equal to 58 smart devices per person on our planet, according to a study by CISCO. IoT industry analysis conducted by Statista at the end of 2017 reported that the global market value of IoT will hit USD 8.9 trillion by 2020, and 7% of the overall market value comes from the healthcare sector. With the introduction of IoT and cloud technologies into the healthcare industry, healthcare providers are able to deliver healthcare facilities that are quicker, more effective, and cheaper, resulting in better customer engagement. As a result, better hospital facilities, better customer engagement, and fewer paperwork for health workers are brought in.

Big Data in medical services alludes to such vast and complicated electronic well-being information collections that they are problematic (or difficult) to deal with standard programming or possibly equipment; nor could the board instruments and techniques be efficiently made up of traditional or usual information. Because of its amount and the breadth of information forms, and therefore the pace at which it must be monitored, large-scale information in medical care is daunting. It includes emotionally supportive clinical information and clinical choice networks (doctor's composed notes and medications, clinical imaging, research centre, drug store, protection, and other management information); quiet information in electronic patient records (EPRs); machine-generated/sensor information, as from the verification of critical signs; web-based media posts, including Twitter channel posts And not a lot of patient-explicit data, including information on crisis treatment, news outlets, and clinical journal articles. There is room for the enormous knowledge researcher, among this enormous amount and exhibition of knowledge. Huge data investigation will theoretically improve consideration, save lives, and lower costs by identifying affiliations and having examples and trends within the data [8].

Big Data in medical care requires the processing of large quantities of knowledge from various medical service institutions, followed by the processing, supervision, dissection, analysis, and dissemination of viable interactive data. Six attributes, viz., amount, assortment, speed, veracity, fluctuation, and value, describe the enormous knowledge in medical care. There are numerous large-data logical devices such as Apache (Pig, Spark, Flume, Tez, Oozie, Hive, etc.), Hadoop (HDFS, MapReduce), MangoDB, and so on. Each instrument has its own utility and strength [9].

The remainder of the analysis paper is sorted accordingly. The IoT feature in healthcare structures is audited in Sect. 2. Section 3 addresses the analysis of IoT in different structures of medical care. Section 4 explains the analysis of the examination with its consistency and shortcomings provided in a table. In Sect. 5, the conclusion is given.

2 Role of IoT in HealthCare

The aim of the IoT is to disrupt the medical care industry with innovative advances. The worldwide pandemic caused due to COVID-19 has offered degree to new developments in the web of things. IoT-associated medical services applications offer continuous observing and keen clinical IoT gadgets synchronized to a cell phone application that empowers specialists to gather clinical information of their patients at some random spot or time.

In the event of a health-related crisis such as cardiovascular breakdown, diabetes, asthma attacks, and so on, continuous monitoring using associated gadgets will save a million lives. The associated IoT gadget collects and moves information about well-being, such as pulse, oxygen, and glucose levels, weight, and ECG data. The knowledge is put away in the cloud and, according to the sharing access authority, can be imparted to an authorized person or a doctor.

Interoperability, machine-to-machine communications, data trade, and knowledge creation are facilitated by IoT in medical care, rendering the transmission of medical care administration extremely financially savvy. By minimizing superfluous visits and using higher-quality properties, this innovation-driven structure will minimize costs.

In dangerous situations, continuous follow-up and alarms will transform as a hero to protect the well-being of a simple patient with clear reminders and ongoing cautions for valid testing, review, and study.

For a patient looking for professional assistance, it is a terrible situation, but being unable to communicate with a specialist because of impediments, such as region and lack of knowledge. Via medical services conveyance bonds associated with patients through IoT gadgets, patients may take clinical remedies comfortably. IoT medical care applications help doctors practice, forestall, and analyze medication all the more without any problem. With continuous information and the likelihood to break down past medicines and determination of a patient—Smart medical care frameworks utilizing IoT assists with decreasing mistakes. Besides, consistent robotized

observing and upgraded investigation of the patient's condition prompt appropriate treatment without the chance of mistake.

The information accumulated by IoT medical services gadgets are exceptionally precise and empowers the specialists to settle on educated choices. Understanding history can be examined and estimated quickly. Information can likewise be sent to a leading body of specialists or medical care experts on a cloud stage.

3 Literature Review

Versatile advancements these days assume basic parts in medical care checking and benefits. These advances incorporate cell phones, individual computerized associates (PDAs), portable cameras (e.g., SenseCam), savvy watches, and so forth. As the vast majority of cell phones are installed an assortment of inertial sensors (e.g., accelerometer, spinners, and so forth) and biomedical sensors (skin temperature, pulse, and so on), they are intended for giving customized and nonstop cares to clients. This segment intricately talks about the writing survey on how IoT has been dealt with various constant sicknesses.

Earlier, Al-Makhadmeh and Tolba [10] introduced an IoT-focused clinical gadget for social events, followed by HD patient heart status results. The data was prepared in the wake of being relentlessly communicated to the HC emphasis using the higher-request Boltzmann deep neural organization conviction. The deep learning process, which prompted the strong control of unpredictable data to achieve efficiency, discovered the previous HD angles. The framework's exhibition was processed with an emphasis on these attributes [particularity, f-measure, misfortune function, affectability, alongside collectors working qualities (ROC)]. This current method had 99.03% accuracy with a minimum time complexity of 8.5 s successfully; minimal HD mortality was achieved along these lines by reducing the multifaceted architecture in HD diagnosis.

Majumder et al. [11] implemented a different tactile system by using a keen IoT that gathered information from the Body Area Sensor to provide early provision for fast approaching heart failure. The aim behind the current work was to construct a synchronised brilliant IoT that integrated a correspondence unit of lower power so that one could unnoticeably accumulate pulses using a cell phone alongside internal heat levels without blocking their normal daily life. For sensor information review for detecting and predicting abrupt coronary failure with greater precision, the sign preparing alongside ML techniques was presented.

Mohan et al. [12] suggested a method that discovered big highlights by implementing ML techniques to boost the precision of the cardiovascular disease conjecture. By joining the singularity of the RF couple with the Linear Method (LM), the half and half RF with a direct model was used. This is set up in the HD figure to be very accurate. By means of the forecast model planned for HD, this approach gave an enhanced exhibition level with an 88.7% accuracy level.

Miramontes et al. [13] have planned the PlaIMoS fixed estimation station which estimates persistent blood oxygen immersion, breath rate, and galvanic opposition, which are distinguished by Radio recurrence recognizable proof (RFID) sensor and a PlaIMoS far off hub that gets understanding blood temperature, electrocardiogram, beat rate, and fall information. The fixed estimation station is associated with the web by methods for its Wi-Fi interface which sends all data onto the PlaIMoS information base, situated inside the cloud. The PlaIMoS distant hub utilizes the IEEE 802.15.4 norm to communicate information to the WSN foundation. The Web administration gathers the data from the WSN framework and communicates the information to the PlaIMoS data set. All data put away inside the information base is used by the PlaIMoS API (Web administration) and introduced in JavaScript object documentation (JSON) design for the different applications. The iOS, Android and Windows applications show the information to the taking an interest patients, specialists, and overseers and push cautions when the clinical boundaries surpass the extents set up by the specialist.

Tan and Halim [14] present the AI system to consequently foresee the potential dangers, for example, diabetes and kidney malady. The system measures three fundamental main signs, such as internal heat intensity, beat rate, and heartbeat, planning and adjusting sensor signs to meaningful yield with high precision and displaying the observation results on web apps, for example. The medical services system infrastructure structure is split into a front-end (introduction layer) and a back-end (information access layer). The system coordinates microcontroller-powered sensors throughout the front-end layer to measure a client's critical signals and uses Arduino Nano and Intel Edison as discernible yields to move across the known indicators. The front-end layer contains an interactive UI (GUI) or software application that helps the two patients and specialists to navigate and display the information and data collected. The yield from the information procurement system is imposed on the cloud data collection in the back-end layer and the prior knowledge of information is analyzed. The synchronized sensors are attached to the Intel Edison point, and the yield readings are sent to IBM Bluemix for the database and display of cloud information. The consistency of the model produced is 90.54% and 87.88% respectively, between a stable human and patients with diabetes and kidney failure.

A patient behavior observing system of subjective examination for cardiovascular disease ID and dropping detection was introduced by Chui et al. [15]. It is an enormous knowledge and IoT-based patient behavior control system that can be extended to various applications I malignant growth medicines and genomics; (ii) alert and alarm for quiet detection of vital signs; (iii) medication viability review; (iv) market security of medical care; and (v) prevention and location of extortion. The patient data floods that will be absorbed into Kafka, which is a celebrated open-source, low dormancy, high performance, and scalable programming stage for stream planning. Breathing rate, pulse, circulatory tension, and internal heat level sensors are above all controlled by the mill's clinical and body sensors, as are electrocardiogram, electroencephalography, electrooculography, electromyography, accelerometer, cardioverter defibrillator, and pacemaker. The number of sensors associated with each patient depends on the use, normally directed by specialists in medical services. Segment

statistics, safety data, study centre findings, and clinical records are contained in the very own data of the patients. Third, data logging allows all agreements to be pursued by details, documents or applications that are modified, obtained, or placed away on capability applications or gadgets.

A portable gadget with a bio-detecting facial cover is designed by Yang et al. [16] to track a patient's tormenting strength using facial surface electromyogram (sEMG). The wearable gadget functions as a remote sensor hub and is fused for distant agony observation into an Internet of Things framework. Up to eight channels of sEMG could be investigated at 1000 Hz within the sensor centre, to allow the maximum recurrence spectrum, and gradually transmitted to the cloud worker through the entryway. Expansion of that, through the portable gadget strategy for long-term monitoring, both low vitality use and wearing solace are regarded. A compact web application is created for persistent gushing of high-volume sEMG information, advanced sign planning, deciphering, and representation to detail endless pain information to guardians distantly. As an extension between the sensor centre and the software, the cloud stage within the system supervises interactive communication with the worker and the web application. In summary, this research proposes an adaptable IoT system for continuous biopotential regulation and a wearable reaction by external appearances for programmed torment assessment.

Using Arduino Uno and GSM/GPS technology, Veyilazhagan and Bhanumathi [17] have developed a health surveillance device to protect sick patients and elderly people by an embedded system. To successfully maintain the system, sensors such as temperature, gas, drop detection, heart rate, and blood pressure rate are used. As the central diagnostic tool, this control system was primarily developed for cardiac treatment with electrocardiogram (ECG) signal analysis. The machine consists of three key components, namely (a) a mobile gateway, a mobile computer that collects 12-lead ECG signals from every ECG sensor, (b) a remote server component that hosts algorithms for precise annotation and interpretation of the ECG signal, and (c) a doctor's point of care computer to obtain a medical diagnostic report from the server hardware on the server hardware. For modeling and visualization, the Proteus virtual instrument is used. The GSM module sends SMS updates and health information to the doctor's cell phone.

4 Comparison Table

The comparison table for the techniques reviewed, sensors, devices, network, and data set used along with strength and weakness of the related work is evinced in Table 1.

Table 1 Comparison table on techniques, devices, sensors, network, and data set used in survey

Year	Techniques	Sensors used	Device	Network	Data set	Strength	Weakness	Reference
2019	HOBDBNN Approach, Deep learning	ECG, HR, BP sensors	Wearable watch	Bluetooth	UCI Machine Learning Repository data set	most extreme acknowledgment precision and least time intricacy Limited the HD mortality	The calculation didn't utilize any advancement calculation focused on include choice, which expanded the preparation season of the calculation and that raised a few troubles in dataset the executives for forecast	[10]
2019	Multisensory utilizing a system with smart IoT	PR, Temp sensor	Arduino Uno^{TM}, smart phone, wrist band	Bluetooth	Public data sets	Mix of sign handling alongside ML calculations viably recognized the unexpected cardiovascular failure with higher exactness	The calculation didn't bring up information security notwithstanding the framework isn't savvy	[11]
2019	HRFLM	HB, Temp, humidity sensor	Arduino/Genuino, smart phone	GSM/Bluetooth	UCI Cleveland Repository	Having the improved presentation level with 88.7% precision level	The framework didn't have the ability of observing the HD continuously	[12]

(continued)

Table 1 (continued)

Year	Techniques	Sensors used	Device	Network	Data set	Strength	Weakness	Reference
2017	Not mentioned	Airflow, Temp, HR, ECG, BO, respiration rate, galvanic sensors	Rasperry Pi	Wi Fi	Public data set	PlaIMoS stage performed well in an emergency clinic setting, safely checking, and detailing understanding data progressively conditions	The framework didn't cross allude referenced to give a top to bottom symptomatic to clinical professionals	[13]
2018	Machine learning	Temp, BP, PR sensors	Arduino Nano and Intel Edison	Wi Fi	UCI ML repository	The investigation presents system to naturally foresee the potential dangers, for example, diabetes and kidney infection	The framework introduced examination are a fundamental examination that requires further clinical test and constant information to additionally approve the ML model before framework coordination	[14]

(continued)

Table 1 (continued)

Year	Techniques	Sensors used	Device	Network	Data set	Strength	Weakness	Reference
2019	Machine learning	BR, PR, BP, Temp, ECG sensors	Not mentioned	Wi Fi	Not mentioned	The system can be applied for various applications as cancer treatment, genomics, patient vital sign monitoring, efficiency of treatment, fraud prevention and detection	The framework needs true contextual investigation and restricted subjective examination on just two patient social observing applications	[15]
2017	Big data processing and deep learning	sEMG sensor facial mask	Not mentioned	Wi Fi	Public data set	Low vitality utilization and agreeableness expand the capability of detecting facial cover and sensor hub for long-haul measure	The system needs to test on large data set	[16]
2017	No algorithm	Temp, Gas, Fall, HR, BP, respiration, PR sensors	Arduino Uno	GSM/GPS	Not mentioned	This system is implemented with the low cost to save life in emergency conditions	The system did not apply any optimization algorithm and it needs to be tested on real-time data	[17]

HR Heart rate, *BP* Blood pressure, *PR* Pulse rate, *Temp* Temperature rate, *HB* Heart beat, *BO* Blood oxygen, *BR* Breathing, *ECG* Electrocardiogram

5 Conclusion

The worldview of the Internet of Things speaks to the vision of the subsequent ICT transition sprint. IoT-enabled PHS advancement would allow faster and safer preventive evaluation, lower total costs, increased patient-focused practice, and improved managementability. IoT empowered PHS can possibly fortify our way of life in numerous different viewpoints. In this overview, We checked on the overarching best-in-class innovations for IoT-empowered medical services applications from different points of view. We examined current innovation, sensors utilized, and preparing procedures. All the more critically, we gave an elevated level depiction of differed IoT empowered medical care applications. However, the objectives discovered for IoT in medical services are not effectively reachable, and there are as yet numerous difficulties to be confronted and, thusly, this examination field is getting increasingly more impulse. Therefore, it can be summarized that the entire idea of the IoT and its complete implementation in medical treatment and human prosperity will come from this synergistic approach.

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Big Social Media Analytics: Applications and Challenges

Sonam Srivastava and Yogendra Narain Singh

Abstract Social media plays an indispensable role in the ever-expanding human population, which will in turn result in generating a huge volume of data. Social media analytics is the technique used for acquiring and analysing the data from social networks. The big data associated with social media finds state-of-the-art applications in the distinctive socio-economic domains. A considerable research literature evidence is available on the challenges that are inherent in particular applications of social media or big data separately, but there is hardly any exclusive study that has been performed on the social media big data. To address this gap, this paper presents the state-of-the-art social media big data applications in business, healthcare, education and crisis management with which the challenges associated with them are also critically evaluated. Also, different frameworks of big social media analytics are presented, and their potential in addressing the application-specific challenges is also described. Henceforth, this research article leverages significant advantages to researchers and experts, who wants to gather and analyse the social media data.

Keywords Social media · Big data · Social media analytics · Business · Healthcare · Education · Crisis management

1 Introduction

Today, the amount of data is undergoing unprecedented changes as a result of advances in Web technology, social media, smart phones and sensor-based devices. There are over 3.9 billion social media users worldwide, and their penetration rate is about 51% [1]. Big data market report estimates that the global size of the big data industry will rise from 138.9 billion USD in 2020 to 229.4 billion USD by 2025

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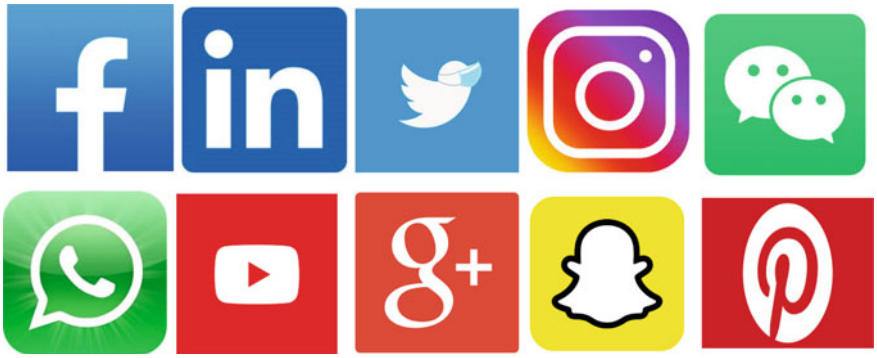

Fig. 1 Social media platforms

[2]. Big data deals with different ways of analysing, systematic data extraction and dealing with data sets that are too complex to handle the conventional data processing applications.

Social media is generally Internet-based applications that are used for sharing the information about social, economic and political interests among virtual communities [3, 4]. The user contents, *i.e.*, comments, textual post, videos and digital photographs, that are generated through the online interactions are remaining as the impulse of social media. The prominent resources of social media include Facebook, LinkedIn, Twitter, Instagram, WeChat, WhatsApp, YouTube, Google+, Snapchat, Pinterest, *etc.*, as shown in Fig. 1. The social media provides a range of benefits and opportunities to empower both people and communities in a variety of ways. Social media has also become a crucial handler for the acquisition and dissemination of information across various domains such as science, entertainment, business, politics, academics, healthcare and crisis management [5]. The social media has become an integral part of digital society with the proliferation of social websites and applications, thus resulting in explosion of data during the recent years. The social media big data holds the characteristics of big data, *i.e.*, it is voluminous, structured or unstructured and generated in real time or streamed. The data generated from social media can be imprecise and uncertain, while issues of information security and integrity are the prime ones [6].

The enormous growth of social media usage has led to an increasing accumulation of data called social media big data. This data may be of unstructured or structured nature [7]. The textual content of social network is an example of unstructured data, while the friends' relationship is the examples of structured data. The social media big data is highly dynamic and complex in nature. It may be incomplete and inconsistent due to availability of unreliable internet sources. Unlike traditional data processing and data mining techniques, the available social media big data needs processing and

knowledge discovery. These social media big data possess enormous market value potential in distinct fields of transport, genetics, online advertisements, finance and energy management. Traditional methods, however, are failing in the face of such large data.

In the recent past, a significant interest is shown in analysing voluminous social media data ranging from business interests to societal benefits. This paper presents a critical survey of big data social media applications in business, healthcare, education and crisis management. This research work critically evaluates each domain of application and the associated challenges with the growth of digital data from its current volume of 44 zettabytes (ZB) to 175 ZB by 2025 [8]. This work also presents the application-specific frameworks of social media analytics to address their challenges, for example, the identification of potential customers, opportunities for targeting advertising, social customer relationship and business intelligence for marketing in business applications [9, 10]. The sharing of medical information with practitioners, feedbacks, health alerts and awareness programmes in pandemic like COVID-19 affects the patient care quality in healthcare applications. The sharing and exchange of academic information to their stake holders make the education convenient and exploration of improved learning methods in education application. The social media data also helps in minimising the losses due natural calamities while defending state or organisational reputation in crisis management applications.

The rest of the paper is organised as follows. The literature review of big social media data analytics is given in Sect. 2. The applications of social media big data along with their challenges are presented in Sect. 3. The description of frameworks of social media analytics to different applications are given in Sect. 4. Finally, the conclusion is drawn in Sect. 5.

2 Literature Review

The big data transformation aims to change the conventional way of how humans work, function and think by allowing process optimisation, enabling the exploration of knowledge and enhancing decision-making. In the context of big data, Heureux et al., have presented a comprehensive analysis of the challenges associated with machine learning and classified them according to the four major Vs of big data, *i.e.,* volume, velocity, variety and veracity [11]. Sivarajah et al., have conducted a comprehensive review that presents a futuristic view of big data challenges and big data analytics. Their study assists researchers to build new solutions on the basis of the challenges that they spotted. Stieglitz et al., have presented the issues of social media analytics, conducted literature analysis and also suggested solutions for the addressed challenges [12]. Their work focuses on the major steps involved in social media analytics, *i.e.,* data discovery, collection, preparation and analysis. The findings may benefit to the researchers working in the area of social media analytics by providing them an insight to solve the issues for social welfare.

Oztamur et al., have intended to examine the role of social media with respect to small- and medium-sized enterprises. They considered social media as a novel strategic tool for social network marketing [13]. Their research focuses on analysis and comparison of American and Turkish companies' accounts on social media. In order to analyse social media data for understanding students learning patterns, a work flow is presented integrating qualitative analysis and mining techniques [14].

Nowadays, social media platforms can be used to track diseases. Alessa et al., have claimed that social media and search engines can be used to predict the seasonal epidemics faster than the government agencies [15]. They have reviewed prevailing alternate solutions that track influenza outbreak using Web blogs and social networking sites. A similar research has been conducted by Qin et al., in the context of pandemic using social media search index [16]. It used to predict the number of novel coronavirus, *i.e.,* COVID-19 cases. The authors have claimed that social media search index is an effective predictor to find the correlation with newly confirmed COVID-19 cases. The methodology for crawling, processing and filtering the tweets accessible freely by the public has been presented in [17]. They used REST API to acquire tweets from Twitter in real time. The authors asserted that mining tweets have potential to supplement current traffic incident data in an inexpensive manner. The concept of crisis and key developments that affect the sense of crisis management around the world is presented in [18]. The conceptualisation of crises, their management and the effects on growing use of social media and connected devices is studied.

3 Applications of Social Media Big Data

It has been reported that in the currently existing digital universe, where 49% of worldwide data would be based on the public cloud environment by 2025 [19]. Nearly 30% data of the world will require real-time processing by 2025. By now, there are over 5000 GB data shared to each person that needs to be processed and discover knowledge from them. There are less than 1% of worldwide data which is analysed, and less than 20% of this data is protected. The sources of this data are business and advertising, healthcare, academics, politics, environmental and social media platforms including machine-generated data. The different applications of social media big data are described, for *e.g.,* business, healthcare, education and crisis management along with their challenges in this section.

3.1 Business

Social media finds its importance in marketing products, promoting brands, connecting to new customers and fostering new business. It provides information on the hobbies, demographics, habits and characteristics of social media users. Social media

marketing takes the benefit of social networking to assist the firms to enhance brand exposure and widen customer reach [20]. It utilises the features of social media, *i.e.*, online communities, and social data in order to take effective business decisions [21]. Social media data enables the advertisers to determine how current and potential customers perceive their products in real time [22, 23]. Thus, it is evident that the social media helps the organisations to acquire customers feedback related to their product which can be used to improve decisions and get value out of their business. It requires careful thinking and planning to use social media for getting the optimum benefit out of business.

In order to resolve the challenges, it is necessary to recognise and leverage the business services provided by social media platforms. Social media makes it simpler for businesses to target consumers directly, create brand awareness, promote products and interact directly with current and future clients. Although, social media enables consumer loyalty, engaging in a public discussion platform often poses risks. There must be a clarity on how negative reviews, inappropriate language and libellous material about the organisation should be handled. It is challenging to ensure that whatever content is shared on social media and how one communicates with people conveys a professional image to the world. Preparing a set of guidelines to handle social media would help to steer through the challenges.

To address these issues, it is necessary to understand the legal consequences and best practise using social media. For example, before launching any website, the insurance about legal aspects like privacy policy, disclaimers, terms and conditions need to be understood.

3.2 Healthcare

In 2018, 2.65 billion individuals worldwide used social media. This number is expected to rise to 3.1 billion by 2021 [24]. Contemporary lives are going digital, and healthcare is not an exception. Social networks have emerged as an essential health resource not only for millennials but also older generations those utilised social media for seeking and sharing health information. Over 99% hospitals across USA have their own active Facebook page, and a rising number are also establishing their existence on other social media platforms like Instagram and Twitter. Through these platforms, the health systems and physicians receive feedbacks, share health alerts and strengthen their brand with focus on creating faith. Medical health researchers have utilised Twitter to identify the publics' behaviour towards disputed health subjects such as E-cigarettes [25]. Medical field mines social media data to rapidly determine the outbreaks of contagious diseases and to circulate useful information in suppressing the spread of these diseases [26, 27].

In the digital era, empowered and digitally-enabled customers want more value than just 'social' from social media. They are searching for meaningful information that educate, inform and help them for finding resources and make more objective health care decisions. The interests of social media healthcare data are protected by

Healthcare Insurance Portability and Accountability Act (HIPAA) [28]. The common violations of this act include the posting of data, diagnostic reports, photograph and videos that could enable the identity of patients without their consent.

The demand of patients with the trust of healthcare system to keep up with social trends having a social media presence for smart care. For example, 65% of Americans attempt to self-diagnose health problems using the Internet instead of simply consulting health professionals. The results of their searches induced stress in 74% of these individuals [29].

3.3 Education

Social media enables the students to get more useful information and connect with educational systems and other learning groups to make education favourable. Social media has gained eminence as a credible source of information where educational institutions can link with their stakeholders globally. Studies have revealed that 96% of students have access to Internet and at least one social media site [30]. Students exchange valuable information about their examination and classes through personal computer, laptops, tablets and mobile phones. They also transmit tips, study materials, views, school projects and several kinds of valuable reading stuffs each another. Many universities and colleges have completely embraced social media networks, *e.g.,* Facebook, YouTube and Twitter, which are connected with large number of students [31]. These channels are convenient in publishing school news and educational information, make declarations and tackle various issues related to students through group associations. It also serves as a tool for the benefit of the students where they establish connections among stakeholders of academia.

However, social media also has an adverse impact as it affects relationship with others, people get distracted easily, and might cause cyber bullying [32]. There is a concern that students will be caught up in the chaos of social media rather than concentrating on their work [33]. It could be detrimental to their mental health to place young students on social media platforms for the sake of education. Based on the survey of teens and young adults, an increased use of social media can cause depression, anxiety and loss of self-esteem. Such problems can impact how an individual functions normally and can be harmful to education. If a student is overcome by heavy social media use and mental health problems, then it will be difficult for them to concentrate on their studies [34].

The use of social media in higher education has its drawbacks, such as educator dominance in student–teacher interactions, privacy issues and discriminatory behaviour [35]. The enormous amount of heterogeneous data are created by several universities and other educational sectors. Educators, students, instructors, tutors, researchers, developers and people who deal with educational data are also challenged by the velocity of different data types. Institutes that handle streaming content such as click streams from websites need to update information in real time to serve

the relevant advertising and the best deals to their consumers. Thus, social media has a dual influence on student achievements, and it is imperative to catch up with adolescents use of social media network with prime responsibility.

3.4 Crisis Management

Social media is the two-edged sword in crisis management. Platforms such as Facebook, Instagram and Twitter can be the critical networking tool for handling crisis efficiently. But, if they are not used carefully, then they can also create a crisis worse than ever. It is often utilised as a means of emergency management by informing people about the current status of crisis in the affected area or what actions are to be taken [36]. Various natural disasters such as forest fires, floods, earthquakes and major outbreaks of diseases causing severe symptoms such as pandemic influenza, ebola and corona viruses are experienced at distinct places and around the globe [18]. These dramatic events are communicated, documented and understood via social media using smart devices by citizens, leaders, observers and official responders.

The accumulated social media data can be analysed for spotting a specific location where the traffic accidents occur in real time. The location can be derived from the data by applying named entity recognition method, geocoded tweets or global positioning system [17]. Law enforcement has begun to utilise social media content to solve crimes. To prevent crime, the ATHENA system was developed to assist law enforcement [37]. Accenture collaborated with Singapore government and developed solution for predicting crowd behaviour and potential responses to incidents during 50th anniversary celebration of independence which gave 85% accurate results. Another example includes Kumbh mela experiment that predicted crowd behaviour and possibility of stampede [38]. Thus, social media data assists crisis management to provide public safety by predicting potential activities that disrupt public harmony.

However, the speed of communication on social media is a two-edged sword. This makes it possible for negative feedback to spread rapidly in a way that gets impossible for the organisation to control. Therefore, a new issue can be quickly connected to past crises by the media, and thus, awareness of older facts can exacerbate a situation. Social media involvement makes misinformation propagation even more probable. The arrival of social media, however, also implies that an entity has less power over what is said about them, which can impact their reputation.

4 Big Social Media Analytics

Big social media analytics is the synthesis of online behaviours of the users of social websites such as Facebook, WhatsApp, Twitter and LinkedIn. The proliferation of social media applications provide immense opportunities and challenges for researchers. The large data generated by users of social media is the result of their

behaviour, feedbacks and routine activities. Therefore, the aim of big social media analytics is to device intelligence strategies that addresses their application-specific challenges. Different frameworks of social media analytics and their potential in addressing the challenges are also described.

4.1 Social Media Business Analytics

The key concept of business is return on investment. Jeremiah Owyang has built a hierarchy of metrics for social media investments [39]. His idea is to combine different metrics for social media, representing different stakeholders in different positions.

The social media business model aims to perform business and predictive analytics tasks for addressing the issues of an organisation as shown in Fig. 2a. The model recognises crucial success factors and key performance indicators for general online communications. The business analytics is performed by managers and employees engaged in social media with the focus on how social media impacts the business. Business metrics are evolved summarising the social media analytics responsible for predicting growth of the organisation. The predictive analytics measures the strategies and outcomes that lead to learn from failures and direct the company into the foreseen future to the best.

Applying the model can result in creating an overall dashboard for the organisation to track its progress. It can be used to identify the indicators and their interaction to assess the performance in corporate world.

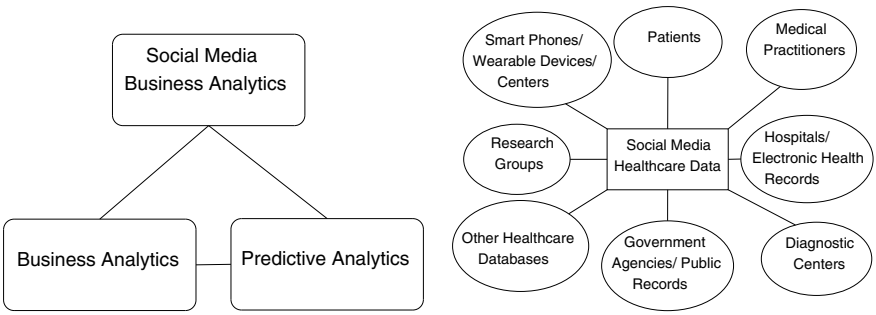

Fig. 2 Big social media **a** business analytics [40] and **b** healthcare analytics

4.2 Social Media Healthcare Analytics

The social media healthcare analytics objectives are to increase the accessibility, communication and interaction between health practitioners and patients using social media subscriber-based platform for improving healthcare delivery to society. In a normal scenario as shown in Fig. 2b, the patient is registered with the system using social networks. The patients can communicate within their peer group members those are formed on the basis of same disease and symptoms. The findings of these communications are prepared using data analytics techniques.

The patients are monitored using the data shared by biomedical sensors, and the data is forwarded to the system for arranging medical practitioners for consultation. Under the non-availability of the medical practitioner, the system locates other alternatives such as hospitals available nearby using global positioning system. However, the system continuously monitors the patients whether they are admitted in the hospitals or away from the hospitals.

The presented model illustrates how different factors, *e.g.,* medical practitioners, electronic health records, diagnostic centres, public records, research groups, wearable devices and other healthcare databases, can communicate using social media platforms for better healthcare. Although, the model needs to address the issues of data privacy and protection as healthcare applications are combined with social networks.

4.3 Social Media Education Analytics

Presence is considered to be a central concept of online learning. Using the community of inquiry framework, the presence of students available online can be monitored [41]. The framework suggests that when interdependent dimensions of presence, *e.g.,* social, teaching and cognitive interacts, then students experience a meaning learning. The social media education analytics aims to bridge the gap that exists in online education and to overcome the disconnected students feel when studying online. The schematic of SMEDA is shown in Fig. 3. The model explores the role of social media big data in education using big data analytic techniques. Their interrelationships, *e.g.,* education data analytics (EDA), social media educational data (SMED) and social media data analytics (SMDA), make possible how educational communities communicate, socialise and learn themselves. Finally, the educators explore the opportunities to help students and themselves for life-long learning using social media educational data analytics (SMEDA). Further, the pros and cons of social media in education need to be explored and adopt ways to make sure that a healthy educational environment can be built.

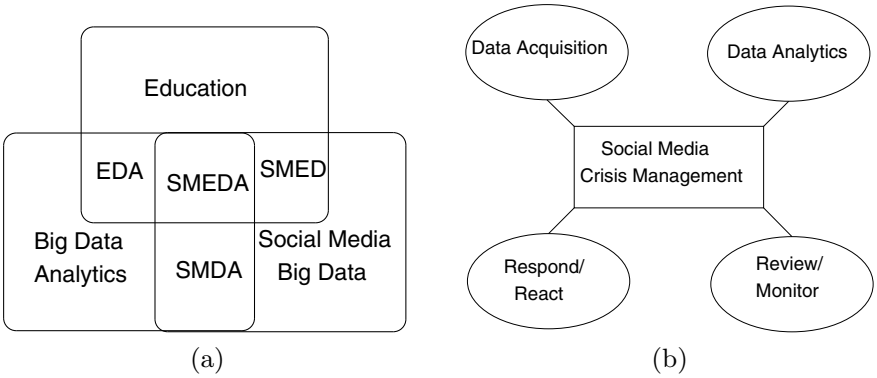

Fig. 3 Big social media **a** educational analytics [42] and **b** crisis management analytics

4.4 Social Media Crisis Management Analytics

The role of social media analytics in crisis management is very critical in the existing digital universe, where people using social networks are more educated and spoken than their non-users. The intelligent practices of crisis management include to forecast the crises well before the organisation may encounter and suggest appropriate measures.

The social media crisis management analytics model is shown in Fig. 3b. It acquires the information from users of different social media platforms and performs data analytics work to discover the knowledge from them. The model then observes the responses of users and their reactions on an incident belong to social, economical, cultural, political or a natural disaster. Finally, it reviews the reactions of people and suggests the remedial actions to avoid any confusion, restrict the misleading information going viral, and prepare a crisis management strategy to prevent the occurrence of that incident in future.

5 Conclusion

Social media is growing rapidly that allows individuals to connect, engage and share ideas online. This paper has presented the state-of-the-art applications of social, economic and political arena. It finds distinctive applications in business, healthcare, education and crisis management. Critical evaluation along with the challenges associated with each application due to exponential growth of social media data has also been done. The different frameworks of social media analytics are presented, and their potential is described for addressing the application-specific challenges.

Social media big data helps companies make more informative business decisions by analysing large volumes of data. Traditionally, by the limited availability of stan-

dardised and consolidated data, the health care industry has faced many setbacks. However, the use of social media in healthcare may extend efficient services to the patients. The use of social networking in education needs an evaluation on student accomplishments. Strategies of crisis management are themselves very challenging, but social media analytics can help in preventing the antisocial activities for maintain public harmony.

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A Cost and Power Analysis of Farmer Using Smart Farming IoT System

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Abstract Day-by-day India's population is consistently increasing, and it is expected to reach beyond 1.3 billion. In fact after 25 years, serious problems will be predicted regarding food. Hence, it is necessary to develop an innovative system for benefiting the agricultural sector as early as possible. The farmers are suffering due to the reduced rainfall and water scarcity. The traditional farmland irrigation techniques require manual intervention. To overcome this challenge, the proposed research work has developed an automatic irrigation system, which is powered by a smart solar system for saving time, money and work of the farmer. Solar panels will continuously track the position of the sun to ensure the maximum energy production. In addition, an intruder detection system [IDS] is installed into the irrigation system with the help of passive infrared sensor to track where the birds and some other animals are repelled from entering into the field. A Wi-Fi module has been used to establish a communication link between the farmer and the field. The farmer can access the information about the field condition anytime.

Keywords Smart farming · Internet of Things · Agriculture · Sensors · Regression analysis · Crop · Estimation theory

1 Introduction

Agriculture provided us with a solution to feed all, and it has now come to a halt due to the rapid growth of population. Agricultural lands will not be able to follow the same pace but the worldwide population is expected to grow nearly 10 billion

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by 2050 [1]. Agriculture as mentioned earlier in one of the definitions would come under the management of man [5]. With the growth in technology, almost anything can be just controlled with just a click, and in most cases, this is all possible with the help of Internet of Things (IoT). IoT is an ecosystem of connected physical objects. This technology can be incorporated with farming to catch up with the rapid pace of population growth. It would be better to call it smart farming as the entire idea is to make it smart by using technology to increase the productivity by minimizing the cost, power and time as much as possible. A recent Beecham's report entitled toward smart farming agriculture embracing the IoT vision predicts that food production must increase by 70% in the year 2050 [1], in order to meet our estimated world population of 9.6 billion people. It also describes growing concerns about farming in the future: climate change, limited arable land and costs/availability of fossil fuels. Therefore, solution is smart farming. IoT can connect devices embedded, represent digitally, control and connect from anywhere, and then, it helps us capturing more data from more places, ensuring more ways of increasing efficiency and improving safety and IoT security. The main problem farmer faces is that the returns percentage is quite less. This means that farmer returns are not high as much as it should be. This leads to several problems. Many farmers become financially hit due to this, and hence, because of being unable to repay the debts, they end in situations where they end their lives. This is quite common in countries where the global hunger index is high because of the rapid rate of population and the farmer failing to meet the high demands. To overcome this problem, a smart farming system has been developed by using IoT. Smart farming with the help of automation and sensor technology benefits the society such as conservation of water, optimization of energy resources and better crop [14]. The objective of this work is to provide an automatic farming management system which is powered by a smart solar arrangement in this manner saving time, money and power of the farmer. With the automated technology of irrigation, the human intervention can be minimized. Soil parameters like soil moisture, pH and humidity are measured. Then, pressure sensor and sensed values are displayed on the system. If change in parameters such as humidity and temperature of the surroundings, then sensors sense the change and send interrupt signal to the IoT device. With these, farmer will get the alarm notification. The intruder detection system is installed with the help of a passive infrared sensor (PIR sensor) where the birds are repelled from entering into the field. The solar panels continuously track the position of the sun to ensure maximum energy production. Wi-Fi module has been used to establish a communication link between the farmer and field. The farmer can access field condition through the server anytime, hence this likely outcome reducing the manpower and time [2–4, 13].

In the agricultural field, the IoT-based smart farming system predictive and estimation system models play a role, nowadays, to the development of the agro-ecological and socio-economic conditions. In the amounts of resources of the field and farm experiments to provide the information and to identify appropriate and effective management practices. IoT-based model helps to identify the management to cost, time and manpower for land managers and estimation theory approach method use to

make the information save farmers money to great extent and use the smart technique concepts to take the decisions for problem.

2 Earlier Work

The following sections present a brief summary on earlier research works carried out in the field of smart agriculture using IoT-based system. Today, IoT leads to the development of many applications such as education, industrial, manufacturing, medical, governance and transportation [6]. The big data predictive analysis techniques are used to analyze crop and cost of fertilizers; IoT technology is used to in the field to collect the data through the sensors and stored in the cloud database through the Internet [7].

R. N. Rao et al. proposed IoT-based smart crop field monitoring and automation irrigation system in the paper discussed [8]. As farmers does not have any thought regarding what amount of water ought to be included and in what manner can the observing of crop should be possible. As huge measure of water is squandered, crop yielding is not appropriate and proposed the accompanying procedures. Brilliant farming is a developing idea, in light of the fact that IoT sensors are equipped for giving data about agriculture fields and afterward follow up on dependent on the client input.

A. J. Raju et al. proposed to build up a savvy agriculture framework that utilizes focal points of bleeding edge innovations, using remote sensor system. Observing ecological conditions is the central point to improve yield of the proficient crops [9].

S Rajeswari et al. proposed new model for crop yield prediction for agriculture field, and it helps to identify the better crop sequence [10].

Wen-Yaw Chung et al. have presented their work in agricultural field combine the cloud and wireless sensor techniques [11, 12]. From the above literature review, a less amount of analysis and data collection were carried out such time, cost and manpower. The proposed system is compressive solution to field activities using smart farming IoT-based technique.

3 Smart Farming System

In this work, the smart farming system using the IoT technology is designed in such a way that it is simple to install and use. The proposed system consists of dividing the working of the farm into different areas so that each part can be managed individually. The field consisting of the crops will be installed with the soil moisture sensors, temperature sensors and the PIR sensors. The soil moisture sensor is used to sense the soil moisture and control the drip irrigation correspondingly. The temperature sensor will sense the temperature of the surrounding environment, which will help us in weather analysis. The PIR sensors are installed around the field in specific

locations, which will detect the presence of any intruders, and then, the required action is to be taken. The system includes an efficient water management system to keep a check on the amount of water. Apart from these, the solar system based on the sunflower technology is installed in appropriate part of the field to facilitate the best results. The power system to run proposed system in the field is achieved so by two separate power units. One unit powers the system during the day while the solar system recharges the other, and this second system is utilized to power the system during the night. The main concept of proposed system is that it is smart and automated. The entire system is to be controlled by the microcontroller. The concept of IoT is that it connects all the devices over the Internet. The system is designed in such a way that all the data obtained from the system is sent to a server. Data includes how much water let out, and the soil moisture, temperature, any intruder detection and much more are all sent from the system to the server. The server data used to analyze to make appropriate outcomes. The smart farm consists of a number of components including the field, solar unit and the watering system. In order to achieve the best results, six numbers of prototype model have been constructed in the most efficient way and installed surrounding of Bangalore zone and Mysore zone region India. The farmer can access the system and can keep an eye on all the progressing data being performed in the field. All these are controlled by the Arduino microcontroller. All the sensed values from the field are sent to the microcontroller which then performs the required operations such as controlling solar unit and the drip irrigation system [5].

The entire system is run on the Arduino Uno board which is a microcontroller based on the ATmega328 shown in Fig. 1. The smart farming system has to undergo an entire process of transformation to be able to satisfy the large demands in real world.

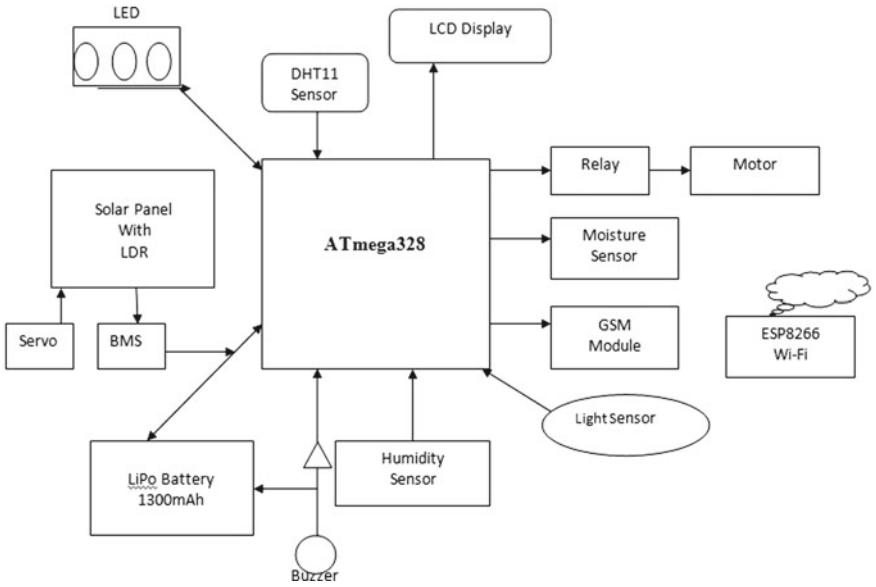


Fig. 1 Smart farming system

On the whole, the number of devices in the system would increase depending on the size of the field. In the small model, the soil moisture can be tested by examining difference zone region soil moisture. But in real world, since the area of the field is going to be very large, where an efficient method is utilized to install the proposed system, fewer soil moisture can be deployed to sense the soil moisture along an entire crop line. The PIR sensors can be changed based on the area of the field and can be installed in the most appropriate locations so that it can able to identify the intruder on any point on the field. The solar unit which powers the entire system can be scaled up to match the demands of the real-world system.

4 Likely Outcomes

To build the system error proof and ensure that it would perform as expected, the proposed system has been tested in many scenarios during the COVID-19 pandemic lockdown periods. The soil moisture sensor is used to sense the amount of water in the soil, and based on the value, it is decided whether the water is fed into the field or not. The capacitance to measure dielectric permittivity of the surrounding medium soil used for proposed system trial works on the value of around 2.9–3.0 V (520 values). If the sensed value goes below this value, then the drip irrigation is activated, and once the value reaches around 650, it stops. Similarly, the PIR sensor is used to sense the presence of any intruder in the field. The sensor has to cover to avoid including the areas of the neighboring fields. The outcomes of the above tests case it is observed that proposed system successively transmit, receive and record the data on server. The data available for transmission through the ESP8266 Wi-Fi module which would utilize the available Wi-Fi connections and exchange the encrypted messages. The data sent consisted of the readings of the moisture, the temperature, number of times water is let out, intruder detected details and much more. Same data also recorded and made to be displayed onto the on field LCD display.

4.1 Cost Analysis

Cost analysis is essential for farm budgeting and planning enabling farmers to effectively compare and determine the profitability of various commodities, thereby creating an opportunity to identify and venture into farming as an enterprise based on current data. The farmer has to consider a number of things when it comes to cost analysis of the farm. By adopting the smart farming system, there are a number of ways in which money can be saved. First and foremost, the entire system runs on solar power. Solar panels are installed that track the position of the sun at every degree. That is, the system consists of a sunflower-based solar system to track the position of the sun, and this is done to ensure that maximum input is captured and converted into energy that powers the system. The solar-based system also recharges the power unit

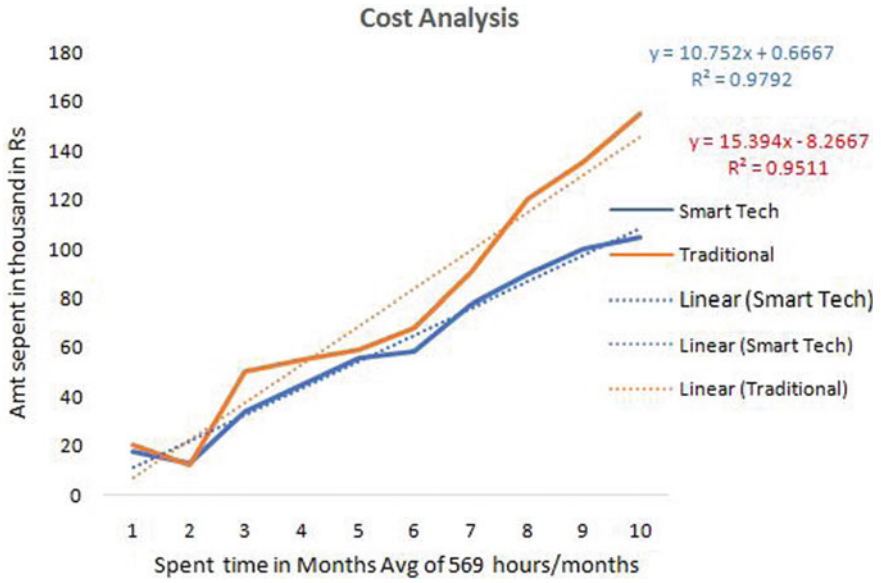


Fig. 2 Cost analysis

that will be able to run the entire system during night. Based on the farmer feedback and estimation theory approach, this saves the farmers money to great extent. From Fig. 2, a red color indicates the regression analysis from the plotted graph, and blue color indicates the smart farming. This is predictive method using statical modeling regression analysis, and it is clear that expenditure of cost considered parameter is optimally less for small area, as compared to equation plotted in Fig. 2; hence, it has been suggested to compare with the traditional farming, a smart farming is optimally better. This is predictive method able to reduce the power cost by around 10–12% approximately. Another way in which the amount of money can be reduced is by monitoring the amount of water that is being fed into the field. The cost analysis on the data is shown in Fig. 2.

4.2 Time Analysis

A farmer time into field says about its dedication. But this restricts the farmer from being able to perform any of his other activities. Hence, strive to make the system to be able to perform some tasks on its own such that the farmer is able to get save time for himself. This is where our smart farming system into picture. Some important tasks are automated in order to save more time. First, the drip irrigation method is automated by including sensors that sense the soil moisture and let water into the field as and when needed. The amount of time saved here is less but it cannot be

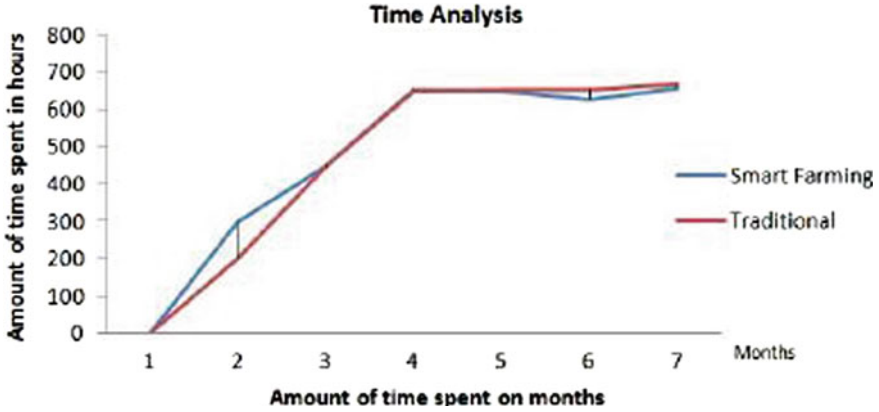


Fig. 3 Time analysis

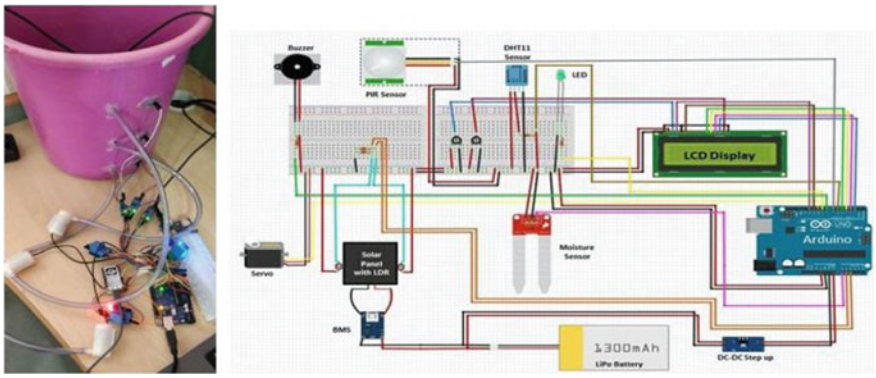
ignored. Some other ways in which time can be saved are by the intruder detection and avoidance system included in our system. Based on the above analysis, the time can be saved by around 8% per annum. The time analysis on the initial data is shown in Fig. 3.

4.3 Power Analysis

Power analysis power not only refers to power to run the system but also the manpower involved in farming. Analysis of power for the system has been explained in the cost analysis section. In the next section tells about more on manpower how can be managed efficiently. A farmer alone cannot run an entire farm. He needs manpower that will work for him on the field and also perform many other tasks. In proposed cost and time analysis, smart farming system with IoT technology automates some of vital tasks of farming. The smart drip irrigation system saves time and cost, but it saves manpower to some extent. The rate at which manpower is saved can only be noticed at the yearly level. The more important aspect is that proposed system would open more career opportunities for people into the field of agriculture to perform tasks such as data analytics, field engineer and may be some more.

5 Experimental Setup

The experimental setup is shown in Fig. 4 in two places; the proposed system has been tested in many scenarios during the covid-19 pandemic, where Fig. 4a shows the experiment model, and Fig. 4b shows the schematic diagram of proposed model.



(a) Field Experiment Setup model

(b) Schematic diagram

Fig. 4 Proposed system model

The soil moisture sensor is used to sense the amount of water in the soil, and based on the value, it is decided whether the water is fed into the field or not. Volumetric soil water content 0–10% for dry soil moisture condition, 11–20% Idel condition.

Water content is measured in two places by isolating the mass of water from the dry of soil is multiplied by 100. The moisture in the soil is characterized as the ratio of the water mass per unit of soil, to the mass of dry soil per unit, and it is expressed as:

$$\mathrm{WC} = \frac{w1 - w2}{w2} * 100 \tag{1}$$

where $w1$ is wet soil + container, and $w2$ is dry soil + container. WC is water content in percentage. Table 1 shows the equation for determining slopes in various sensors. In which x value presents the soil moisture content in percentage, whereas y is cost value is calculated from the equation, respectively.

The proposed system trial works on values of 500–550 values. If the sensed value goes below this value, then the drip irrigation is activated, and once the value reaches around 650, it stops. Similarly, the PIR sensor is used to sense the presence of any intruder in the field. The surrounding area of 120 m is tested in order to sense the PIR sensor. The sensor has to cover to avoid including the areas of the neighboring fields.

Table 1 Linear equation table and for slope and R^2 values

S. no.	Analysis	Traditional method	Smart tech	Sensor values
1	Cost analysis	$y = 15.394x - 8.2667$ $R^2 = 0.9511$	$y = 10.752x + 0.6667$ $R^2 = 0.9792$	508…550
2	Time analysis	$y = 91.71x + 54.19$ $R^2 = 0.7667$	$y = 86.6x + 72.44$ $R^2 = 0.786$	545…600

6 Conclusion and Future Work

All experimental and observations test cases prove that and time analysis and the proposed system are a comprehensive solution to field activities, such as smart irrigation and smart warehouse management system, respectively. This approach helps the farmer to improve the yield of the crops and overall production. It is possible to add many additional features to the system based on the demands. An extra water management system can be used to the monitor the water levels, and it can be optimized to get the most efficient results. In the future, farm can also be integrated with smart fertilizer and pesticide feeding system, which would run on satisfying certain constraints. Drones can be included to monitor the entire farm and report to the server so that the farmer can monitor the farm from his home itself can be future work. Data analytics can be improved and can be made to produce better outputs, so that the farmer can be prepared for future. Smart agriculture is already becoming more commonplace among farmers, and high-tech farming is quickly becoming the standard sensors. Future work may be Drone-y estimation that drones can spray fertilizer more times faster than doing so by hand.

Notes and Comments. To build the system error proof and ensure that it would perform as expected, the proposed system has been tested in many scenarios during the COVID-19 pandemic lockdown periods at different district regions surrounding Bangalore and Mysore cites. Based on the farmer feedback, the cost and time analysis are presented. The proposed research work was installed, and test beds are started from January to June 2020.

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Intelligent Computing Application for Cloud Enhancing Healthcare Services

Anandakumar Haldorai and Arulmurugan Ramu

Abstract Intelligent computing is a novel means of delivering computing services and resources. Due to massive demand of healthcare services that are transforming the face of health information systems (HISs), investing in healthcare research becomes more fundamental. Nonetheless, just like any form of healthcare advancement, intelligent computing needs to be investigated and evaluated before health practitioners decide to apply it globally. The application of innovations as a result of intelligent computing can be one of the best means of transforming healthcare provisions especially during the process of sharing patient data between medical practitioners during the urgent actual-time cases. However, before initiating the complete transformation of the healthcare sector, there should be a specific strategy that requires thorough evaluation. For instance, a feasible intelligent strategy that is applicable in the healthcare facility must use a public domain cloud infrastructure to permit public accessibility to fundamental engineering healthcare data during the process of retrieving medical resources.

Keywords Information technology · Intelligent computing · Cloud infrastructure · Health information systems (HISs) · Electronic health records (EHRs)

1 Introduction

Healthcare clinics and public hospitals are in the best position of using publicly available cloud services for remote data storage which is only available in medical domains, and with that regard, this research paper evaluates the concept and present position in healthcare sector. It utilizes four fundamental aspects, i.e., technology,

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management, legal, and security. These four critical aspects are utilized to evaluate the key challenges and opportunities of cloud computing framework for one-stop strategy implementation and procedure which can be utilized by the healthcare sectors to evaluate its strategy, resources, and directions that are used by medical practitioners to shift or transform their services from traditional to cloud-centered healthcare services. This form of transition is also discussed in this literature analysis. Intelligent computing represents the present demand in self-services of the network infrastructure which allows potential users to get access to cloud computing resources in real time from any geographical location to some of the most utilized healthcare applications that include Google docs and Microsoft Hotmail including some of the healthcare-based applications such as Google help platform in the Microsoft Health Vault [1]. Compared to the conventional form of computing, this type of computing has three novel merits: a wide range of computing resources that are present to users, removal of any form of upfront applications by clients, and any form of payment for usage as required. Some literature texts, blogs, and forums have also evaluated the merits and advantages of this form of computing in transportation business, national security, and education.

Many healthcare facilities have already transformed the most used legacy frameworks to incorporate the electronic health records (EHR) which represent a digitalized format of manuscript. Healthcare record systems incredibly follow the standards published by the HIS organization for the clinical healthcare sectors. This form of transformation in the healthcare sector has facilitated the growth of medical provision by nurses, physicians, and administration personnel who have the capabilities of accessing healthcare records whenever required. EHR in most healthcare facilities are presently enclosed in ancient clan's server architectural frameworks. Information technology has incredibly assisted in the process of simplifying healthcare operations as discussed in this paper. This has in turn made it possible for healthcare practitioners to be more effective and client-centric compared to how services were provided a few decades ago.

Embracing the idea of cloud or intelligent computing remedies, it helps to facilitate the smooth running of hospital operations in a convenient and affordable manner. Intelligent computing provides on-demand computing services since it makes use of the latest form of technology in the process of deploying, accessing, and utilizing Internet applications, resources, and information. However, this form of technology incorporates complex system infrastructure that might be problematic to comprehend. In most instances, it is believed that intelligent competing is the most effective selection for learning healthcare activities. This is probably due to the fact that intelligent computing is affordable compared to the cost of installing multiple computer systems in multiple medical facilities.

In case, multiple PC systems were to be installed in every medical room; this system will require efficient software, hardware, networking adaptability, and accessibility to effectively retrieve, store, and upload medical or patient data. For a long time, information technology for healthcare issues has been considered to be relevant in the healthcare sector [2]. Since more sophisticated security and privacy systems have been incorporated in the intelligent computing frameworks, the providers of

services, careers and healthcare industry can professionally identify the control methodologies for specific sensitive patient information. The expenditure of information technology data is on the rise. Cloud-centered electronic healthcare records are constantly having a significant effect on the healthcare sector.

Just like any forms of service operations, the healthcare sector requires more systematic and continuous advancements to remain efficient, timely, and unaffordable to consumers who have a privilege of enjoying high-quality services. A lot of experts and managers can project that intelligent computing is effective for enhancing healthcare services, enhancing healthcare research, and transforming the status of information technology globally. Due to the advent of technology, intelligent computing has significantly reduced EHR start-up costs such as software, hardware, personnel, electronic, and licensing costs that have significantly facilitated the adoption of healthcare technology. According to the research done by researchers, the biomedical informatics society has been able to share applications and data based on the novel computing paradigm.

Apart from that information-handling issue, complexities and unavailable computing remedies are some of the issues that researchers have to focus in the process of evaluating biomedical research information management and evaluation. A number of informatics advancements have also been demonstrated to show that intelligent computing is effective in the process of mitigating these problems. The lack of privacy and security are some of the two major revealing concerns that healthcare practitioners face in selecting the best cloud computing remedy. To effectively mitigate these problems, the healthcare sector should select the most reliable cloud computing provider with the capacity to act according to the provisions and guidelines set by the Health Insurance Portability and Accountability Act (published in 1996).

Due to the constantly increasing breach of big data, there has been a growing uneasiness among healthcare patients who are afraid that doctors and hospitals who utilize intelligent cloud services will complicate the security and privacy of their personal data. Apart from that, there still is a prevailing issue of permitting multiple users to use and share EHR throughout the healthcare facility. In addition to the patient safety and privacy information, breaches are expensive to deal with since the healthcare sectors over the past few decades reported to have lost millions of funds annually.

According to the recent research on the fans of data breaches lost, analysts from Pennamon School argue that healthcare quote losses have been reported to be twice as much as the global average which is typically $380 in 2017, where the global average is reported to be $141 [3]. Irrespective of their wide-range benefits connected to diligent computing applications for the medical sector, there are several technological, management, legal, and security issues that should be mitigated. In that regard, this paper focuses on discussing the aspect of intelligent computing, its present application in the medical field, its opportunities, its challenges, and how the concept can be implemented for strategic planning during the introduction of new models of services in the healthcare facility.

2 Literature Review

According to many previous studies, the adoption and status of intelligent computing in the healthcare system have been evaluated. These literature texts explain the potential advantages of intelligent computing, the projected frameworks, and models that are supposed to enhance healthcare provisions. Among some of these projections, researchers have conducted an analysis on the cloud-centered framework that is meant to automate the process of gathering patients data using a system of sensors linked to the legacy medical devices. Moreover the system is vital for the processing and delivering datasets to healthcare centers which have to be stored, processed, and distributed. The main advantage of healthcare systems is to provide users with daily and actual-time datasets in an automated manner, hence eliminating manual gathering of data and typing including deployment of healthcare services.

Researchers [4] have also evaluated cloud-based computing standards for management systems to effectively provide multimedia sensing signals and security frameworks as vital services for users of mobile devices. Apart from that, the system has also relieved mobile devices from undertaking mass multimedia and privacy algorithms that facilitates the process of delivering mobile healthcare services. This will therefore enhance the application of intelligent mobile devices that are essential for community services which also enhance healthcare provision to marginalized and vulnerable communities. In another research done by researchers, aversive cloud initiatives have also leveraged the impact of intelligent computing and wireless advancements in the process of allowing physicians to retrieve vital health data at an actual time from any geographical location. Researchers have also explained the prototype emergency healthcare framework for the Greek national healthcare service enabling it to integrate emergency frameworks with individual healthcare records insistence that is meant to provide healthcare practitioners an immediate accessibility to patient personal data from any geographical location and the use of any computing device at an affordable price.

A wide range of resources and articles has also evaluated the effective application of intelligent computing in bioinformatics analysis. For instance, researchers have projected the system-based computing framework and concept that is applicable in the colorectal cancer analysis meant to alouette critical imaging in clinical operations. Due to this research, the application of the Amazon EC2 services that include 100 notes has been applied in the process of assembling a complete human genome approximately 140 million individuals who are capable of reading sequences from the sequence searches and alignment of hashing algorithms. Researchers [5] also appreciated the application of the Amazon EC2 in the process of computing autologous connections of more than two hundred thousand in numbers which have also been compared in multiple research analysis. This kind of computation took the researchers more than 200 h and a fund of $8000 to complete this research. The analysis also applied intelligent computing in the process of evaluating the implication of the G Quadruplex onto the Affymetrix array.

The laboratory system for individualized medical activities and biomedical informatics has also appreciated the advantages of intelligent computing in the process of developing genetic science in economics that will potentially manage massive amounts of data that are recorded in real time. Other than this academic analysis, most globally recognized software industries have significantly invested in cloud computing hands extending their novel services and offers for healthcare records services such as the Microsoft HealthVault, the Amazon's Web service, and the Oracle exalogic elastic cloud system which represents some of the services and technologies used in the storage of individual healthcare data in an online system. Moreover, application of the healthcare intelligent computing system has been appreciated by researchers globally. For instance, Amazon's Web service application allows providers and healthcare practitioners to gather HIS offerings that are considered a scalable storage system infrastructure in a healthcare facility.

According to the American occupational network, improvement of patient care through the application of modernized healthcare record systems is essential to facilitate the process of updating healthcare processes under a cloud best software application. Many companies at the moment can avail accurate and prompt services in real time, hence minimizing any medical transcription expenses by approximately 80% [6]. The department of healthcare and human services in United States is in conjunction to the national coordinator for healthcare information technologies that have recently selected acumen remedies and intelligent customer relationship management systems to effectively select and implement EHR frameworks through the country.

This software is effective since it allows localized extension facilities to effectively manage and interact with medical practitioners on matters concerned with the application of the EHR framework. The Royal College in Australia has gathered healthcare practitioners to work together in the process of developing an electronic healthcare cloud system with the assistance of a leading telecommunication provider Telstra in Australia. The medical school is composed of more than 20,000 members who have the access to sophisticated medical facilities to build a modernized electronic healthcare facility. The software is advantageous in a number of ways: Developing medical software, introducing care plans, facilitating quality medical training, making proper medical decisions, and enhancing proper management services in the healthcare facility.

3 Intelligent Computing: A Novel Economic Computing Framework

Cloud computing is still a constantly enhancing development whereby its attributes, definitions, and features are deemed to advance in the next few years. However, there are a lot of definitions that have been proposed over the past few decades including the mini mall explanation that incorporates fundamental features of the concept. In

relation to this paper, a cloud system is described as a massive segment of easily accessible and usable virtual resources, i.e., development platforms development services and hardware systems. All these resources can vibrantly be recognized by practitioners to effectively adjust to the variable scales which have the capacity to optimize the utilization of resources. This massive segment is normally exploited on the basis of a pay-per-usage framework which assures providers of an effective infrastructure that delivers expected results in real time.

Considered from the perspective of a typical service, intelligent computing incorporates three essential archetypal frameworks: platforms, infrastructure, and software.

- Software-as-a-service (SaaS): Some applications such as HR are normally controlled in a cloud service provider before being unveiled to two specific customers through a specific network connection, i.e., the Internet.
- Platform-as-a-service (PaaS): This enhancement application, i.e., operation framework, is typically hosted in an intelligent computing system which can only be accessed through the Internet with PaaS, and healthcare practitioners can work with developers to build structural Web applications without necessarily installing any form of tools in their PC systems before deploying them to users without any form of administrative knowledge.
- Infrastructure-as-a-service (IaaS): With this application, the cloud users can effectively outsource useful tools for supporting clinical operations with the assistance of storage systems, hardware, applications, and networking elements. The application programmers have the capacity to possess the tools and assign users the responsibility of maintaining, running, and housing these applications. However, the users are expected to enjoy the application on a pay-per-use basis.

To effectively deploy intelligent computing, the United States National Institute of Standards and Technology (NIST) has recommended four essential frameworks.

- The public cloud: Cloud service providers have to make resources such as storage and application systems to be available to users in real time via a networking system. For instance, the Amazon's elastic computing cloud system (EC2) permits its users to utilize virtual computers on a rental basis which also allows operators to utilize their own customized applications. EC2 operates within the Amazon network data centers and data infrastructure that allows users enjoy the services at a minimal fee.
- The private cloud: Intelligent cloud infrastructure, over the past few decades, has been used by many organizations for sharing a single concern which include privacy requirements, security, mission accomplishment, and standard requirements. For instance, the Microsoft azure permits clients to establish foundation for encrypted cloud infrastructure by using the windows service and the system centers for creating growth products with dynamic information center toolkit.
- Community cloud: The cloud infrastructure represents the private, community, and public domains of the cloud system. Here, the healthcare sector is capable of managing and providing privacy requirements, policies, missions, and compliance

standards. The communication cloud-enabled the Los Angeles City council to make use of the Google cloud system to safeguard its data and applications that can only be retrieved and accessed by the agencies working for the city council.

- The hybrid cloud system: The hybrid cloud infrastructure incorporates the cloud system and community system. This system allows an organization to manage and provide IT services within its own domain which fails in certain services in an external domain. For instance, IBM can effectively collaborate with the Junipers network system to avail hybrid cloud services and infrastructure to companies that need to advance their private cloud systems at remote areas in an accessible manner.

4 Critical Analysis of the Healthcare Cloud Computing Challenges and Opportunities

According to recent research, approximately 75% of the basic information and datasets from office hours have reported the necessity of applying intelligent computing in the process of advancing the future status of healthcare services. The projections indicate that the number of users using the mobile cloud system is proposed to increase from 70 million to about 1 billion over a couple of years to come. In the medical sector, a wide range of organizations, experts, and managers have the belief that intelligent computing can incredibly increase a fundamental service required in medical activities [7]. Apart from that an analysis by the European network and the data security agency in the UK stated that the novel computing framework is projected to enhance an incredible global investment in information technology by many companies and industries including the healthcare sector.

The report also projected that by the end of 2020, the USA alone would have spent an approximation of 50 billion on intelligent computing applications which are essential for the advancement of healthcare services. Just like any form of innovation intelligent computing, it has to be evaluated thoroughly before being applied internationally. A number of research analyses have recently evaluated the implication of cloud computing in the medical sectors which have been discussed in this research, in terms of challenges and opportunity from the perspective of technology, management, legality, and security. The subsection below discusses these challenges and opportunities in detail.

5 An Evaluation of Cloud Computing Challenges and Opportunities

5.1 The Management Perspectives

Opportunities

The key merit of intelligent computing is its affordability. For instance, the Amazon Company charges users about 0.1 dollars every hour for 1.0 GHz instruction data architecture for a typical EC2 service. The company also charges users about 0.12 dollars for 1.0 GB data per month and transfers information across Amazon's Web service network. In that case, the company gets cost-effective advantage, while it is also considered to provide quality information technology solutions through intelligent computing without necessarily purchasing or evaluating hardware and software or requiring users to pay for in-house technological infrastructure. Resultantly, this makes it possible for the company to concentrate on crucial applications without worrying about additional expenses such as training IT staff. Moreover intelligent computing methodologies enhance the deployment of services where it helps in maintaining crucial flexibility which means rapid accessibility and ubiquitous elasticity to healthcare resources. This capacity implies that even though demands of services change, medical facilities and hospitals do not require transformation of their systems and infrastructure as a result of these transformations.

Challenges

In intelligent computing, the main issue is about the privacy and security of users in retrieving their personal data, governance loss, management inertia, and uncertainties on dealing with the provision of services. Maintaining trust when using a specific service is a key aspect in business that has to be assured in intelligent computing as well. Challenges normally tend to occur when sensitive information and mission-essential applications are transferred into the cloud system where network providers do not effectively assure the privacy and security of data systems [8]. Organizational inertia also known as cultural resistance in the process of sharing data is capable of transforming the manner in which typical management challenges are mitigated in intelligent computing. In case a provider is not capable of meeting the compliance standards, regulations, applicable protocols, and policy transitions, networking users might have their activities rendered to risk. In most cases, particular service provisions such as money transactions cannot be undertaken in such cases.

5.2 Technological Aspects

Opportunities

Small-ranged hospitals, laboratories, and medical practices normally do not include an internal information technology staff to ensure the maintenance of in-house infrastructural systems for mission-critical applications like an EHR. In that case, dealing with novel infrastructural costs and Internet technology maintenance costs can effectively mitigate a wide range of obstacles following EHR adoption. In case of wide-ranged hospital organizations, incorporating data storage systems and technological applications is essential for the intelligent computing system to effectively manage and mitigate issues from a third-party network provider. Based on the perspective of technological management, intelligent computing can significantly advance the level of flexibility and scalability which resultantly increasing the affordability of computing infrastructural services. Moreover intelligent computing has some merits which can be realized from the green computing that is known for its efficiency and application in the ecosystem to promote energy savings. Application of already available resources established in a healthcare system significantly enables providers to provide cost-effective services. In an energy system for instance, electricity costs can drastically be rationalized to help providers to save the resources required to establish PC systems and other computer components in an organization. This helps to minimize the production of dangerous resources or materials in the ecosystem.

Challenges

Some of the technical issues related to the utility of intelligent computing include the exhaustion of resources, performance unpredictability, information lockage, and potential bugs at a massive scale in the distributed intelligent system. The minimal costs and intelligent computing resources that are present when demanded by users are two fundamental characteristics of cloud computing. Nonetheless, the healthcare sector is gradually becoming crowded with more technical service providers coming to market. Due to the rapidly increasing demand of services subjecting to competition, a lot of cloud computing providers commit themselves to cloud computing resources such as storage spaces, mobile applications, and CPU locations to attract potential clients.

To effectively manage profits in an organization, the value of delivery system has to be evaluated in a manner that suits the interests of clients. For instance, providers might decide to limit accessibility to cloud computing resources or focus on introducing outdated software or hardware which target on shuffling CPU technology. However, a lot of cloud computing customers are not capable of controlling virtualized system architecture which makes it necessary for network providers to deny permit to audits from potential clients. As such, it might be challenging to predict the performance of a specific healthcare sector. This form of a relation between the expectation of a client and healthcare providers can significantly lead to potential challenges for cloud service clients who are interested in providing high-quality services to end users.

Data lockage is also a fundamental challenge that has to be analyzed critically. In most instances, cloud computing clients might be stimulated to shift their services or data to another cloud provider to enhance the process of establishing an in-house information technology ecosystem in case service providers cease their service or business operations. For instance, Google made a decision to halt its Google Health Services in 2012 which stimulated users to take an approximate of 12 months to retrieve their healthcare information. However, some of the intelligent computing infrastructures provide minimal applications, data, and services to the users.

As a result, it poses significant challenges to clients who focus on migrating from a single service provider to another or transferring the services or data back to the in-house information technology ecosystem. A number of intelligent computing users such as biomedical research laboratory might require frequently downloading or uploading significantly massive amounts of data from the cloud system [9]. The users of mobile applications might have noticed some form of information such as transfer bottleneck as a result of physical network bandwidth limitations. Apart from that users might face the challenge of handling technical risks since bags might have been distributed in the intelligent cloud system in abundance. When these challenges are compared to the in-house information technology system, some of the mistakes or bugs pose a significant challenge in debugging errors in the massive-scale distributed cloud infrastructure.

5.3 Privacy Aspects

Opportunities

Actually, one of the most vital concerns in the process of incorporating intelligent cloud computing in healthcare facility is linked to data privacy and security. However, in contrast to the localized housed data system, this framework is not fully secure. In some instances, it normally enhances security and privacy since cloud service providers such as Amazon, Google, and Microsoft are capable of devoting massive amounts of resources to mitigate any privacy and security challenges which might be affordable to users [10]. This might significantly help in mitigating any potential distractions of healthcare legal documents and medical records which is one of the challenges that the New Orleans hurricane disaster posed to the healthcare sector.

All forms of security and privacy measures such as software or hardware, human resource management, and the control of funds are affordable whenever implemented on a massive scale. A number of intelligent cloud service providers have a tendency of replicating customers' data in multiple geographical locations which is an aspect used to enhance the redundancy of data and system independence in case any potential failures of the system are reported. Apart from that, the cloud service providers typically have the capacity to vibrantly reallocate privacy resources for the process of data filtering, traffic modeling, and data encryption to enhance any potential support for the available defensive measures such as the denial-of-service attacks on critical

healthcare services. The capacity to vibrantly scale-out defensive measures whenever demanded by users has significant advantages for system resilience.

Challenges

In information technology, many data privacy challenges have been reported. These include network breakage, natural phenomena, hackers' intrusion, management failure, poor data encryption, management, and data privilege mismanagement. Certain threats in the intelligent computing sector include privilege misuse, poor data encryption management, and failure to manage public data. Intelligent cloud computing is typically available in multiple geographical locations for mobile users. For instance, if a client requests to eliminate data encrypted in virtual computing infrastructure with sophisticated operating frameworks, this might potentially make data systems to erase fundamental information. The sets of data are available in a disk which can only be accessible by the service providers. For multiple hardware resources and tenancy, ecosystems used by customers' datasets might be accessed or deleted by a third-party provider [11]. As a result, this puts the encrypted data into significant risk for the cloud computing users.

5.4 Legal Aspects

Opportunities

Information and security privacy protection is the fundamental for enhancement of client trust required for intelligent computing to access its massive potential. In case the provider adopts clear, better practices or policies, users are in the best position to assess potential risk during the use of the cloud computing system. Advantageously, a lot of the main providers are committed to enhance and formulate the best policies and user practices to safeguard clients' privacy and data. Other than the commitment of these providers, a number of computing organizations like the cloud security alliance have formulated an incredible and well-understood guide to handle privacy and security problems. Such organizations have also structured software and hardware initiatives which are meant to establish the most secure platforms for cloud computing. The Federal government is also essential when it comes to fostering globalized agreements and regulations for both providers and the users.

Challenges

The application of intelligent computing presents a wide range legality challenges like intellectual property rights, contract laws, information jurisdiction, and privacy rights. Among them, information jurisdiction and privacy challenges are some of the major prevailing issues. In the cloud computing sector, the physical storage is distributed widely over a lot of jurisdictions whereby each of them is governed by a set of laws that are designated to usage, privacy, and intellectual user's rights and properties. For instance, the health insurance portability and accountability act in the

USA has placed restrictions on companies that disclose individual health information to third parties who are not affiliated to the healthcare sector. In that case, these regulations provide the Federal government mandate to retrieve and ask for data in case conditions are deemed, essential, and emergent to the homecare security framework. As such, these acts potentially regulate the power of industries and organizations to utilize, disclose, and collect personal data for commercial purposes. Nonetheless, providers without the consent of users might transfer the data from one direction to another. Information in the cloud system is composed of a single legal location at a specific time with variant legal challenges.

6 Discussion

6.1 Intelligent Computing Strategy and Planning

Whenever a healthcare organization considers shifting its services into a cloud system, it requires strategies and planning frameworks to analyze its novel benefits, potential risks, and also evaluating capacities to accomplish missions and establish the planning frameworks scheduled for implementation. There are a lot of references for the creation and establishment of a secure intelligent computing strategy and planning framework. For instance, organizations can use the cloud computing life cycle that has been adopted to include nine stages to assist users to launch intelligent computing projects. These are some of the proofs, concepts, piloted projects, and road maps that enhance modeling, integration, maturity, collaboration, expansion, and planning of the computing system. The institute of project management which is a non-profit membership organization for project management professionals did the research on intelligent computing which can be used by cloud project managers. This research provided eight fundamental steps that are required in the implementation of intelligent computing.

The federal health information technology strategic planning that was established by the Federal government in 2008 can be significantly used by large government in detail for the process of implementing healthcare cloud computing projects [12]. The strategy and planning framework provided a mandate to the national coordinator for health formation technology to enhance the development of local implementation of the HIS infrastructure. This duty is purposed to enhance efficiency and quality in the healthcare sector. The strategic planning is also projected to have some fundamental merits: patient-concentrated health with a purpose to enhance privacy and security, adoption, interoperability, and associative government.

The projections to attain every objective have been proposed in approximately 43 strategies which illustrate the works required in attaining every merit and objective. Every planning framework is connected to the major milestone over which the developments might be evaluated, and some actions are undertaken to effectively implement certain strategies. Other than the discussed strategic methodologies, this

research considered the recommendation of healthcare cloud computing planning frameworks known as the HC^2SP model which might be utilized by the healthcare sector for cloud-centered services. This framework incorporates four fundamental stages: identifications, evaluations, actions, and follow-ups.

1st Stage: Identifications

In the HC^2SP model, the initial stage is meant to evaluate the present condition of the healthcare sector; its process is to effectively identify fundamental objectives to critically enhance the improvement of services which utilizes the voices of patients and customers. The major evaluation methodologies might be essential to evaluate the issues of the present service processes. The process of patients' admission in the healthcare facility is considered too long. There is significantly unessential charting throughout the process due to the absence of automatic data systems like electronic medical records (EMR) and HER which incorporate a lot of upfront information technology maintenance and investments. The objective identifications and its entire scope might be clarified to effectively serve the entire end users who are the patients in this case. Moreover, strategic planning groups have to provide an illustration of the healthcare services including an explanation of the healthcare quality indicators and their main obligations. In this stage, the team is able to structure a defined scope of service issue that the facility faces.

2nd Stage: Evaluations

In the second stage of the framework, an evaluation of the potential challenges of launching cloud computing and intelligent security alliance is done. NIST have created a comprehensive standard which is meant to analyze the advantages and challenges of implementing intelligent computing with this potential users might be able to apply the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis in the process of evaluating the feasibility levels of intelligent computing or the cloud-centered approaches. Moreover, users have to access the methodologies that are meant to deal with the identified problems. In the present literature, there are some of the analyses that evaluate the purpose. For instance, researches have reported a number of obstacles following the implementation of the intelligent computing. Every obstacle has been computed to have some potential solution and opportunities which is varied from product management to fundamental projects. Researches have also evaluated a number of internet-federated organization challenges like the process of information transfer bottleneck, sharing logs, and the federated distributed cluster.

Apart from that, these researchers have also recommended further research evaluations meant to mitigate the discussed challenges. Moreover, researches have recommended the XML-centered mediators meant to deal with data locked issues. The intelligent cloud-based security alliance illustrates about twelve domains that are linked to cloud computing. These are some of the domains that are categorized into two significant segments: operation and governance. Remedies and recommendations might also be categorized in every domain [13]. According to the NIST standards about privacy and security of the publicized cloud systems, the privacy issues and security frameworks should correspond to the precautions recommended by the

healthcare facility. These standards and guidelines have to be followed whenever initiating and planning publicized cloud services.

3rd Stage: Action

Once novel computing frameworks have been evaluated, the organization might be capable of determining whether new services have to be adopted or not. If that is the case, there is need to upgrade an implementation framework. In this process, there are five essential steps that should be considered.

Firstly, the organization has to determine the intelligent computing service models. As evaluated in this paper, cloud computing represents a number of various services (IaaS, PaaS, and SaaS), including various models of deployment such as hybrid, community, public, and private cloud). Every service model is defined by its individual risks and benefits. In that case, the major consideration in differentiating the forms of deployment and services should be varied.

Secondly, there is need to compare the various cloud service providers. Selecting the most effective cloud provider is the most essential segment of a proper implementation plan. Various providers might project various frameworks, audit procedures, pricing frameworks, security, and privacy guidelines. As such, the healthcare organizations should facilitate the comparison of various offerings. Moreover, there is need to evaluate the providers' performance and reputation before signing any form of contract.

Thirdly, obtaining assurance from the chosen cloud computing providers should be facilitated. The organization has to accept assurances which the chosen providers might use to avail the quality of services (QoS), imitate sound security, privacy, legal regulations, and practices. The QoS assurance incorporates the pay-per-use, on-demand accessibility, timely troubleshooting, and operation transparency. The assurance of security and privacy handles the information availability, integrity, confidentiality, non-repudiation, and authorization. Moreover, the providers have to assure that information and the essential backups are encrypted in the specified geographical locations through service management frameworks, service regulations, and contracts [14].

Fourthly, there is need to consider future information migration. The healthcare sector may be required to shift services and data to other service providers or essentially back it up in a form of an in-house IT ecosystem since the providers might cease their service or business operations [15]. For instance, the recent ceasing of the Google Health followed the diminishing of services' quality which has also amounted to the disputing of contracts. The portability of data has to be viewed upfront as a portion of this plan [16].

Fifthly, it is essential to consider pilot implementation in the healthcare sector. A lot of previously implemented planning aspects suggest that organization without any cloud computing experience might consider pilot implementation. The process of piloting has to be suitable to effectively facilitate the process of cloud computing in the healthcare sector [17].

4th Stage: Follow-ups

Initiating follow-ups is the final segment in the process of deploying intelligent cloud computing infrastructure which is based on a proper follow-up plan. The structured plan shows the points when the organization has to measure or the manner in which this measurement has to be done for the purpose of improving potential services. Considerable targets have to be established prior to the analysis of results when novel services are valuated over the specific targets or whenever the performance evaluators have to be assessed based on the magnitude of service improvement.

7 Conclusion and Future Directions

In conclusion, cloud computing is a novel framework which assures affordability, efficiency, and flexibility in the information technology services to the end users. Moreover, it provides the chance for enhancing the adoption of HER, research services, and the healthcare services. Nonetheless, as evaluated in this paper, there are some potential issues in the process of fostering novel frameworks in the healthcare sector. Certainly, the most firm resistance to launch cloud computing in the HIS segment is connected to legacy issues and information security. However, a lot of the main providers such as Amazon, Google, and Microsoft have focused in the process of developing the best practices and policies to effectively secure the clients' privacy and data. A number of the non-profit organizations like the cloud privacy alliance and the entrusted computing segment have effectively developed more comprehensive software and hardware technologies, which effectively enhances the construction of cloud computing applications. Apart from that, the federal government has also fostered some regulations such as PIPEDA and HIPAA to safeguard cloud users information privacy and security. Moreover, a number of legal regulations in the intelligent cloud computing typically revolve in the contract negotiation and evaluation. In future, providers should put more focus on the development of HC^2SP that is applicable in the healthcare sector to effectively determine its strategy, resources, and directions to shift to the paradigm of cloud computing. The framework incorporates four fundamental stages such as follow-ups, action, evaluation, and process identification. The future works should focus on further expanding the SWOT evaluation which will definitely allow organizations to evaluate and determine potential of launching the novel model, and also some of the remedies to deal with cloud computing issues also require more in-depth research.

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Coronavirus Detection and Classification Using X-Rays and CT Scans with Machine Learning Techniques

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Abstract This work aims to detect the signs of the Coronavirus, also known as Covid-19. A dry cough, sore throat, and fever are the most common symptoms of Covid-19. For Covid-19, it is important to find fast and precise results at the time to stop it in the early stages and to avoid it from the vast spread. To interpret and identify the symptoms from X-rays and CT scan images, the machine learning and computer vision principles were applied. The works are usually performed with the CSV datasets. However, the analysis is performed to compare the images of patients with Covid and Non-Covid. To enhance the classification performance, it is feasible to use feature extraction techniques such as CNN, local directional pattern (LDP), gray-level run length matrix (GLRLM), gray-level scale zone matrix (GLSZM), and discrete wavelet transform (DWT) algorithms (Barstugan in Coronavirus (Covid-19) classification using CT images by machine learning methods [1]). In this paper, the convolution neural network model is selected as the classifier. Softmax is used during the classification process to classify the images given, whether they belong to Covid or Non-Covid. This implementation is carried out on both the X-ray images dataset and the dataset of CT scan images which are obtained from the repository that is publicly accessible.

Keywords Covid-19 detection · Coronavirus · CNN · CT scans · X-rays · Machine learning · Computer vision

1 Introduction

The outbreak of the Covid-19 Coronavirus, SARS-CoV-2, has raised a catastrophic worldwide crisis end of the year 2019. Day by day, the cumulative incidence of Covid-19 is steadily increasing. Cloud computing and machine learning (ML) can be used very efficiently to monitor the outbreak, forecast the epidemic's progress,

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and model strategies and policies to control its spread. To evaluate and forecast the development of the epidemic, this study applies an enhanced mathematical model. Forecasting the potential hazard of Covid-19 in countries worldwide and improved ML-based model has been applied. A better fit to create a prediction system which can be obtained using the iterative weighting to fit the generalized inverse Weibull distribution. This has been implemented with a more precise and real-time prediction of the epidemic's growth activity on a cloud computing platform. For a constructive response from the government and people, a data-driven strategy with greater precision can be quite useful. Finally, for more practical applications, a collection of research opportunities and setting-up grounds were suggested. To make a prediction, it is required to determine which algorithm can be effectively used to classify the given image into a favorable or unfavorable result. This paper aims to work with convolutional neural networks and classifies the category using softmax.

2 Literature Review

The expert radiologists detected from CT images that Covid-19 shows different behaviors from other viral pneumonia. Therefore, clinical experts specify that the Covid-19 virus needs to be diagnosed in the early phase [1]. At the beginning of this research work, it is planned to work with a CSV file, but after finding many empty spaces and incomplete datasets, the implementation is done with CT scans and X-ray images [2, 3]. These days when access to the corona data is very limited, experiments are carried out with a dataset with very little data and inter-class imbalance. Due to the limitations of the dataset, feature extraction methods are preferred over deep learning-based methods [2]. The working on images dataset rather than CSV dataset, it is quite difficult to find CT scan and X-ray images datasets. After searching numerous sites and repositories, a public repository is sorted out with both CT scans and X-ray images [4]. After selecting the dataset, the images were not in a similar way to get the proper result. Preprocessing the images of both datasets is using computer vision techniques mentioned in [5], which guided us to convert all images into a single format 'png'. The next task is to convert all the images into the same dimensions for processing, done by verifying the work in this citation [6]. While researching the working with CNN, the best in feature extraction of images was recognized. Referred some articles to know the working of the algorithm and to observe the results of implementations [7–9]. To gain the working and processing knowledge of convolutional networks, some research were undergone to know the exact implementation of this algorithm [10, 11]. After going through all the data, it is decided to implement CNN for feature extraction from images.

3 Proposed Methodology

In this paper, the classification is applied with Covid and Non-Covid patients from their CT scans and X-rays. Apart from the normal approach, this paper uses an images dataset which is publicly accessible by every one of CT Scans and X-rays of Covid and Non-Covid patients for best classification. At first, convert all the images into a single format which is 'png'. Later resize the dimensions of every image into 128 $\times$ 128 by reducing the size of the dataset. That resulted in the dataset is used in the classification. Both the Covid and Non-Covid datasets are combined, shuffled, and divided into train and test. The sequential model is used because only the single input and single output were obtained. In this model, three convolution layers and two hidden layers are used. Early stopping is used to stop the loss. The softmax function is used to predict the score and classify the image into either Covid or Non-Covid. The results of implementation are compared in both CT scan and X-ray images (Fig. 1).

4 Experiments

4.1 Dataset Description

For better classification and a better outcome, the input of CT scan and X-ray images was directly considered. By this approach, the there will be no missing of features during the implementation of CSV dataset. These CT scan and X-ray images are publicly available. The dataset contains both Covid and Non-Covid patient's lung images of both CT scans and X-rays. In this paper, to find and compare which images will give the better accuracy and prediction of the classification were executed. The separate datasets of Covid and Non-Covid are combined separately for CT and XR images.

4.2 Data Preprocessing

The combined dataset of both Covid and Non-Covid mentioned in the data description is converted into the same format which is 'png' for better classification. Considering the images with different dimensions that are difficult to use and undergone a process for re-sizing results in 128 $\times$ 128 dimensions for all images. This resulted in the dataset is wrapped into a zip file and used for implementation. After unzipping the dataset in the working environment, combine both Covid and Non-Covid images and shuffle them.

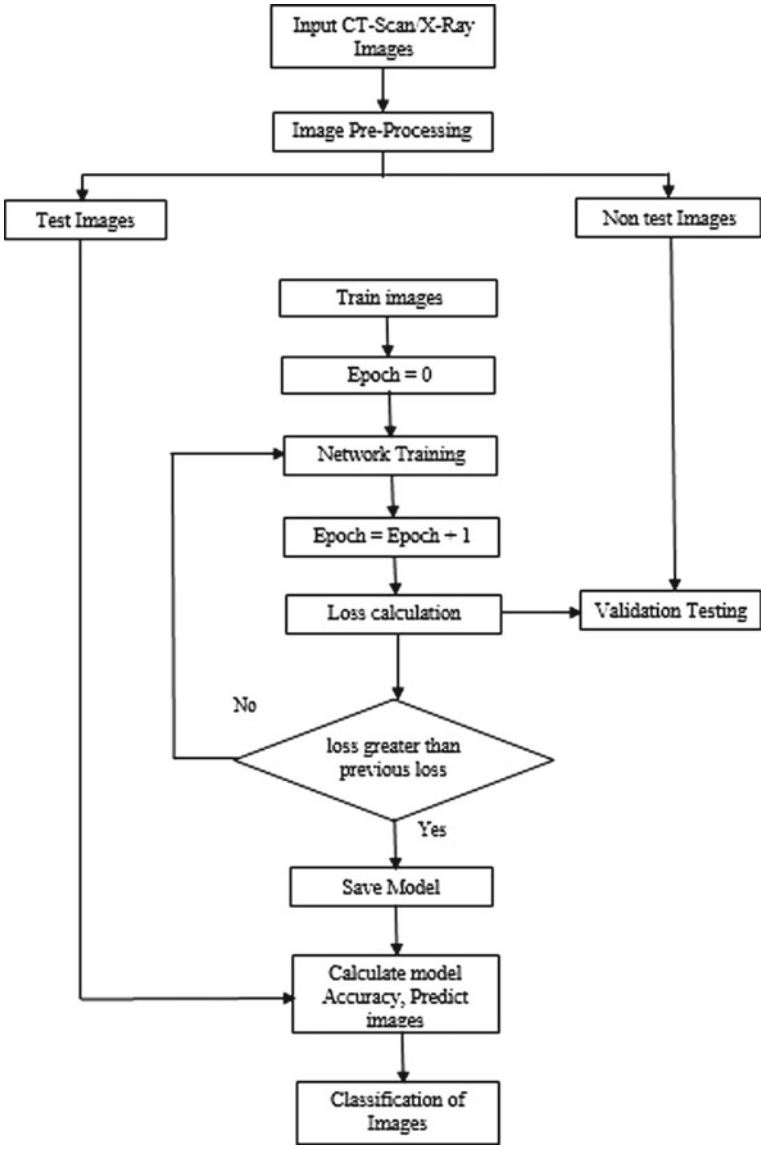


Fig. 1 Flowchart of working model

4.3 Feature Extraction Technique

In this paper, convolutional neural networks (CNN) are used for feature extraction. The resulted features are sent to the softmax function for classification. From this, it can be determined whether the image belongs to Covid or Non-Covid patients.

4.3.1 Convolutional Neural Network

A convolution Neural network is a feature extraction method that contains layers such as a convolutional layer, dense layer, max-pooling layer, and so on. It can have more than one same layer. Various processes take place in layers that extract features of an image. Those features are not visible, but it is possible to classify them based on using other classification techniques (Fig. 2).

4.4 Analyzing Results

Softmax is used to get the score of the predicted model. For evaluating the results obtained from classification, some of the metrics were used in which the commonly used by everyone are precision, recall, $F1$-score, error rate, and accuracy. The confusion matrix is used, which shows the exact number of images classified correctly and incorrectly.

Total is taken as the Number of all the images which are used to classify either correctly or incorrectly classified.

A confusion matrix is represented as cm.

$$\text{cm} = \begin{matrix} x1 & x2 \\ y1 & y2 \end{matrix}$$

$$\text{Total} = \text{cm}[0, 0] + \text{cm}[0, 1] + \text{cm}[1, 0] + \text{cm}[1, 1]$$

Accuracy is calculated by dividing the sum of the correctly classified number of images for Covid and Non-Covid by total.

$$\text{Accuracy} = \frac{\text{cm}[0, 0] + \text{cm}[1, 1]}{\text{Total}}$$

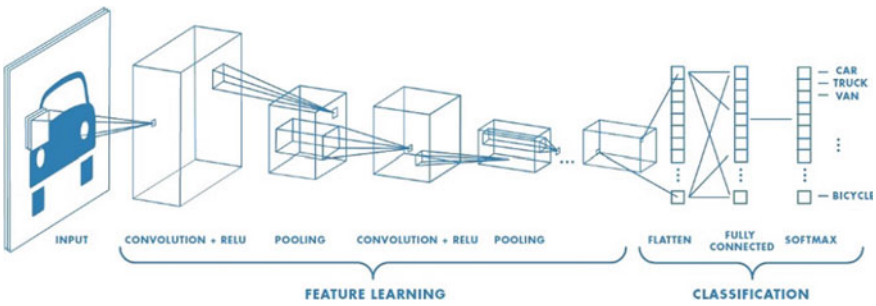


Fig. 2 Softmax function for classification

Error rate is calculated by dividing the sum of the incorrectly classified number of images as Covid and Non-Covid by total.

$$\text{Error Rate} = \frac{\text{cm}[0, 1] + \text{cm}[1, 0]}{\text{Total}}$$

Precision is calculated by dividing the number of correctly classified Non-Covid by the sum of incorrectly classified Covid images and correctly classified Non-Covid images.

$$\text{Precision} = \frac{\text{cm}[1, 1]}{\text{cm}[0, 1] + \text{cm}[1, 1]}$$

The recall is calculated by dividing the number of correctly classified Covid images by the sum of several correctly classified Covid images and several incorrectly classified as Covid images.

$$\text{Recall} = \frac{\text{cm}[0, 0]}{\text{cm}[0, 0] + \text{cm}[0, 1]}$$

$F1$-Score is taken as the weighted average of recall and precision.

$$F1\text{-Score} = 2 \times \frac{\text{Recall} \times \text{Precision}}{\text{Recall} + \text{Precision}}$$

5 Experimental Results

5.1 Results of CT Scan Images

See Figs. 3 and 4.

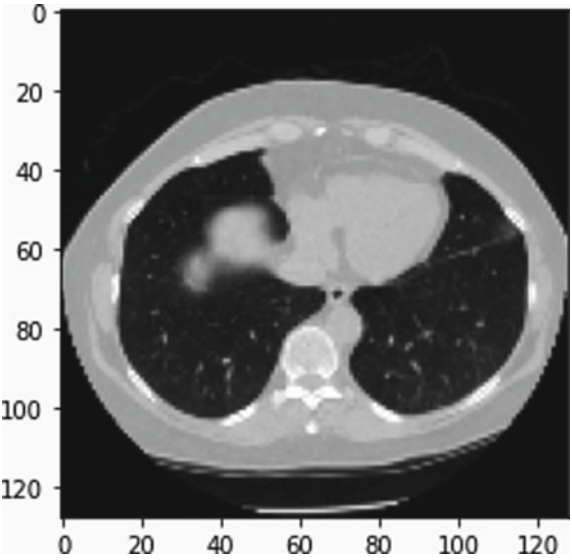
	precision	recall	f1-score	support
COVID	0.96	0.93	0.95	834
NONCOVID	0.86	0.92	0.89	375
accuracy			0.93	1209
macro avg	0.91	0.93	0.92	1209
weighted avg	0.93	0.93	0.93	1209

Fig. 3 Model results

Fig. 4 Confusion matrix

```
[[777  57]
 [ 30 345]]
acc: 0.9280
sensitivity: 0.9317
specificity: 0.9200
```

Fig. 5 Non-Covid patient with 73.11%



5.1.1 Result of Input Images

(i) This person most likely is a Non-Covid patient with a 73.11% confidence (Fig. 5).

(ii) This person most likely is a Covid patient with a 66.03% confidence (Fig. 6).

5.2 Results of X-Ray Images

See Figs. 7 and 8.

5.2.1 Result of Input Images

(i) This person most likely is a Covid patient with a 72.26% confidence (Fig. 9).

(ii) This person most likely is a Non-Covid patient with a 53.45% confidence (Fig. 10).

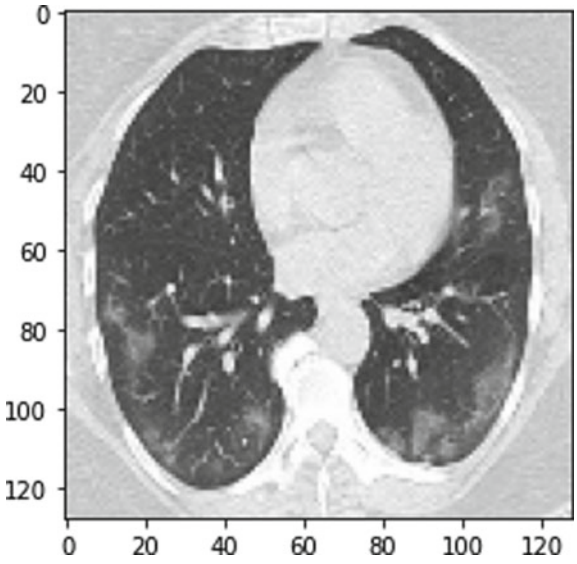


Fig. 6 Covid patient with 66.03%

	precision	recall	f1-score	support
COVID	0.82	0.74	0.78	803
NONCOVID	0.70	0.80	0.75	628
accuracy			0.76	1431
macro avg	0.76	0.77	0.76	1431
weighted avg	0.77	0.76	0.76	1431

Fig. 7 Model results

Fig. 8 Confusion matrix

```
[[591 212]
 [126 502]]
acc: 0.7638
sensitivity: 0.7360
specificity: 0.7994
```

The accuracy obtained of 93% using CT scan images and 76% using X-ray images. By comparing the results between CT scan images and X-ray images, it can be concluded that using CT scan images for the classification of Covid-19 is better than using X-ray images.

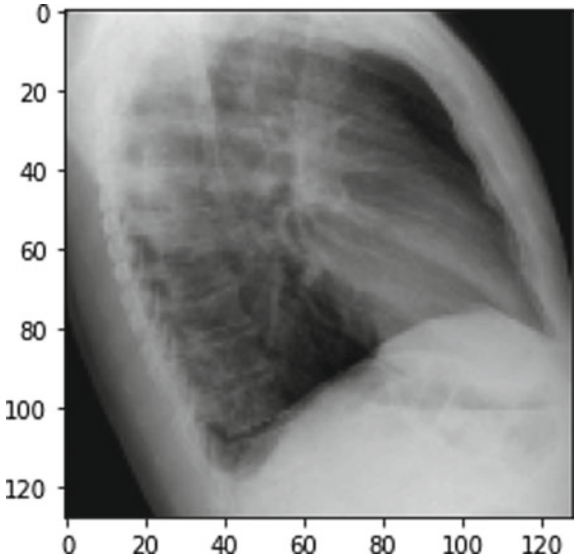


Fig. 9 Covid patient with 72.26%

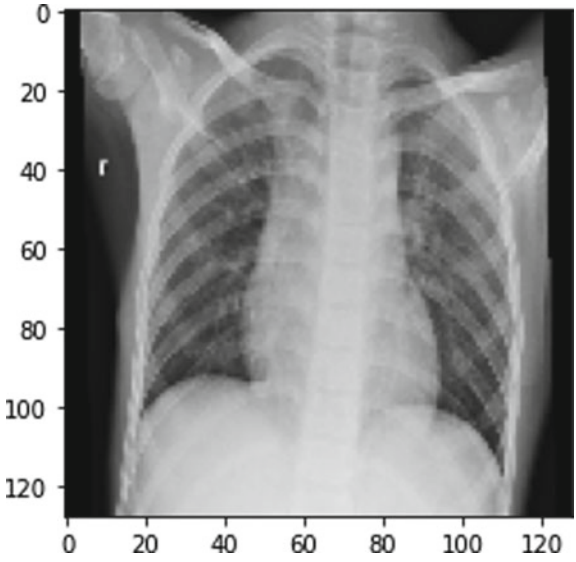


Fig. 10 Non-Covid patient with 53.45%

6 Conclusion

There are many ways to predict Covid-19 from various symptoms such as cough, cold, fever, and tastelessness, and all these aspects are from the past. In this research, an alternative way to predict Covid-19 was suggested. Generally, inputs that are symptoms of Covid-19 were collected in the form of a CSV, i.e., a dataset in which

the findings are not quite reliable. To overcome this difficulty, a new type of dataset consisting of images such as CT scans and X-rays were considered. The amount of precision is much higher than that of the standard CSV dataset. The machine learning and the computer vision concepts like CNN were utilized, and the activation functions like ReLU softmax and CV2 were employed in obtaining high accuracy in the overall Covid-19 prediction. From our findings, it can be concluded that CT scan images are more reliable than X-ray images.

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Johnson's Sequencing for Load Balancing in Multi-Access Edge Computing

P. Herbert Raj

Abstract Multi-access/mobile edge computing (MEC) is a structural design for enabling cloud computing platform at the edge of mobile network, so as to reduce network congestion, improves fast response, and optimization of mobile resources to compute complex applications. MEC provides a distributed computing environment for its applications. In MEC, all the computational reserves will be brought to the base location of the mobile networks. It has the ability to store and process the contents at physical proximity to the mobile subscribers to assist delay sensitivity and contextaware applications. Generally, the packet forwarding and filtering will be operated by the traditional edge network. At present, applications' online computations and storage are done at remote servers, and those servers are placed far away from the users. New technologies are emerged to shift all the available resources to a edge from a cloud. Radio access network (RAN) could able to do the computational off-loading to the edge of the mobile network. So, it is mandatory to have a load balancer at the edge to distribute all the job to all the available processors without any congestion or delay. A routing specifies how to route the traffic between each origin-destination pair across a network. The traffic sharing is applied in a routing and allocating process to enhance the survivability of a network. The experimental results show the proposed algorithm works better than the existing dynamic load balancing algorithms.

Keywords Mobile/multi-access edge computing (MEC) · Flow shop sequencing · Load balancing · Mobile cloud computing (MCC) · Cloud computing (CC) · Make-span and completion time

1 Introduction

When IoT devices are connected to the MEC clouds, there will be latency. So, monitoring this latency will be done by latest apps, even though they suffer due to

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long time travel delay. Because modern apps need to support videos, real-time traffic, and augmented reality (AR). MEC is a pioneering technology that is going to lead the mobile communication technology. Mobile edge computing (MEC) primary job is to move storage after remote storage of cloud to edge.

The mobile users of mid-sized and small-scale industries are gaining profit through mobile cloud computing. It provides a facility to retrieve the data whenever necessary at no matter of time and place. With less or no investment in their storage technology in clouds, these companies can harvest the benefits of protected storage space. Portable devices and users can interact with the clouds, and data management can be done inexpensively in mobile clouds. Ensuring the reliable and authenticated service facility for these portable devices and users is the crucial concern in MCC [1]. The traffic and process will be distributed in order to increase network reliability [2]. The traffic sharing is applied in routing and allocating process to enhance the survivability of network [3]. It is mandatory to devise a routing algorithm to handle all the portable gadgets and mobile users' traffic realistically. So, numerous users' countless requests to access the cloud must be handled properly this algorithm [4].

2 Load Balancing

2.1 Multi Access/Mobile Computing

Computation off-loading in MCC for portable devices will be much simpler than expected, but the key issue is latency in partial or full computation off-loading [5]. MEC aims to deliver mobile users a fast response to their request without any delay. Therefore, the local clouds with very few reserves for their processing must handle multiple mobile user requests effectively at a time.

2.2 Load Balancing in Multi-Access/Mobile Computing

This research paper is devised to do load balancing uniformly to all the available resources to improve the usage of the resource and reduce any sort of delay in responding to a user request. A significant job of a load balancing algorithm is to pack an under utilized or over-utilized VMs with number of tasks to get optimum results.

MEC has numerous mobile devices and hosts as depicted in Fig. 1. All the hosts in MEC feed diversified resources to the MEC network's mobile devices, namely RAM and central processing unit for different sort of obligations which includes computation, saving, and optimization. Remotely located clouds are communicated by the hosts of MEC for processing and saving. For example, any environmental data could be fairly collected and transmitted to any one of the hosts in MEC [6]. Host of

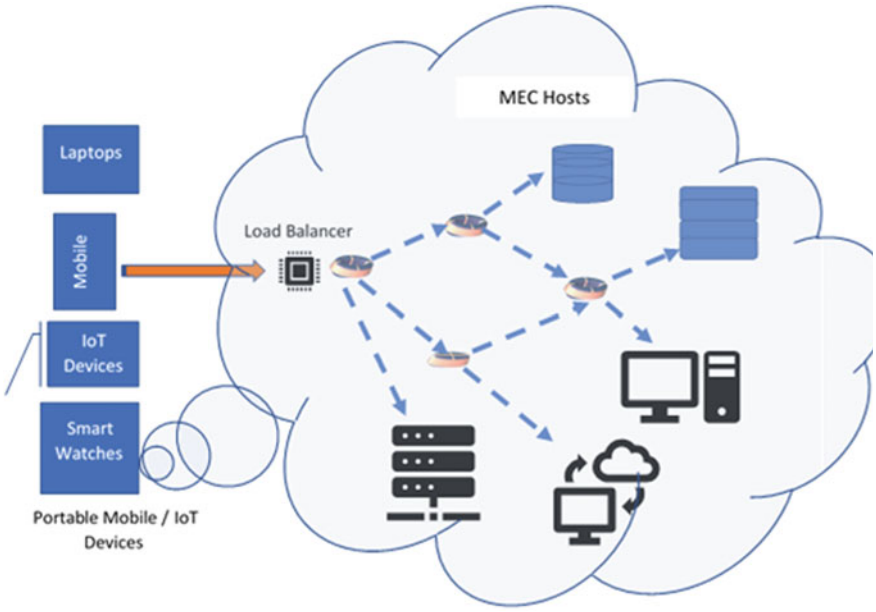

Fig. 1 MEC model

a MEC collects, examines, and sends the data to a far-flung cloud. MEC hosts which run an analytical video app can able to sense any unusual events after the date stated by cameras, such as burglar, trespasser, lost vehicles to a control center [7].

Resource virtualization is a significant service provided by MEC to other mobile and portable devices. When a mobile device connects to MEC, it does not have any clue about which host of MEC is delivering this service. A mobile edge computing load balancer (MEC-LB) is installed between mobile edge hosts and mobile users. Different sort of apps they need diverse cloud structure namely latency and network bandwidth [8].

3 Flow Shop Sequencing

Job sequencing or scheduling is a kind of optimization procedure where jobs or user requests in MEC will be allotted to the requested resources as soon as possible. This will reduce latency and energy consumption [9]. The major goal of this sequencing is to make all the machines busy. There are few conditions that must be considered for this sequencing.

- Job sequence must be orderliness persist equally on each machine.
- The orderliness of job administering on each machine is equivalent.
- Each job must be processed in all the available machines.

3.1 Proposed Flow Shop Algorithm for Load Balancing

The given jobs are having even weightage, and user-submitted jobs are arranged in the order in this proposed method. Resources for the underlying networks are provided by the queue manager. Queue manager or load balancer is meant to handle user requests and allocate these requests to available servers. The flow shop load balancing will authenticate the balancing of load and complete resource utilization. The following subdivision 3.2 and 3.3 comprise the approach for load balancing in MEC.

3.2 Flow Shop Sequencing for MEC-LB

In job scheduling, resources are allocated with jobs in order to achieve optimization. Consider there are 'n' jobs or user requests $j_1, j_2, j_3 \ldots j_n$ which are to be allocated to 'm' machines in MEC hosts m_1, m_2, m_3 … m_n. The aim of the job scheduling algorithm is to engage all the machines without being idle. The overall processing spell must be diminished by arranging available jobs properly to all the machines. The aim of this algorithm is to minimize the make-span.

3.3 Flow Shop Sequencing Problem

Schedule 'n' jobs on two machines using the flow shop sequencing technique. The time required by each operation of these jobs is given by the following matrix.

There are totally five jobs, each job should go through Machine $M1$ and Machine $M2$ in the same order with the job handling time as shown in Fig. 2. Here, the total makespan is 52 according to the given job sequence Fig. 3.

Fig. 2 Job sequence

Machine / Job	M1	M2
J1	10	6
J2	6	12
J3	8	9
J4	8	10
J5	12	5

Fig. 3 Flow shop sequence

Completion Time	M1	M2
J1	10	16
J2	16	28
J3	24	37
J4	32	47
J5	44	52
Makespan		**52**

J1	J2	J3	J4	J5

3.4 Johnson's Sequencing

According to Johnson's algorithm, priority will be given to a job with less processing time, and it will be selected; if there is a draw, then select any one of among these jobs. If a job is selected from a first machine, then it will be placed in a first position of the sequence. If a job is selected from a second machine, then job will be placed in a last position of the sequence. The job once allotted in the sequence must be deleted for further sequencing. Repeat the process for other jobs in the list and continue it until all the jobs are sequenced. The processing time of jobs might fluctuate, so the makespan and machine inactive time will be computed by job check-in and check-out policy.

If job sequencing is calculated for the same problem given above according to Johnson's algorithm, it will be resulted in two sequences. These two sequences are shown in the following Figs. 4 and 5. These two sequences yield the same make-span.

Fig. 4 JA sequence 1

Completion Time	M1	M2
J2	6	18
J3	14	27
J4	22	37
J1	32	43
J5	44	49
Makespan		**49**

J2	J3	J4	J1	J5

Fig. 5 JA sequence 2

Completion Time	M1	M2
J2	6	18
J4	14	28
J3	22	37
J1	32	43
J5	44	49
Makespan		**49**

J2	J4	J3	J1	J5

3.5 Benefits of the Proposed Methods

Johnson's algorithm harvests good result than the flow shop sequencing. Johnson's works courteously in two machines, and it can be extended to 'm' machines ($M > 2$) [10]. Johnson's algorithm not only reduces the make-span but also minimizes the indolent time between servers; moreover, it yields promising optimal results by reducing server response time [11]. Hereby, it concluded that Johnson's algorithm works well for in the MEC-LB. Figure 6 shows the comparison between makespan for flow shop sequencing and Johnson's algorithm.

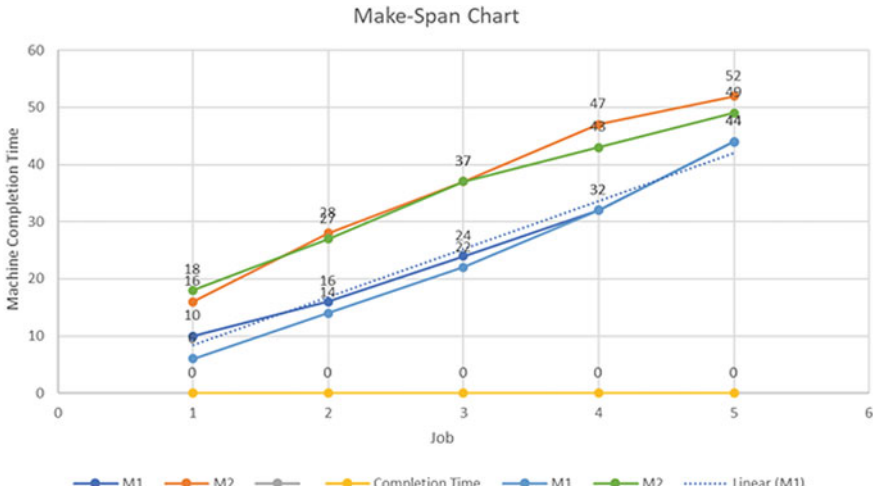

Fig. 6 Makespan chart

3.6 Johnson's Algorithm

- Consider 'n' number of jobs and '2' machines
- Define, Ai and Bi for $i = 1, 2, 3 \ldots n$ Min $[A_i, B_i]$
- Determine the least time A_k for some $i = k$, process and add the kth job at first of a sequence
- Determine the least time B_r for some $i = r$, process and add the rth job at last of a sequence
- If there is a tie, $A_k = B_n$, then select any one of the jobs.
- Repeat steps 3 and 4 until all the jobs are assigned in the sequence.

3.7 Lemma

Let $X = X(1), \ldots, X(n)$ is a list built by the above given algorithm

Then	… X List
U: $X(1) \ldots X(t)$	… Left List
R: $X(t+1) \ldots X(n)$	… Right List
Concatenating $X = UoW := X(1)$	$\ldots X(n)$
$\min\{Q_{k1}, Q_{m2}\} < \min\{Q_{m1}, Q_{k2}\}$	… 'k' job 'm' machine

denotes that the job k performed earlier than job m in X [12].

3.8 Proof

If $Q_{k1} < \min\{Q_{m1}, Q_{k2}\}$, then $Q_{k1} < Q_{k2}$ denotes that the job k goes to U.
If m is inserted to R, then the job is done.
Else m occurs followed by k in U because of $Q_{k1} < Q_{m1}$.
If $Q_{m2} < \min\{Q_{m1}, s_2\}$ [12].

3.9 Advantages

There are numerous advantages of using this type of sequencing in MEC-LB. The significant objective is to minimize the make-span. The primary advantages are minimizing the makespan and augment the utilization of the servers. Achieving nil idle time, maximized machine usage, proficiently progress the process, minimized overall handling time are the superfluous goals of this sequencing method [13].

4 Conclusion

In this research article, the proposed Johnson's algorithm considerably reduced the time taken to handle the user requests. This diminishes the network latency. The time complexity of Johnson's algorithm is $O(n \log n)$ [14]. The calculation showed in this article with apt sequencing and routing of machines clearly affirms that flow shop sequencing by using Johnson's rule reduces the total makespan by 5.7%. In MEC-LB, it is a must to optimize the user requests based on the available servers, so that the servers are able to serve the user requests swiftly. The MEC servers' utilization time also will be increased considerably without any idle time. This proposed algorithm accomplishes the significant purpose of MEC by giving information processing amenities at the verge of portable network and users [15]. This research article can be enhanced with calculating the makespan for 'n' number of jobs and 'n' number of machines. Few heuristics methods also can be applied here to broaden this research scope.

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A Study on MPLS Vs SD-WAN

S. Rajagopalan

Abstract Internet service providers and techno enterprises evolved with CISCO IOS called MPLS built a strong and diligent network for succeeding generations to utilize all sorts of full-fledged amnesties over a solitary structure. MPLS is considered as a routing method, and it is not a facility or a service. MPLS can be encased with any prevailing infrastructures, namely digital subscriber line, asynchronous transfer mode, frame relay, and IP. MPLS is not platform dependent. It can work seamlessly without making any change in the current environment of these technologies. But implementing MPLS is quite expensive, so with the support of SD-WAN, ISPs and enterprises are attempted to enhance its usages using inexpensive Internet connection. This survey articled aimed to compare the pros and cons of both the technologies MPLS and SD-WAN.

Keywords SD-WAN (software-defined wide area network) · MPLS (multi-protocol label switching) · LSP (label-switched path) · TE (traffic engineering) · ATM (asynchronous transfer mode) · FEC (forwarding equivalence class)

1 Introduction

MPLS is a WAN-based system launched to foredetermine the well-established and extremely effective routes to forward data from one node to another node by using short bit sequences called labels instead of lengthy network addresses. A routing method selects a route to direct traffic from source to destination [1]. All the real-time traffic can be handled easily by this method. MPLS technology has been ruling private-based connectivity for the past 20 years. Internet protocols IPv4, IPv6, frame relay, ATM and IPX are all supported by MPLS [2]. SD-WAN is evolved from MPLS technology. SD-WAN guarantees the secured, smooth and secluded connectivity [3]. But MPLS has few issues such as security and backup link. WAN backbone

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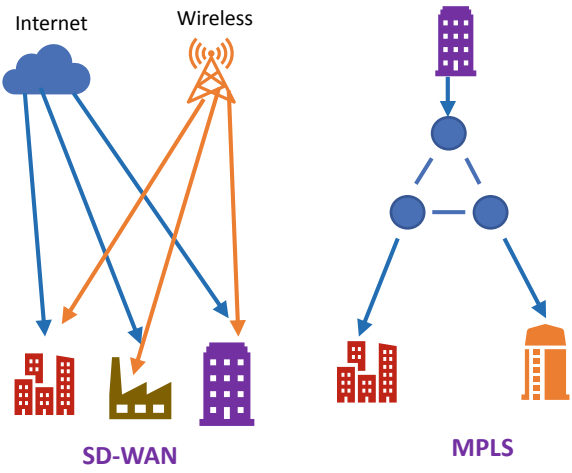

Fig. 1 SD-WAN and MPLS network. *Source* https://www.fieldengineer.com/sd-wan/sd-wan-vs-mpls-vs-sdn

architecture is completely integrated by the SD-WAN and also drives online traffic by using a centralized strategy. This issue could not be handled properly due to incongruent fragments of its structure and approach. This article discusses those issues in detail in the upcoming sections.

MPLS works alike a router or switch in layer 2.5. Here, data will be forwarded by the decisions of the packet forwarding methods. SD-WAN employed certain WAN connections, namely LTE and 5G which connect large enterprises located in remote places all over the world. Figure 1 illustrates the network connections of MPLS and SD-WAN.

2 MPLS

MPLS works independently, and it is not tangled with any of the existing fundamental technologies. The simple MPLS architecture with two sections, namely forwarding (data plane) and control (control plane) is shown in Fig. 2. In MPLS, once a packet arrives, it will be allotted to a forwarding equivalence class (FEC) which is specified by the labels. In the network, every router has a table about neighboring node. So, router will not try to find the header rather the succeeding routers utilize the labels as an index in order to provide new FEC. The job of these path labels is to find out the effective path to destination node instead of finding out endpoints [4]. It was designed to improve the drawbacks in frame relay and ATM [5]. MPLS resides on enterprises and on carrier's infrastructural backbone to support campuses, offices and its branch offices, enterprises and Ethernet-based services in order to achieve QoS for the reliable real-time traffic. The MPLS infrastructure could not fix itself properly with OSI layers. So, it is considered as 2.5 layer [6]. MPLS can establish forwarding tables for any protocol. A label-switched path (LSP) will be established to route

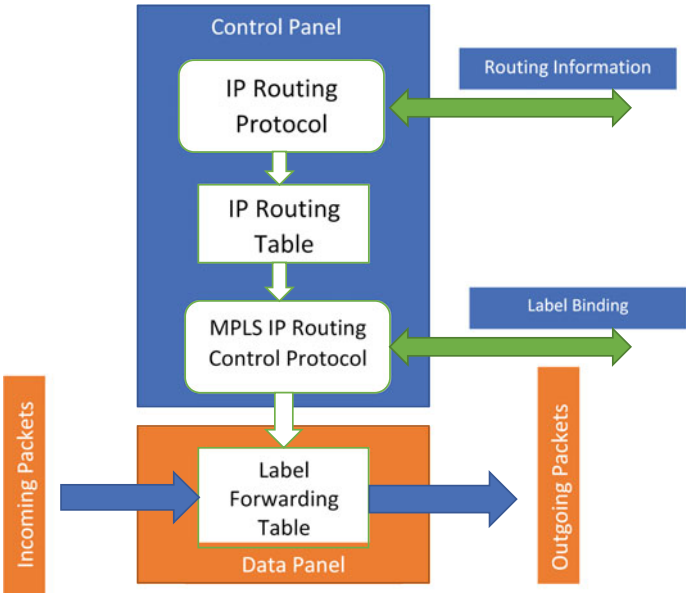

Fig. 2 MPLS architecture

traffic between foredetermined path in MPLS networks. A unidirectional LSP must be established before the communication starts. Based on this, forwarding would take place. When a user wants to communicate in MPLS network, then MPLS label will be added at the ingress node of the MPLS router. Each MPLS label consists of four parts, namely label, QoS experimental bits, stack bottom and TTL [7]. A label consists of all the details for the MPLS routers to identify the destination of the packet forwarding. Experimental bits are meant for QoS to assure the precedence of the labeled packet. Stack bottom informs MPLS router that the label reaches the egress router, i.e., it reaches the destination.

2.1 Boon and Bane

There are few paybacks in using MPLS, namely bandwidth optimization, congestion reduction, scalability and improved performance. Congestions could be minimized by finding optimal routes [8]. MPLS is not so susceptible to denial of service attack. MPLS is considered to be secured and private transfer mode [9]. MPLS is considered being an expensive mode of transfer because this service must be obtained from a carrier. There is very few MPLS service providers giving global coverage. So, if a company wants to extend its service to its branch office, MPLS communication will be costly and branch office communication to the headquarters will be troublesome

unless they start using clouds. Clouds provide anywhere and anytime services for their users in a cost-effective way [10].

2.2 MPLS Future

ISPs need lot of infrastructural assets to manage the emerging amount of users and applications [11]. MPLS is an essential part of the WAN environment. Nowadays, industries are gradually passing on to a hybrid landscape which has both MPLS and basic Internet service. Point-to-point services still be provided by MPLS for branch offices of big firms, retailers and other data centers. MPLS is very expensive, dependable and consistent but Internet connection is very cheap and reliability is very low. Moreover, incorporation of MPLS-TE with SDN has improved the resource usage and load balancing of a network.

3 SD-WAN

Conventional WAN's distinct job is to allow employers in a branch or an institution's campus to link and access the applications installed in their servers. Usually, MPLS's dedicated LSP is used to maintain a secured and authentic connection. This cannot be applied in the present cloud-based scenario. Industries and enterprises started using SaaS and IaaS applications in numerous cloud environments. Present-day IT has lot many contests to be addressed. So IT realizes that the user's application proficiency is complicated and deprived. WAN was intended for the past decades, and it could not handle the current traffic explosion due to the clouds. This caused applications' unreliability, traffic issues and insecured data. Evolution of SD-WAN overpowers these issues.

The era of clouds transmuted backbone of firms. SD-WAN rapidly improves the performance of a business, diminishes budget and provides vigorous security [12]. The SD-WAN architecture is shown in Fig. 3. SD-WAN architecture clearly separated the data plane and control plane and its services. The SD-WAN architecture is cloud scope and protected, flexible and programmable. SD-WAN improves the users' proficiency. It can route IP packets through the most efficient paths, but once it reaches Internet, pursuance is not guaranteed.

3.1 Challenges and Benefits

In the present-day enterprise scenario, over 50% traffic is through clouds but the network available is not at all a cloud serviceable network. SaaS works very pathetically. It has to manage very complicated data flow. The working charges of bandwidth

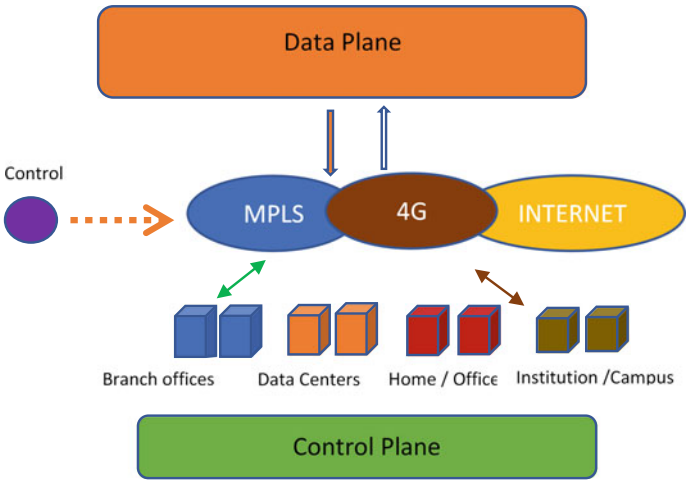

Fig. 3 Architecture of SD-WAN

will be elevated. Every year, the network traffic flow is increased by 30%. A small architectural change will take months to complete it. User application experience is quite unpredictable, and more than 70% of application disruption is due to network problems. Enterprises' another significant challenge is to implement security. Hybrid architecture's susceptibility leads to many other issues.

Enterprises who would like to migrate to SD-WAN will harvest few benefits. Firstly, they will get optimized cloud and SaaS accessibility and reply times. Any public clouds can be accessed impeccably. Operating cost will be reduced by 50%. Any structural changes will not take long. Any applications SLA will be manageable and easily foreseeable. A rigorous security will be implemented for hybrid networks.

3.2 Features

SD-WAN has lot of features regarding the security, cloud environment, user application experience and cost. User application experience will be very active with hybrid links. In the cloud environment, very vibrant optimization can be done. A data center, cloud and local offices can be connected in single overlay. It can be combined with MPLS and less priced broadband. Due to the base elements of the cloud architecture, it is more vulnerable for any sort of attacks [13]. Cloud security can be provided for hybrid networks when SD-WAN is used. Centralized server system feature is available in SD-WAN. An integrated SD-WAN requires a minimum IT workforce for WAN computerization and segmentation [14].

3.3 SD-WAN Load Balancing

Dynamic routing method to find optimum route is automatically done in SD-WAN. When SD-WAN finds the burdened MPLS, it will shift the traffic automatically to the Internet. This makes less congested network route in an inexpensive way [15].

4 SD-WAN or MPLS

It is very difficult to determine whether SD-WAN is better than MPLS. Any company routes real-time traffic over WAN, and then the company must need MPLS. SD-WAN utilizes common Internet to connect other Web sites. If an IP packet reaches this common Internet, then there will not be any guarantee of delivery because latency, loss of packet and jitter may affect it. If a company only uses traffic that does not involve real-time applications, namely resource sharing, file sharing, email, file transfer, etc., then SD-WAN would fetch many benefits over MPLS.

4.1 High Bandwidth

SD-WAN can assure high-speed Internet through an inexpensive way. It grants a company to use high bandwidth Internet connections. SD-WAN groups several connections to achieve high-speed bandwidth at inexpensive manner.

4.2 Better Uptime

Numerous WAN connections can be combined in SD-WAN in order to provide seamless uptime. Cloud services must be always available for the users [16]. MPLS sometimes faces failure to handle this issue.

4.3 Increased Performance

SD-WAN regulates the traffic in the fastest way through the circuit. MPLS does not perform any action unless specific settings are made.

Table 1 SD-WAN and MPLS differences

	SD-WAN	MPLS
Types of connections	5G, LTE and MPLS amalgamation	Twofold MPLS
Cloud admittance	Straight and shortest access to clouds	Cloud takes from datacenters
Security	Lines are dedicated	Entrenched security
Elasticity	Capacity can be increased	Delay in adding the capacity
Quality	Business policy based traffic routing	Dedicated lines for Internet traffic

Source https://www.riverbed.com/blogs/sdwan-vs-mpls.html

4.4 No More ISP

SD-WAN does not bump into ISP issue so that it can join or eliminate ISP at anytime without much difficulties. It has the ability to do vibrant link selection [17]. MPLS is struck with same service providers that creates lot of hassle in packet forwarding.

Table 1 focuses on significant differences between the SD-WAN and MPLS.

4.5 SD-WAN and Cloud

If an enterprise uses many cloud-based applications, SD-WAN is the game changer. There are various users who need various services in the cloud environment, and integrating those services is a difficult task in clouds [18]. SD-WAN directs network traffic to a facilitated cloud gateway, and this will connect it to the cloud applications and keep the connection alive [19]. When network flow reaches SD-WAN providers' closest gateway, then it can be straightaway connected to a cloud provider. So the latency, jitter and packet loss will be less comparatively. This will improve the user experience considerably. Secured direct internet access allows branch offices to connect to the cloud applications without any attacks.

5 Conclusion

SD-WAN is an upcoming alternative for MPLS, and it makes wide area network connections more adaptable and secured. Any sort of policies can be easily implemented without much changes across the WAN but MPLS always needs a predetermined route. If non-real-time traffic is handled by WAN, then SD-WAN is a perfect choice. If real-time traffic is handled by WAN, then the MPLS must be used. But MPLS connections are quite expensive. Anyway, both kinds of traffic have some

benefits such as high bandwidth, performance improvement, increased uptime, low cost and better performance. SD-WAN can replace MPLS with its centralized trafficking system and gives a more secured and flexible network. Nowadays, nearly 40% of enterprises embraced SD-WAN and 83% of companies attempting to adopt SD-WAN. These numbers may grow in the upcoming years.

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Security Issues and Solutions in E-Health and Telemedicine

Deemah AlOsail, Noora Amino, and Nazeeruddin Mohammad

Abstract Telehealth uses wireless communications and Internet services to offer healthcare services remotely. In fact, during pandemics such as COVID-19, telemedicine and e-health services play a crucial role. Security and privacy are of prime importance in e-health systems/services. This paper describes common security issues in telehealth services, such as attacks on end users, medical equipment, and access networks. Further, it also discusses security solutions are employed in telemedicine, including encryption techniques, watermarking, message authentication code (MAC), digital signatures, and the zero trust model. This paper concludes that the use of e-Health services will continue to increase, and security solutions/architectures for these services are of research interest.

Keywords E-health · Telemedicine · Security · Privacy · Ransomware · Masquerade attacks · Encryption · Watermarking · Non-repudiation · Zero trust model

1 Introduction

Health care is going through numerous transformations. Advancing information and communications technology (ICT) played a major role in the health system's transformation. In the e-health system, the health providers and consumers, policymakers, and researchers can access the healthcare system electronically [1]. Telemedicine is using technology and wireless communication to diagnose, check, treat, and operate on patients via cloud computing [2]. Through telemedicine, patients communicate with medical staff or even medical colleagues to get necessary medical advice. Patients can use telephones or smartphone applications to get their medications. Also, telehealth provides several services to patients. First of all, telemonitoring is to observe the condition of the patient and to monitor the progress or complications that

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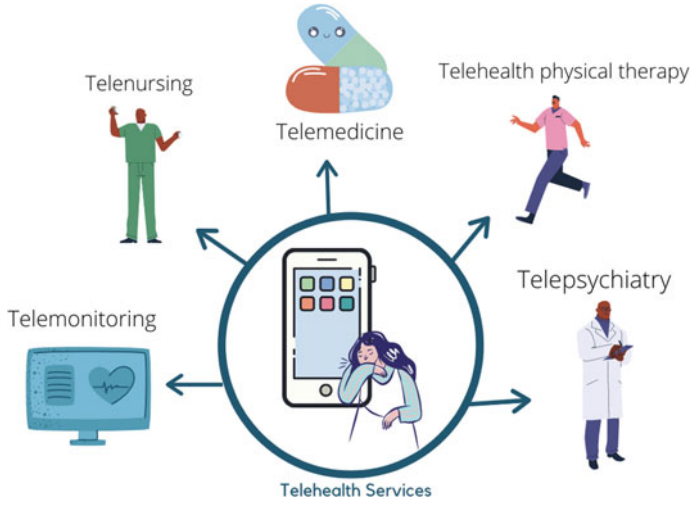

Fig. 1 Telehealth services

occur to the patient anytime. Secondly, telenursing is where consultations and diagnosing of patients happened. Thirdly, telemedicine involves prescribing the needed medications to the intended patients. Fourthly, physical therapy treatments are where a specialized medical staff offers a physical treatment and makes sure that the patient is following accordingly. Finally, mental health treatment is where sessions are taken online to observe the psychological condition of the patient. Figure 1 lists telehealth services.

The demand for telehealth services has increasingly grown due to the spread of coronavirus disease (COVID-19). Millions of people around the world are infected, and some, unfortunately, faced death. The development of a system to uphold volumes of regular patients as well as COVID-19 patients is necessary to respond to the outrageous disease [3]. With the COVID-19 pandemic, telemedicine's role became significant to manage the challenges that face the health system. Patients are communicating by using applications and Web sites to receive doctors' consultation instead of going to the clinic directly and doctors prescribing medications online. Thus, telemedicine can decrease overcrowding in clinics and emergency units. Furthermore, telemedicine increases health access to those who live in rural areas with minimized care access which can lead to less mortality rates of COVID-19. As reports say, mortality rates due to COVID-19 are higher in areas that have low healthcare access areas in China compared to other areas that have high access [3]. Hence, telemedicine can reduce such burden as Centers for Disease Control and Prevention (CDC), and some other health organizations specified that telemedicine must be present as a healthcare procedure especially during the pandemic which shows the importance of telemedicine [3].

Every week in Saudi Arabia, there are almost 400,000 appointments [4]. Saudi telehealth network's aim is to reach and link remote areas to primary health centers [5]. Thus, it will improve services of the healthcare system, and it will be of high quality [5]. STUE, the Saudi Telemedicine Unit of Excellence, provided some regulations for consultations, such as video consultations, legal requirements same as physical consultations, documenting activities, and training staff [4].

Saudi Ministry of Health provided services for patients, during the COVID-19 pandemic, such as prescription refills online or by telephone calls. Besides, some applications provide telemedicine services for patients to consult doctors by online video calls and doctors prescribe drugs if necessary. For example, Sanar is a Saudi application providing telemedicine services. Security is a crucial factor in the e-health system.

Three crucial fields in security for e-health include availability, confidentiality, and integrity. Moreover, telemedicine includes records and clinical databases, documents' electronic transfer, and data storage and data disposal which are associated with security.

This paper discusses the security issues, considerations, and solutions in telehealth systems. The paper is organized as follows: Sect. 2 describes the major security issues in telehealth systems, masquerade attack, ransomware attack, injection attack, attacks on healthcare cloud system, attacks on implantable and wearable medical devices, home network attack, public network attack, and end user attacks. Section 3 describes security considerations: authentication, integrity, confidentiality, availability, and access control. Section 4 includes security solutions in telehealth, encryption, watermarking, MAC, digital signature, audit, and zero trust model.

2 Security Issues

Security issues in health care can cost a huge amount of money. Furthermore, it can cost lives as well, and that is why security problems should be prevented. The main two issues that security targets on e-health and telemedicine are securing the medical data and providing privacy to the patient's information. In e-health, there are several causes for breaches of data that include insider or malicious attacks, lost or stolen devices, and healthcare staff's mistakes. In order to mention the solutions to these issues, we must first address the common cyberattacks on e-health and telemedicine systems. Ransomware and other malware are serious problems in healthcare systems because they may lead to huge consequences such as loss of lives [6].

Hackers tend to target patient healthcare data that includes everything from the medical records, the patient personal details, and even the payment information. One incident happened because a network server hack caused more than 80 million health data records to be stolen. Since the beginning of the year 2014, several major cyberattacks have happened against the healthcare industry and several hundreds

of thousands of patients affected [7]. Clearly, hackers tend to breach the healthcare system in order to get funded but why does healthcare information have a higher demand and cost than credit card information? Some of the reasons are described below.

Healthcare information has a higher value, and it is hard for victims to change or delete their social security number or birthdate in order to protect themselves while the credit card can easily get canceled anytime. Furthermore, the stolen health patient records cost $363 per each and the credit card information often sold for only a few dollars. Moreover, the major cause of these breaches is that organizations do not make use of records' encryption as well as the encryption of data at transit and rest which lead to increasing the number of breaches on the system. As a result, actions beyond the financial aspect could occur, such as purchasing drugs or medical equipment, getting medical care, and other illegal acts [7].

2.1 Masquerade Attack

Hackers from hacktivists and cybercriminals use masquerade attacks to get unauthorized access to the system's personal information and data. They will use a fake identity which could be from utilizing the vulnerabilities on the security system, bypassing the mechanism of authentication, or simply from stolen IDs or passwords.

Moreover, e-health masquerade attacks could occur from internal attackers, like medical staff or from external attackers. After the attacker gets into the e-health system, he\she will have full access to the patient's records and confidential data. Also, the attacker will be able to delete the data and make any modifications even in the network configurations [8].

Furthermore, the masquerade attack can be more dangerous for medical applications based on a wireless sensor network because if a denial of service (DoS) attack was launched, it will cause major and serious disruptions on the healthcare applications in which to make it inaccessible. A masquerade attack could also happen on implantable or wearable medical devices. Figure 2 shows an example hack on the cardiac monitor showing wrong readings of the patient's condition. This can result

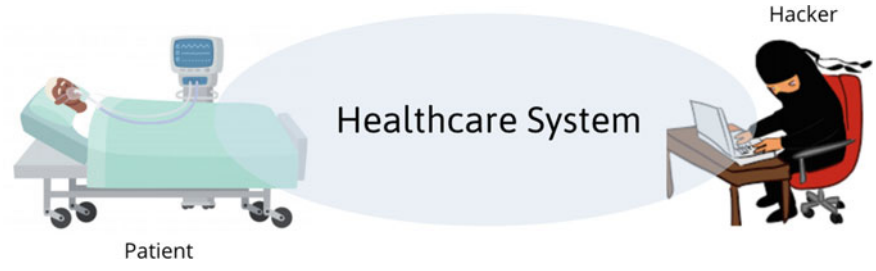

Fig. 2 Masquerade attack

in performing serious actions by doctors, like giving an overdose or injection that can threaten the patient's life [9].

Additionally, if a masquerade attack gets to capture the patient's physiological data, it can make use of replay threats; where it resends the old treatment messages to the healthcare application again and again causing mistreatment or in other cases overtreatment. These health applications are designed in a way to use the latest medicine messages from the medical sensor networks. Therefore, masquerade attack is considered dangerous to e-health and telemedicine.

2.2 Ransomware Attack

Hackers have found a way to make money by selling healthcare data and records. Therefore, another type of attack arrived called ransomware [8] [DNM1].

Ransomware is a type of malware that prevents the user from accessing the data. It happens by encrypting a key that is known by the hacker, after encrypting the user's data displayed a threat or demand of money, and if the user did not give him the money, the hacker will block the user from accessing data or will publish these data.

On e-health, the hacker will access healthcare providers' records or even the whole hospital records, and this type of attack started in 2016 causing lots of corruption and damage to healthcare data and patient records [8].

2.3 Injection Attacks

One of the major attacks on Web security is the injection attack, where an attacker sends untrusted input to the Web application, and after successful processing it alters the whole program. It is considered as an old dangerous attack where it can lead to data loss or denial of service and in some cases data theft.

SQL injection is a type of the injection attack, which is considered a very dangerous and popular one. It works by injecting an SQL query which after processing targets the SQL database, allowing the attacker to access all databases with the ability to add, delete, or change data [10]. What makes injection attack dangerous is that by only using some tools even inexperienced attackers can try the vulnerabilities of the system and gain control [10].

2.4 Attacks on Healthcare Cloud Systems

E-health systems often use public/private clouds to maintain the medical data of the patients. There are two types of attacks that could occur in a cloud—internal attacks,

which are done by someone who has access to the cloud where the attacker uses his privileges to modify or replace various data within the cloud. On the other hand, an external cloud attack is done by unauthorized users where the attacker uses social engineering and the vulnerabilities in the cloud to attack the transferred data [8].

2.5 Attacks on Implantable and Wearable Medical Devices

Like any other device, medical implantable and wearable devices could be hacked causing several complications to the patient's health, and it could be considered life threatening in some cases. Medical healthcare providers have huge and everyday dependence on electronic devices for diagnosing, monitoring, operating, and communicating in a hospital [11].

For example, an attack could occur on an insulin pump that used to monitor and measure glucose level that could happen only by having some public general information like the radio chip specifications of the insulin pump resulting, eavesdropping on the wireless communications, and after reverse engineering of the protocol and packet format, it will offer full access to the PIN of the remote control. This enables the attacker to have ultimate control, such as showing an incorrect reading, or increasing/decreasing/stopping the insulin injection causing hyperglycemia or hypoglycemia and in some cases death [11].

2.6 Home Network Attack

Telemedicine systems use a patient's network to connect a telemedicine terminal to the central system. Information transmits between the telemedicine terminal at the patient's place (home or office) and the telemedicine system. The patient's network could be Wi-Fi, local area network (LAN), and 4G/5G which will be connected to a telemedicine device, such as blood glucose meter, body fat gage, blood testing, and blood pressure meter [12]. Also, general-purpose operating system (GPOS) embedded devices can communicate by various ways to telemedicine systems. Security threats and attacks, like man in the middle (MITM), could be possible at home network-based telemedicine systems.

2.7 Public Network Attack

The standard Internet services are used to provide communications between a patient's home network and the telemedicine provider. Confidential medical information and prescriptions are transmitted through the publicly accessible network.

Security threats could occur in these kinds of environments by using the vulnerabilities of the telemedicine system which can lead to data sniffing and alterations [12]. Therefore, end-to-end guidelines and encryption of transmitted data must be followed and present.

2.8 End User Attacks

Another factor of security threat is from the end user or more specifically the patient who has no knowledge of the cybersecurity guidelines and principles. Therefore, he/she uses the app not in the proper way and uses simple weak passwords that can attract the hackers on launching security threats, like data theft, phishing, and other software attacks [12].

3 Security Considerations in e-Health and Telemedicine Systems

Telemedicine and e-health systems have similar requirements as the general information technology (IT) systems. Some of the requirements are described below.

3.1 Authentication

Authentication refers to truthfulness and originality which means that parties requiring access must be authentic. Authentication issues remain a problem in telemedicine and need solutions. In e-health, for each access, the identities of clients must be confirmed to acquire healthcare data or records [13]. For example, man-in-the-middle attacks could result from incomplete authentication problems in telemedicine. Numerous cryptography algorithms provide endpoint authenticity to especially fight attacks like man-in-the-middle attacks [13].

Cybercriminals including hackers/intruders may also hack the healthcare system to change or delete medical records which can be life threatening [6]. Hackers might steal records to use it to obtain medical services or goods or credit card, and this is called MIDT, medical identity theft [2]. An instance of MIDT was in 2004, and a US electronic medical record was stolen and found in a computer in Malaysia [2]. Thus, authentication of vital information such as medical records or images is a sensitive issue.

3.2 Integrity

Integrity is in need in e-Health to provide data consistency and accuracy with the intended information and confirms that data is not altered. By using e-Health, the system must be reliable and without errors. Nonetheless, in the real world, no such thing as an error-free system, so telemedicine, must confront integrity issues such as modification of records [13]. Therefore, integrity issues must be handled and diminished to defeat failures in the system or worse, consequences on patients' health.

As HIPAA states, the importance to implement policies to protect patients' medical records and information by using verification and integrity functionalism [13]. For instance, using hash or checksum on data and if the check on integrity crashes, e-Health application has to report errors and cease the process.

3.3 Confidentiality

Confidentiality is critical to security in e-health to keep away unauthorized users from getting private data. Entrusting data in e-health to cloud computing means increased data compromises risks because data is being accessed by a larger number of devices, applications, or parties [13]. The risk of data compromises may lead to patients not entrusting the e-health system and therefore affect the patient–doctor relationship [13]. Furthermore, another risk is that it can deter patients' medical treatment and diagnosis. In addition, data disclosing can lead to dismissing employees who disclosed data. Yet, confidentiality is achievable by encryption and access control [13].

Data remanence is the data's residual presentation that has been erased in a way. As a consequence, data remanence might lead to data confidentiality attacks unintentionally. In telemedicine, when data remanence is not put into consideration, data integrity and confidentiality solutions are inadequate [13].

3.4 Availability

Data must be available anytime in the e-health system to avoid critical situations, and this raises the availability issue. Availability includes pursuing medical procedures even when some medical authorities misbehave or during the likelihood of security violations. The system must be available during failures of hardware, denial of service (DoS) attacks, upgrades, and power outages; in other words, the system must have high availability. After administering the HIPAA act on security and privacy, the system has to sustain the usability of e-health data and records [13].

3.5 Access Control

It is a method to limit access to patients' public to only entities that are legitimate [13]. Legitimate entities include people given a right to access control authorized by patients themselves or a third party such as medical practitioners [13]. Some solutions are offered for issues related to access control. The most common models for e-health cloud applications are ABAC and RBAC, attribute-based access control, and role-based access control, respectively [13].

4 Solutions

There are several healthcare practices that could be used to reduce the possibility of potential risks. Accordingly, most solutions deal with a part of the problem instead of completely solving the issues at once. Derriford Hospital in Plymouth, plastic surgery department, used the store-and-forward telemedicine method and found that concerns relating to e-health including confidentiality, security, and risk were solvable and suggested developing more telemedicine services [14]. Kvedar et al., recommend improving and investing to develop telemedicine to increase the quality of the healthcare system. HIPAA, Health Insurance Portability and Accountability Act, in 1996 detects and corrects errors related to security in telemedicine and improves the healthcare system [1].

Security services including firewall, antivirus, and VPN are implemented in healthcare organizations. In Fig. 3, a study stated 81% of healthcare organizations

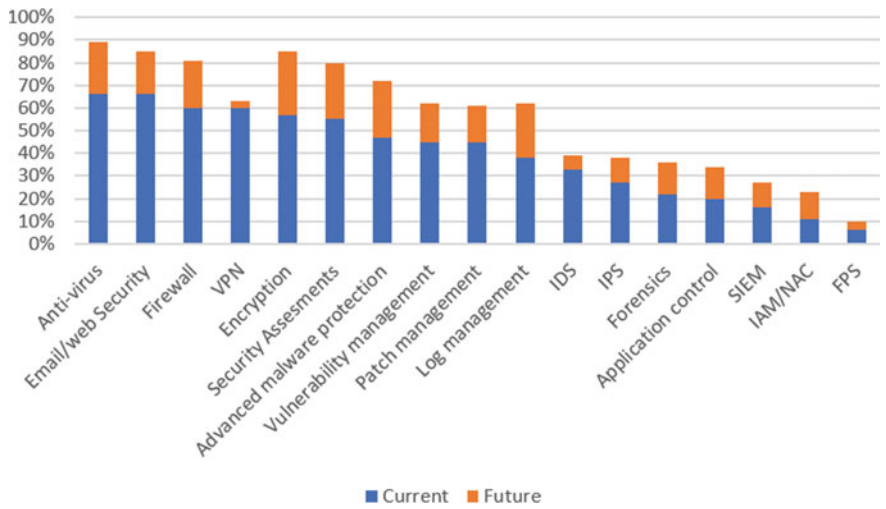

Fig. 3 Security services of healthcare organizations [15]

are either using firewalls or plan to use it in the future. These security services are basic, and more high security services need to be implemented such as SIEM and NAC. As shown in Fig. 3, some healthcare organizations started to implement SIEM and NAC security services.

In the following subsections, some key security mechanisms are described.

4.1 Encryption

An old and effective mechanism to protect data is encryption. When used properly, it protects the healthcare data at rest and in transmission. Al-Issa et al. suggested data encryption and showed that data encrypted as ciphertext is more secure compared to non-encrypted data and prevents unauthorized users to some extent [13]. Furthermore, encryption can provide secure transmission, even though the attacker can analyze the size and timing in network packets by using traffic analysis, which is called side-channel attacks. Accordingly, adding delays may solve the problem of side-channel -attacks.

Transport layer security (TLS) is used to increase communication security in Web applications by reserving an encrypted medium between a sender and a receiver that sends the encrypted text and transfers the key used for encryption via public key cryptographic protocol. Healthcare data that is kept on the public/private cloud can suffer from data-leaking risks [13]. Consequently, self-encrypting drive (SED) can offer automatic encryption and decryption of data in rest. It is highly significant to control and store encryption keys securely in external means. Additionally, data deletion encryptions secure deleted data and make it unrecovered by attackers.

Nevertheless, when data is decrypted by the receiver, the data protection ends, because it can be copied and forwarded using other means by the receiver. Thus, encryption is not sufficient in protecting sensitive data that risks patients' confidentiality [2]. Figure 4 shows how decrypting a CT scan leads to loss of protection and thus might be copied and distributed to others.

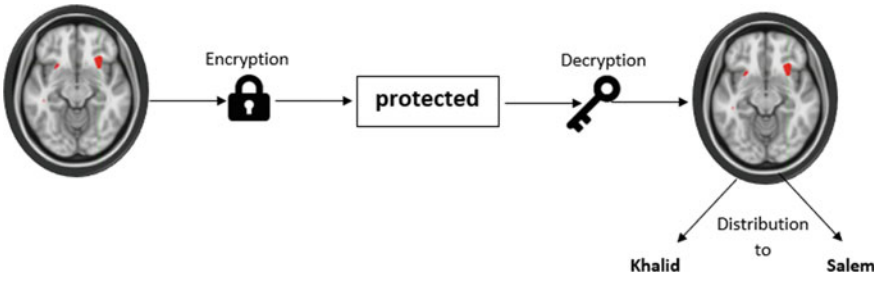

Fig. 4 CT scan unprotected after decryption [2]

4.2 Watermarking

Watermarking is a solution to decrease authentication issues in telemedicine. Digital watermarking is used to fight against piracy, and this raised authentication and integrity of media. Watermarking must guarantee not interfering with the diagnosis in digital images such as mammograms. Additionally, watermarking tracks illegal copies of media and prevents changes in digital media. In fact, watermarking is preferred over other methods that protect data authentication and integrity and that is because of its critical qualities. Some of the watermarking's qualities include the fact that the watermark is imperceptible and inseparable of the content which improves the security of the data [2].

Furthermore, digital watermarking is used to authenticate images, protect copyright, detect corruption, and monitor data. The host signal is the object communicating, and digital watermarking delivers more information about it. Therefore, digital watermarking is used in numerous applications, and it can conceal plaintext, images, information encoded, or identifications [2].

The system of digital watermarking has two main blocks: The first one is the embedding block which puts the information of the watermark. On the other hand, the extractor block extracts the information that has been watermarked. Besides, robust watermarks are required in the system as an algorithm to resist attacks. Methods of watermarking, that detects damage of corrupted images, authenticate images to increase security, integrity, and confidentiality, are not widely used in telemedicine [2]. As mentioned above, watermarking can increase the security and privacy of data. Hence, organizations developing telemedicine should consider digital watermarking.

4.3 Message Authentication Code (MAC)

Message authentication code (MAC) is a block that consists of some bytes that are added on the message, and then the receiver can check it and verify the authenticity of the data. So, MAC is based on sharing a key between the sender and receiver. The main purpose of MAC is to ensure the authenticity and integrity of the message and that there is no one modified it. Moreover, in case any modifications happen, figuring that will be easy [10]. When A and B are communicating, an eavesdropper can listen to the message and MAC; however, he/she will not be able to change the integrity of the message because the eavesdropper does not have the key. Also, MAC has a property that states that MAC cannot be repeated on any other message. Therefore, it can be a solution to masquerade attacks or any integrity issues in telemedicine and e-health services.

4.4 Digital Signature

Non-repudiation is the act of not denying things. In other words, ensuring that a user cannot deny the authenticity of their signature or in a message they already sent. This act is useful in E-communication in order to ensure message transactions between participants [16]. So, if a user signs a contract, he cannot refuse the terms that were on that contract, and he needs to take the responsibility accordingly. Digital signatures can be an example of non-repudiation since it ensures the authenticity of the user and integrity of documents (e.g., telemedicine prescriptions and medical reports) that they have not been changed or modified by any party.

4.5 Audit

Auditing can help secure the e-health system, and it logs activities of users in the system chronologically as in recording each access and changes to data. HIPAA act holds health providers responsible for handling protected information of patients [13]. Auditing approaches may lessen insider threats by detecting unauthorized users and illegal leakage of medical information. Likewise, auditing can support detecting hackers' attempts to interrupt the telemedicine cloud system and help to find weaknesses in the system [13].

4.6 Zero Trust Model

Zero trust model was developed in 2004, and as its name indicates, it has no trust, so it always verifies [17]. Thus, the zero trust model assumes there is a breach so it tends to verify each request. Instead of protecting network segments, the zero trust model protects resources. The strategy of the zero trust model is to show authenticated users what and only what they are allowed to access. The principle of zero trust model is to treat it as the Internet, assuming there are regular and malicious users on the network. The network, application, and database do not trust any action except when it is identified, approved, and authenticated [17]. Nonetheless, this model works well when organizations know their users and their interaction with other devices.

To use the zero trust model in telehealth, the management of assets and devices such as IoT devices, computers, and surgical robots is vital. However, managing all assets manually is not possible, when the network size is big. Therefore, a deployed authentication service that identifies devices or users on connection by connection basis to control access is imperative [17]. The zero trust model in telehealth must focus on device identity and health and access control. For instance, when hackers access the network with stolen credentials, the attack will not proliferate through the network. Thus, the zero trust model in telehealth can decrease the impact of attackers

by reducing the opportunity of malicious users to explore and breach interactions between assets and users because requests and identities are monitored continuously and attackers need to have privileges in every step that makes it more difficult. Furthermore, zero trust makes it easier for the healthcare environment to detect and solve small failures and breaches because often major attacks begin with minor endpoint exploits. Additionally, in the zero trust model, every step done by the attacker is logged and can be investigated later. Such extensive logging makes attackers vulnerable to detection [17]. Although telehealth has a long way to adjust and shift to a system that uses a zero trust model, it should implement a zero trust model because it reduces serious risks. In telehealth, building a strong basis using a zero trust model starts with awareness of people, identity, authentication, and groups. Over time, the zero trust model will save resources and money by preventing the attacks. For example, the US healthcare system spent around $160 million to recover from ransomware as reported in [17].

5 Conclusion

Telemedicine and telehealth are considered a useful way of communication between patients and physicians, especially if both were not at the same place and time. It can increase the quality and access to health care, reduces cost, and provides patient engagement and satisfaction. Furthermore, using electronics in health care can also improve communication, patient care, and safety. However, security and privacy issues can develop in such interactions. Research work discussed some of the cybersecurity issues that could occur in e-health and telemedicine systems. Several attacks, such as masquerade, ransomware, replay, and injection, could occur causing significant damage and corruption to both healthcare data records and patient's personal sensitive information. The research also mentioned some of the proper solutions to these problems, like watermarking, message authentication code, digital signatures, audit, and zero trust model by which the advantages of the new technology and reduced potential risks from happening could be obtained in the future. A code of practice needs to be implemented and followed by healthcare staff to protect and maintain a secure environment.

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Accident Alert System with False Alarm Switch

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Abstract In this fast-paced world, people are busy chasing their lives. The stress, burden, and carelessness have caused different accidents on roads. Over speeding is one of the reasons for accidents which have caused a huge loss of lives due to the lack of immediate treatment. This research work provides an optimum solution to this problem. According to the proposed work, turbulence on the vehicle will be detected by the accelerometer and can be deactivated within the initial 20 s period using false switch alarm in case it is a false emergency. The accident location and other details of the driver will be sent to the rescue team. The paper proposes a system where immediate alert can be given to authorities and thus save a person injured in the accident within minimum time.

Keywords Accelerometer · GSM module · GPS module · False alarm switch · Accident detection · Alerting system

1 Introduction

According to the latest reports, India accounts for about 5 lakh road accidents annually, one of the highest in the world, in which about 1.5 lakh people die and another 3-lakh become crippled [1]. Despite the number of awareness sessions organized by different organizations (governmental as well as non-governmental) about the speed limits and other measures against careless driving, accidents are taking place now and then. However, many lives could have been saved if the accident was alerted

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to the emergency service on time. Conventionally, an accident is informed to the police or hospital only when a concerned citizen passes along that route and takes an effort to inform the authorities. Therefore, an efficient automatic accident detection system that notifies emergency service immediately with the accident location which is a prime need to save lives. Most of the accident alert systems are unable to detect the seriousness of the accident, thereby sending false alarms to emergency service. This has caused authorities to ignore even serious accidents. An accident is an unpredictable and unintentional event. Prompt assistance to those injured in accidents could make a significant difference in the consequences of such accidents and has a high possibility of saving one's life. This system helps in the early detection of accidents by detecting the turbulence on the vehicle and communicating the information immediately to the emergency responses on time to provide quick assistance for the injured person.

2 Existing Works

Accident detection and alert systems have been a major study in the past few years. Many research works are going now and then to reduce the number of road accidents. The existing system, which is proposed to reduce accidents, consist of an android smartphone and an accident detection system which checks whether the vehicle is in normal posture or in fallen conditions then it checks the heartbeat of the person and if finds any abnormalities sends a message through an proposed android application via Bluetooth and alerts the rescue team [2]. Many accident cases finally end up in death [3], due to proper medical assistance at the right time. A GPS and GSM module [4] is used to track the accident spot using Google Map service, as an accident occurs, a crash is detected and alerts the nearby police station and the medical team so that the rescuing operation would be more effective [4]. In other systems, messages are sent using the ZIGBEE module and location is sent through a GPS module. Accident is detected using a microelectromechanism (MEMS) [5] sensor and vibrator sensor [6]. ZIGBEE is used to send the message to the ambulance and GPS module to identify the location of accidents [3] and alerts the rescue team for Speedy recovery. The limitations to this existing work is that, it is not cost-effective. An accelerometer is used in detecting accidents in some proposed works [7]. When an accident occurs, there would be a sudden change in the acceleration of the vehicle and an accident is detected using a microcontroller and sends a message to the emergency [8] medical team via GSM module [9]. All the other existing works did not refer to any kind of false alarm system which can avoid creating a panic situation. We should try to avoid such false alarms, so in the proposed system we have added a false alarm switch to send an alert if the person is safe [6]. This would help to ensure the proper use of the resources and manpower of the medical team. Sometimes these false alarms may panic the closed ones to the person involved with the help of this false alarm switch, we can avoid such situations.

3 Proposed System

The proposed system deals with the detection and alerting of accidents, by detecting the range of impact upon the car. When turbulence or crash occurs to the vehicle, there would be huge variations in the data provided by the accelerometer. The data of the accelerometer is sent to the microcontroller and if the values are above threshold values (confirming accident), an alerting message is sent to the concerned authorities and some personal contacts within 20 s unless it is canceled by a false alarm switch. False accident alerts can hence be overcome by this proposal. The system design of accident detection and alert system is based on various Arduino Mega modules (Fig. 1).

3.1 Technical Specification

See Table 1.

3.2 Implementation

See Table 2.

When turbulence or any accident is met by the vehicle, it is detected by an accelerometer. The accelerometer is used to detect the sudden change in any value in the axis. With signals from an accelerometer, a severe accident can be recognized. When the value exceeds the programmed maximum limit or threshold value, the alert system gets activated. Once the alert system is activated, it triggers a red LED and the buzzer starts ringing. The 20 s timer also starts at this point. After this, two processes happen asynchronously. The system acquires the current location of the

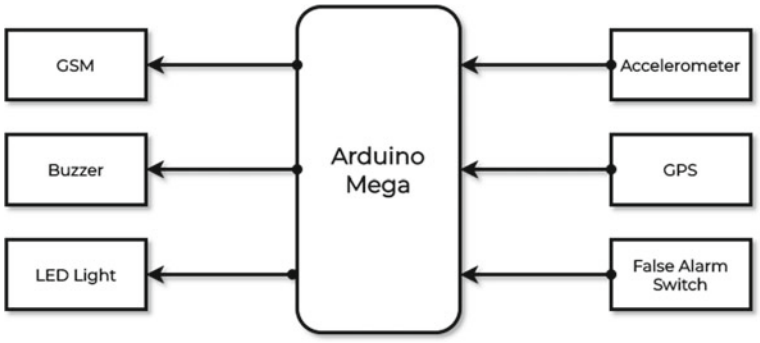

Fig. 1 Proposed architecture

Table 1 Proposed architecture technical specifications

S. No.	Hardware components	Technical specification
1	Arduino mega	Operating voltage 5V Input voltage 7-12V Digital I/O pins 54 Analog input pins 16 Clock speed 16 MHz Length 101.52 mm Width 53.3 mm Weight 37 g
2	GPS module Neo6M	Navigation update rate 5Hz Default baud rate 9600bps Sensitivity -160dBm Supply voltage 3.6V Maximum DC current 10mA **Operation limits** Gravity 4g Altitude 50000m Velocity 500m/s
3	GSM SIM900 module	Dual-Band 900/ 1800 MHz Dimensions 24x24x3 mm Weight 3.4g Voltage range 3.2
4	Accelerometer ADXL335	Operating Voltage 1.8V–3.6 V Operating Current 350µA Sensing Range ±3g Sensing axis 3 axis Sensitivity 330mV/g Shock Resistance 10,000g Dimension 4x4x1.45mm

device and sends it to the primary emergency contact which are your closed ones, so that they can check up on you. It waits for the 20 s timeframe to check if the false alarm switch is initiated and confirmed, if not, it will send a message along with the location to emergency contacts, nearby hospital as well as a police station (Figs. 2 and 3).

Table 2 Proposed architecture component uses

S. No.	Hardware components	Description
1	Arduino mega	For interfacing all the components. It receives the sensor values from the accelerometer where it is evaluated to check whether the accident alert system has to be triggered
2	GPS module Neo6M	To acquire the latitude and longitude of the accident location
3	GSM SIM900 module	For sending out the emergency message to the contacts along with the location data
4	Accelerometer ADXL335	For measuring acceleration, velocity, orientation, displacement of the vehicle which gives analog data as output
5	False alarm switch (FAS)	To disable the system by the driver incase of any false alarm
6	Buzzer	To alert the driver if the system detects any sudden turbulence by producing a beeping sound
7	LED	To alert the driver of any sudden turbulence on the system by emitting a red light

3.3 False Alarm Switch

When the alert system gets activated, it initially triggers the led to start blinking and the buzzer to start ringing. After which, it will start the 20 s waiting period, during which a message along with the current location is initially sent to the rider's primary emergency contact so that he can check up on the rider even if it is a false alarm or not. If the system got activated by mistake, there is an option for the rider to cancel the system from alerting the hospital or police station. In order to do this, there is a false alarm switch (FAS) which the rider can switch on to activate it. Once it is switched on, a timer for 5 s will start to confirm the decision. At the end of 5 s, the buzzer will stop ringing and the rider is supposed to switch off to confirm his/her decision. The false switch is designed in this way so that it does not get canceled due to the impact of the accident. If the FAS is not switched off within the initial 20 s period, then it will not be considered and the message will be sent to emergency contacts, nearby hospitals and police stations. If the FAS is turned off within the initial 20 s period, the LED light will also stop confirming the rider's decision to deactivate the alerting system. The reason why we chose 20 s was based on a study [8, 10, 11] which emphasized on the importance of low response time which is very crucial in car accidents (Fig. 4).

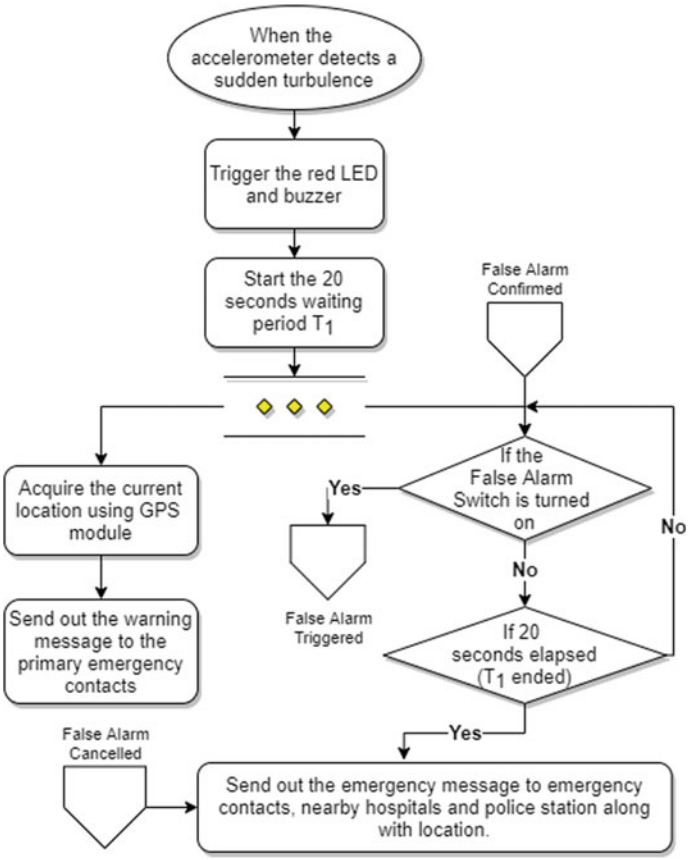

Fig. 2 Workflow of proposed work

3.4 Arduino Mega

During the prototyping stage, we switched to Arduino Mega from Raspberry Pi due to several reasons such as: Arduino is more energy-efficient than Raspberry Pi. An Arduino can run even on the car's charging port which keeps the voltage above a certain level, along with a primary shield to manage the power but for running a Raspberry Pi, and it requires an unfluctuating supply of 5 V. Even if the power drops on the Arduino, it won't end up with a corrupt operating system or any software errors but in the case of Raspberry Pi, if it is not shut down within the operating system like any other computer, there can be corruption and software problems. The absence of analog pins in Raspberry Pi The accelerometer sensor in our system outputs analog data, so our central board should be able to work with analog data seamlessly. Raspberry Pi is a digital-only computer, so it does not have any analog inputs. In order for the Raspberry Pi to read an analog input, we need to use an

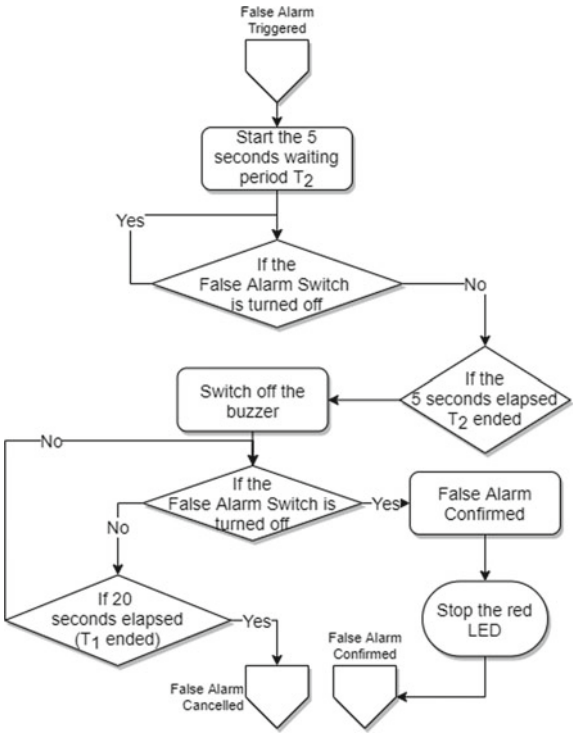

Fig. 3 Workflow of false alarm switch

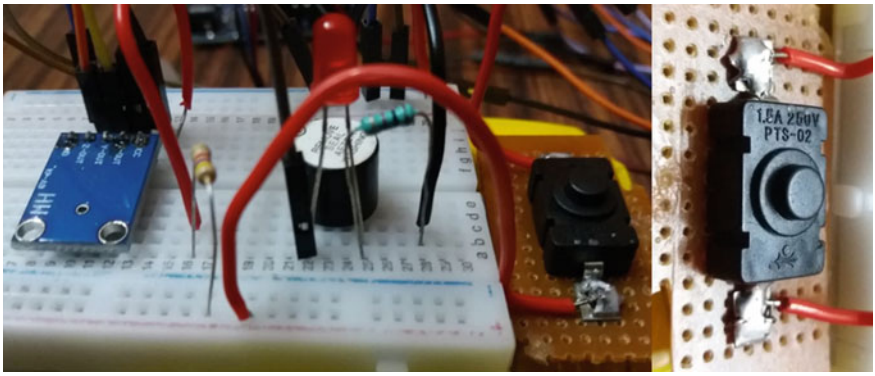

Fig. 4 False alarm switch

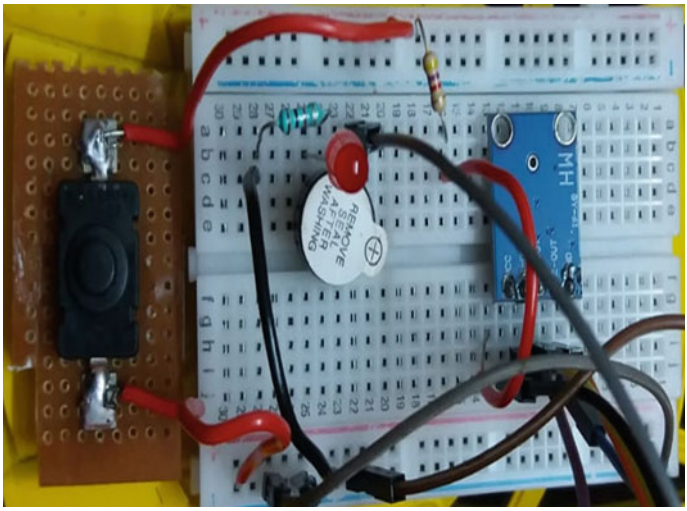

Fig. 5 Proposed system sensor unit + false alarm switch

analog-to-digital converter (ADC) which adds unwanted complexity to the circuit design along with making it bulkier. While on the other hand, the Arduino Mega comes with 16 analog inputs which can be used directly to read the analog input from the sensors. Simpler design since our system is primarily hardware-based, it does not need all the complexity of running an OS for the system to keep running. This will also help us in the future during the production stage, during which we'll be assembling the system by ourselves [12].

4 Result

The system was tested on a very controlled environment, and the results produced are presented here (Figs. 5 and 6).

5 Conclusion and Future Scope

The proposed accident alert system plays a significant role in the field of accidents. This device will be really useful in saving the lives of many who are injured in accidents by alerting the concerned ones in time. If an accident occurs in an isolated area, the device would be really helpful in reporting it and hence improve the chances of faster medical treatment to the victim. This system detects accidents based on impact, and it can be extended by adding computer vision to identify the accident from

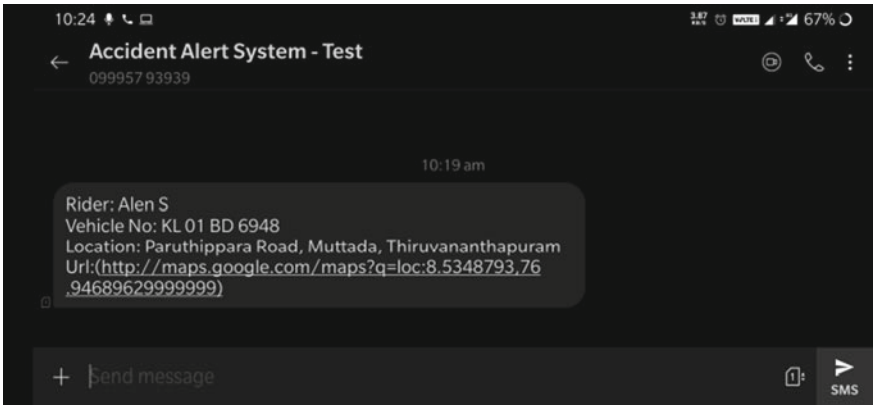

Fig. 6 Accident alert system

the images of the surroundings captured by a camera. A combination of accelerometer and vibration sensor gives more accurate results of the impact. The compact version of this system could be incorporated into different types of vehicles as well as in helmets. It can be commercially distributed to vehicle and helmet manufacturers. A mobile application will be built integrated with this system, giving a detailed analysis of accidents rate, along with precautions and driving rules. The driving pattern of the user will be studied and can be used for further purposes. The project will be beneficial to the automobile industry and will help society. In the proposed solution, the emergency contacts or information of the authorities needs to be stored in the user's device, which arises an issue as the system may not be useful in certain cities. The system can be revamped by sending the accident location directly to the server, from which the details can be shared with the closest hospitals or emergency services located in that city.

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Metaheuristics Algorithms for Virtual Machine Placement in Cloud Computing Environments—A Review

Jyotsna P. Gabhane, Sunil Pathak, and Nita M. Thakare

Abstract Cloud Computing provides on-demand, flexible, ubiquitous resources for clients in a virtualized environment using huge number of virtual machines (VMs). Cloud data centers don't utilize their resources fully which leads into a underutilization of resources. Virtualization offers a few exceptional highlights for cloud suppliers like saving of power consumption, load adjusting, and adaptation to internal failure, resource multiplexing. However, for improving energy proficiency and resource utilization, various strategies have been introduced such as server consolidation and different resource structuring. Among all, Virtual Machine Placement (VMP) is the most vital strides in server consolidation. Virtual Machine Placement (VMP) is an efficient mapping of VMs to Physical Machines (PMs). VMP issues go about as a non-deterministic polynomial-time hard (NP-difficult) issue and metaheuristics strategies are widely used to solve these issues with enhancing boundaries of power utilization, QoS, resource usage, etc. This paper presents an extensive review of Metaheuristics models to deal with VMP in the cloud environment.

Keywords Cloud computing · Data centers · Metaheuristics · Physical machines · Virtualization · Virtual machines · Virtual machine placement

1 Introduction

Cloud Computing is a model which shares a variety of configurable registering resourcing like systems, databases, memories, applications, software development

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platform, and facilities over the web [1]. The Cloud can be seen as an abstract layer on the Internet, which makes all available software and hardware resources of a data center transparent, rendering accessibility through a well-defined interface [2]. Flexibility is one of the alluring highlights of the cloud. It allows obtaining or releasing computing resources on the user's demand. It enables service providers to auto-scaled the resources to their applications which reduces the resource cost to improve the Quality of Service (QoS) [3]. Recently all storage and networking platforms moved towards the cloud in collaboration with IoT (Internet of Things), which introduces many challenges [4]. In the fast-growing cloud environment, many application providers directly host their applications on cloud resources using cloud service providers such as Amazon EC2. It allows migrating local applications to clouds, as an on-demand service [3]. Cloud computing offering infrastructure, platform, and software as pay and use services require Quality of Service (QoS) and Service-Level Agreements (SLAs) to monitor and ensure their efficient delivery. However, clients' dynamic QoS prerequisites and maintain a strategic distance from SLA infringement is a major task in cloud environments [5]. Since 2008, Cloud computing is an admired paradigm in IT Sector with three common models briefed as Software as a Service (SaaS) for applications, Infrastructure as a Service (IaaS) for hardware resources, and Platform as a Service (PaaS) for real-time application [6]. IaaS (Infrastructure as a Service) is a top-layered on-demand infrastructure resource provisioning service of cloud computing. It provides infrastructural resources like hardware requirements in virtual machines, processing powers, network bandwidth, storage, CPU, and Power [7]. IaaS users have control over data, applications, operating systems, storage, and security. Typical examples of IaaS are AT & T, GoGrid, Verizon, Amazon web services many enterprises have adopted the extremely elastic IaaS (Infrastructure as a Service) form [8]. PaaS (Platform as a Service) [9] is to shape a facilitating situation it gives stage level assets, including working framework and structures for programming advancement. The PaaS user has control over the deployment and execution of applications. It is a platform to develop, test, and deploy an application [7]. SaaS provides access to an application to the users online instead of installing or purchasing it [10]. The various deployment models of cloud computing like Private cloud, Community cloud, Public cloud, Hybrid cloud [11, 12] are used as a virtual distributed system. It has been noticed that cloud data center's energy utilization has increased due to the vast usage of cloud computing [4]. One of the ways to deal with this problem is to minimize the active machines and closing inactive servers. From the power consumption point of view, the unutilized server is highly inefficient and hence is the biggest challenge to be dealt with [13]. Virtualization technology is one of the preferable solutions to solve the power incompetence problem. Virtual machine placement (VMP) is the novel approach to increase the power competence of the cloud data center. It improves resource utilization and Return on Investment (ROI) [14]. As an emulation of a particular physical machine, a virtual machine acts as a real machine [15]. VMP improvement is a NP-hard combinatorial issue. The issue can be solved in different ways [16]. Service Level Agreements (SLA) is an agreement between the client and specialist organization, as far as service quality, responsibility, and availability. Hence, good VM allocation

is a core challenging problem nowadays to keep an optimal balance between QoS and energy consumption [3]. In the following sections, the research work proposed the idea of Cloud Computing along with Virtual Machine Placement. VM Placement comes up with the varied problem structure like VMP Optimization approaches, VMP problem formulation, and its objective functions which are discussed in detail in the following section. Existing algorithms of VMP are discussed and analyzed in the given study, finishing with the conclusion of potential answers for the virtual machine placement in the cloud environment.

2 Virtual Machine Placement in Cloud

To provide the services over the internet, a large number of physical devices are required to embed with various software. Every device is not fully utilized every time as the network resource usage is very unpredictable [17]. To solve such issues Virtualization is introduced for cloud environment. Virtualization is the process of partitioning the physical resources like storage, memory, network, and power of the physical machine into the multiple execution environments called Virtual Machines (VMs). Data centers are geographically distributed with VMs are located in it. The number of virtual machines available with resources such as CPU, storage space, network, and memory is effectively handled user's request in the cloud. As per the increase in the demand from the users, VM Selection plays a major role to select optimal PM to run the VM [18]. Virtual machine placement (VMP) is nothing but the allocation of proper Virtual machines at each PMs of the cloud data center. It is also called a placement plan of VM to PMs Mapping. VMP has two major objectives power-saving and delivering QoS [9]. Virtual Machines are typically portrayed by the quantity of CPU centers, CPU limit per center, RAM size, circle size, correspondence data transfer capacity and idleness between sets of VMs or a VM and the client. Requirements of VM can be stable or dynamic depending on the type of application(s) running on it. Cloud data center (DC) uses virtualization technology for serving computation, storage, and networking [19]. Virtualization has basic components like VM migration, VM fault tolerance, VM elasticity, VM consolidation, VM load balancing, and VM scheduling [20].

VMP formulation problem is classified as [21]:

- Optimization approaches
- Objective functions
- Solution techniques.

Each of them discussed details in the following sections.

3 VMP Optimization Approaches

Different optimization approaches discussed in the studied papers based on the various objective functions [22]. A mono-objective approach as its name indicates focused the optimization of only single objective. It is an individual streamlining of more than one target work, each in turn. As indicated by the considered articles, maximum research work follows mono target-based method for tackling the VMP issue [22]. Multi-Objective Solved As Mono-Objective Approach is a methodology where the advancement of different target capacities illuminated as a solitary target work is viewed as a multiple target way understood to be a mono-objective. To perform a right combination of the goal capacities, it requires intense information on the difficult space and as a rule; it is beyond the realm of imagination which might be expressed as a downside of this methodology [23, 24]. The approach which streamlines more than each target work, in turn, is named as Pure Multi-Objective (PMO). Even though lots of work has been done on a mono objective approach for the operational real cloud environment a PMO provides good solution [23]. Last is Many-Objective Optimization (MaOP) which focuses on more than three and up to twenty parameters. MaOPs show up generally in some certifiable applications, for example, building structure [24]. Many-objective Optimization Problems formulation is not yet projected for the VMP problem in the particular research [25].

4 VMP Problem Formulation/Objective Functions

As per previous research to obtain Optimal Virtual Machine Placement some important parameters like minimization of power consumption, Minimization of SLA violations, resource utilization, etc. are always need to be considered. These criteria can change from time to time depending upon the VMP Problem formulation. Various objective functions stated below are superlative for solving the VMP Problem [22, 26, 27] like High Performance, Minimizing Energy Consumption, QoS Maximization, Network Traffic Minimization, Minimizing SLA Violations, Balancing Resource Utilization, Load Balancing, VM Migration, Security, Resource Wastage Minimization, Datacenter Power Consumption Minimization, Operational Cost Minimization, Performance Maximization. Allowing for the above huge number of various objective functions, the following are Five broad classifiers [22, 27] covering almost all objectives in the following sub-sections.

- Energy Consumption Minimization
- Cost Optimization
- Network Traffic Minimization
- Resource Utilization
- Quality of Service.

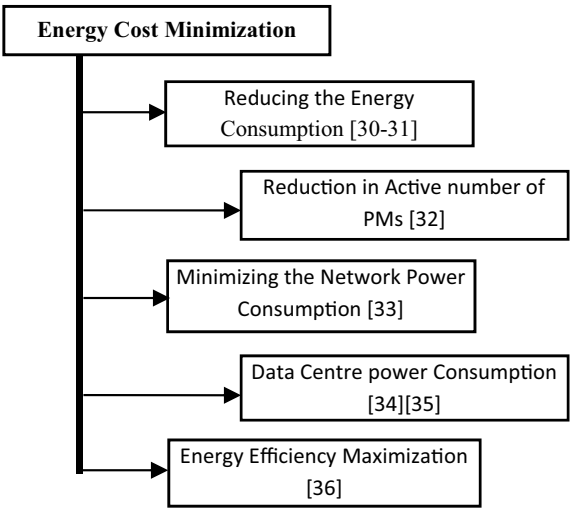

Fig. 1 Objective functions of energy cost minimization

4.1 Energy Consumption Minimization

Datacenters consume lots of power and reduction in such power consumption is a challenging task. Energy Consumption can be minimized by minimizing Active Servers [28]. This paper proposed a strategy to reduce power consumption by Maximum VM Placement to profit in revenue generation. The efficiency of energy can be increased by a reduction in VM migrations. So, the Live Migration technique is proposed in this paper for utilization of virtual machine placement by guarantee a deadlock-free resource allotment based on multi-dimensional resources. The aim is to reduce the energy consumption of datacenter [29]. Maximum studied articles focused on the main objective function of VMP which is power consumption minimization. Various target capacities sorted in this improvement group are: (1) Reducing the Energy utilization (2) Reduction in active number of PMs (3) minimizing the Network Energy utilization (4) Data Center power Consumption (5) Energy Efficiency Maximization [22] (Figs. 1 and 2).

4.2 Cost Optimization

Due to the on-demand service of cloud computing, high rate is a big confront for cloud service providers. This cost includes Reducing Electricity Costs, Network Power Costs, cost of server, reduction in Connection Cost, decrease in SLA Violations as well in Operational Cost, Economical Revenue Maximization [27].

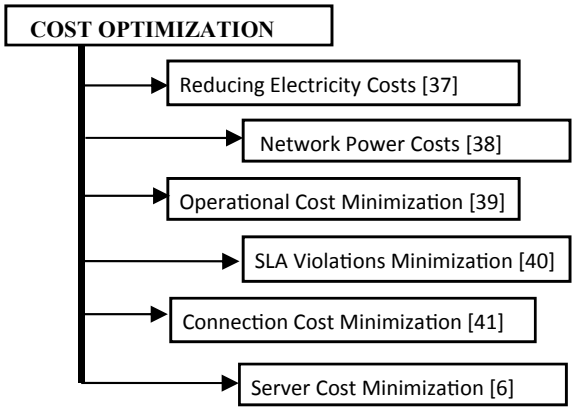

Fig. 2 Objective functions of cost optimization

4.3 Network Traffic Minimization

To enhance the performance of a data center minimizing network traffic is again a crucial parameter need to be focused on. To avoid the consumption of resources VM to VM intercommunication helps to reduce network traffic [42]. Minimization of Network traffic can be classified further by Reducing the Average Traffic Latency, reduction in the Data Transfer rate, Reduction in network traffic, Network Performance maximization [27].

4.4 Resource Utilization

In data center, resources like CPU, memory, and bandwidth are important performance metrics. It aims to utilize resources by guaranteeing the QoS. In Virtualization the services provided on shared resources and utilities in Datacenters [43]. In this context, resource utilization classified further as maximizing resource usage, minimizing resource wastage, and increasing elasticity (Figs. 3 and 4).

4.5 Quality of Service Maximization

Virtual Machine Placement problem can be solved using different constraints as mentioned above. One of the important constraints out of them is the Quality of Service (QoS). Reduction of the resource interference, High accessibility, Performance Improvement, Resource interference minimization, and reliability are the crucial parameters metrics to insure good QoS [27] (Fig. 5).

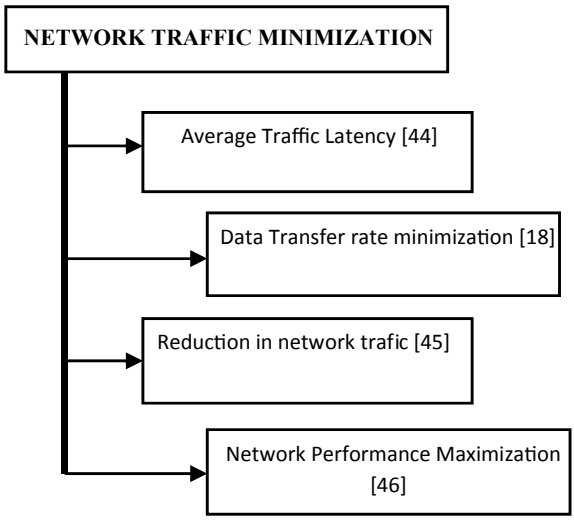

Fig. 3 Objective functions of network traffic minimization

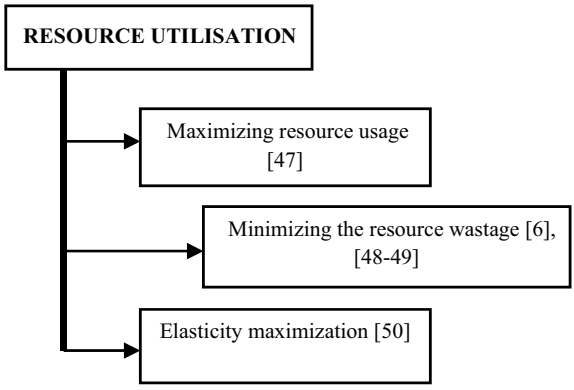

Fig. 4 Objective functions of resource utilization

5 Solution Techniques

Universally, there are many approaches used to solve placement problem of Virtual machines. The major and focused techniques are deterministic algorithms, approximation algorithms, heuristics, and Metaheuristics algorithms [22]. In the following section, Metaheuristics algorithms are discussed in detail.

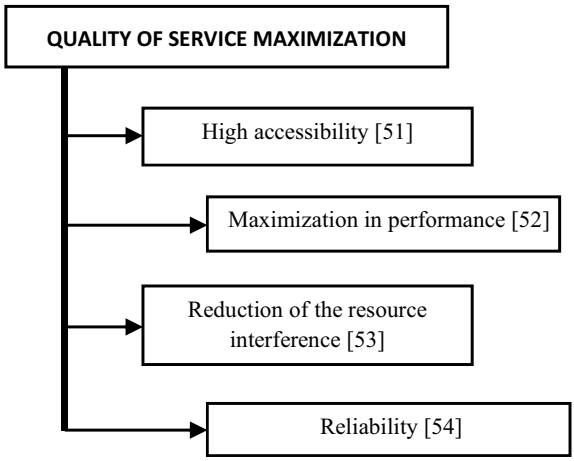

Fig. 5 Objective functions of QoS maximization

5.1 Metaheuristics Algorithms

Meta in Meta-Heuristic is a Greek word means advanced whereas heuristics defines to locate or to identify. It enhances the efficiency of the heuristic approach [55]. The VMP problem is act as or considered as a non-deterministic polynomial-time hard (NP-hard) problem. For these types of problems, it is difficult to create optimal solutions in a short period. Metaheuristics techniques are one of the promising solutions which can provide nearby perfect and feasible solutions within a preferable instance. Because of efficiency of solving large and complex problems, Metaheuristics admired from last few years. Many Metaheuristics algorithms have been used to solve the VMP difficulties in terms of power, resources, network traffic, and cost optimization [56]. The following section discusses more in detail about Metaheuristics approaches.

Ant Colony Optimization (ACO)

A VMP approach used the concept of the Ant Colony algorithm was projected in [57] to enhance power utilization and load balancing of the system. Idle resources and power consumption model was proposed as multi-objective technique and the utilized parameters of virtual machines. For the performance assessment of the method the comparison is done with the traditional genetic algorithm-based MGGA model. Their experimental results indicate that the rate of convergence is increased by 16%, and the average energy consumption is reduced by 18%. This paper [58] proposed an ant colony optimization method for the consolidation of virtual machine (VM) in cloud environment. Some VM migrations plans were proposed for underutilized PMs and are used to reduce the number of PMs. They have considered multi objectives for minimizing VM migration. The researcher claimed that when their algorithm gets compared with existing algorithms, it outperformed in terms of VM Migration, the number of unrestricted PMs as well packing effectiveness. A power proficient

OEMACS for VMP in cloud environment was proposed by [59]. To achieve optimal VM deployment number of dynamic servers needs to be reduced. It avoids possible wastage of computation. An ACS-based approach is proposed coupled with order exchange and migration (OEM) so named as an OEMACS. This scheme focused on reducing working servers with good utilization of energy, consumption of resource, and proper balancing. Finally, they compared the performance of the OEMACS with heuristic and other evolutionary methods, which generally outperforms in resource characteristics, and power optimization than other algorithms. The author [36] has formulated VMs to PMs in a data center as an inhibited problem which uses data from PM to VM to reduce down the full energy utilization of working PMs. The focus is on reduction of power utilization of cloud centers. They proposed an Ant colony scheme implanted through a heuristic approach. The experimental results compared with the two existing ACO methods, ACOVMP and PAVM as well as First-Fit-Decreasing (FFD) algorithm. The authors claimed that their proposed algorithm has an improvement in energy efficiency by 5% (Table 1).

Table 1 The summary of ant colony optimization

References	Objectives	Problem addressed	Algorithms	Comments
[57]	To Optimized Energy consumption and load Balancing	Energy aware	ACO	The proposed algorithm of this paper acts as an energy-saving model
[58]	To reduce overprovisioning of physical machines (PMs)	Energy-aware	ACO	The proposed algorithm outperformed in terms of VM Migration, the number of released PMs, and packing efficiency
[59]	To minimize the number of active servers, and to improve the resource utilization, load balancing, and reducing power consumption	Resource aware Energy aware	OEMACS	The proposed algorithm outperformed for resource characteristics, and power optimization
[36]	To minimize the power consumption of a data center	Energy aware	ACO	The proposed algorithm gave an improvement in energy efficiency by 5%. It also showed a 10% improvement in the new ACS

Particle Swarm Optimization (PSO)

In 2015 [35] authors have proposed the power-aware Particle Swarm Optimization method for the virtual placement of virtual machine to decrease utilization of power in the cloud data centers. The projected approach compared with the non-power-aware algorithm and proved to be superlative. This paper [60] presented a multi-objective optimization model to address the VM Migration problem. VM Migration can generally affect the performance in terms of load balancing, fault tolerance, utilization of energy, and utilization of resource. The proposed algorithm Fuzzy Particle Swarm Optimization (PSO) used fuzzy logic for regulation inertia mass along with conventional particle swarm optimization to resolve the mapping issues. This paper proposed [48] an improved PSO solution for the heterogeneous data center. The aim of the given approach is to fit with proper placement of virtual machine in data hubs with optimal energy consumption. This paper mainly focused on Energy-efficiency of green computing. The proposed algorithm compared the performance with First fit, Best fit, and worst fit strategies and claimed to do a better use of the resource. A resource aware VMP approach stand on the concept of PSO meta-heuristics was proposed in [30] to increase packing effectiveness while reducing power utilization. It was a multi-objective version that considers energy and resource utilization. The VMP Formulation was presented to improve the packing effectiveness and so reduction in power utilization. The simulation outcome showed that the planned technique exhibits excellent performance. As the drawback, the proposed system works only for the static workload (Table 2).

Biogeography-Based Optimization (BBO)

In this literature [6] a novel approach named VMPMBBO projected to discover the best possible placement of virtual machines which reduces wastage of resources and utilizes proper consumption of energy. The author claimed that the proposed technique gives the primary approach that uses Biogeography-Based Optimization (BBO) and composite systems for solving the VMP problem. Finally, it proved that VMPMBBO has recovered authentic properties with more efficient and robust environment. Experiments were conducted on both real-world data and synthetic data from research. Flexibility and scalability of VMPMBBO also proved via various practical outcomes. In 2016, a multi-objective VMP optimization problem [61] with an improved BBO algorithm is proposed named IMBBO (Improved BBO). In the major contributions of the given article, the focused is on the VMC problem a multi-objective task. It includes parameters like minimizing server power consumption, proper loading balancing, and reducing migration overhead. Experimental results based on synthetic datasets and real VMs running data, the proposed IMBBO compared with Gravitational Search Algorithm (GSA) which showed improvement in performance (Table 3).

Genetic Algorithm (GA)

A procedure proposed [31] for controlling power consumption with the active Voltage rate range system is included in the optimization system and Non-dominated Sorting

Table 2 The summary of particle swarm optimization

References	Objectives	Problem addressed	Algorithms	Comments
[35]	To reduce the power consumption of the data centers	Energy-aware	PSO	A model is proposed to minimize in power consumption of a data centers
[60]	To reduce energy consumption and to maximize the resource utilization	Energy-aware Resource aware Cost aware	PSO	The proposed algorithm improves the efficiency of conventional PSO by using the fuzzy logic system and used to solve the optimization problem. The future research direction is to consider the selection of proper PMs to hosts the VMs
[48]	To fit with virtual machine placement in data centers with minimum power consumption	Energy aware Resource aware	Improved PSO	The proposed algorithm uses resource wastage and energy consumption efficiently. The extension of this work can make use of better energy-efficiency models
[30]	To improve packing efficiency while reduction in energy consumption	Energy aware Resource aware	PSO	The VMP Formulation model was proposed to maximize the packing efficiency and reducing the energy consumption. The drawback of the proposed system is that it works for static workload only

Genetic Algorithm (NSGA-II) used for a set of non-domination solutions. The primary goal of this method is to minimizing the energy consumption as well as execution time. To predict Virtual Machine based on so predicting Artificial Neural Network (ANN) is applicable for envisage the virtual machines performance depends on the tasks given as well resource allocations. The results showed that effective minimization of energy consumption by including DVFS in the optimization approach. The VMP bi-objective combinatorial optimization approach was proposed [49]. An

Table 3 The summary of biogeography-based optimization

References	Objectives	Problem addressed	Algorithms	Comments
[6]	To find the optimal VM placements for minimizing power consumption and resource wastage	Energy and resource-aware	VMPMBBO	The proposed algorithm gives optimal VM placements which simultaneously minimizes both the resource wastage and energy consumption. In future author will more focus on the Parallelization of the algorithms
[61]	To improve the classical BBO algorithm	Energy and resource aware	Improved BBO	The proposed strategy minimized server power consumption with proper loading balancing and reduced migration overhead. The future will more focus on the parallelization of IMBBO concerning the re-configuration migration and mutation model in the real

efficient decision-making structure of genetic algorithm and Bernoulli simulation (GAVMP-BO) is proposed for multi objectives which are used to reduce dynamic PMs. The main objective of the research is reduction of unbalanced resources in dynamic PMs. The proposed algorithm was compared to six different competing algorithms. Results show that the proposed work is superlative and outperformance than all frameworks (Table 4).

Simulated Annealing (SA)

In 2015, a Simulated Annealing based algorithm was proposed [62] for improving the performance in terms of cost. A novel approach was introduced to solve the VM consolidation problems by estimating the cost of possible VM migrations. Network traffic and different network topology parameters for consolidation decision left as future work part in this literature. Getting optimal VMP environment is little bit cumbersome method in terms of time. To resolve the issue, this research [63] proposed an improved simulated annealing algorithm (ISA) for VMP. For servers, resource utilization and for VM dynamic models were introduced. The threshold value defined for the annealing process in ISA and the allocation weight vector

Table 4 The summary of genetic algorithms

References	Objectives	Problem addressed	Algorithms	Comments
[31]	To reduce the makespan and energy power consumption of the cloud services	Energy aware Resource aware Cost aware	NSGA II with ANN	The results of proposed approach showed the effective minimization of energy consumption
[49]	To reduce power consumption with the operational costs and resource wastage	Energy aware Resource aware Cost aware	GAVMP-BO	The proposed work is superlative and outperformance than all frameworks

was computed. Comparative analysis showed that the approach got a desired output within a smaller amount time. The mentioned approach improved resource utilization with proper load balancing. In this paper [28] a method called maximum VM placement with least utilization of energy (MVMP) was proposed to increase the revenue of a Cloud Service Provider (CSP). The given method aimed reduction in power cost as well increase the revenue. The proposed algorithm compared with different techniques. MVMP has improved performance than all approaches in power consumption, execution time, and the number of servers used and it is scalable too (Table 5).

Artificial Bee Colony (ABC)

In a Heterogeneous Cloud environment for the reduction in the make-span this paper [64] proposed Heuristic task scheduling combined with the Artificial Bee Colony algorithm (HABC) for the virtual machine. It is a task scheduling approach with proper load balancing. The two major goals of the given method were to maximize productivity by balancing workload and to reduce the total amount of time. The experimental outcomes proved that the given approach improved the effectiveness in scheduling the task as well as load balancing of virtual machines in given environment. Energy-related dynamic VM Consolidation approach (EC-VMC) was proposed [65]. The experimental outcome indicated that the proposed algorithm exceptional in provisions of reducing utilization of power, VM immigration with effective QoS (Table 6).

Firefly Algorithm (FA)

Many research focused on Virtual machine placement parameters like energy consumption, resource utilization, and network traffic. Very few works considered security and privacy issues. This [66] paper proposed a secure and efficient VMP framework by incorporating a proper constraints-based multi-objective model using the Discrete Firefly algorithm (DFA-VMP).To calculate the security and efficiency of the system authors have specially defined the security manifestation, with calculated power consumption as well focus on reduction in loss of resources. The outcomes express that this methodology adequately decreased the likelihood of co-occupant

Table 5 The summary of simulated annealing

References	Objectives	Problem addressed	Algorithms	Comments
[62]	To improve the performance of the system in terms of cost	Energy aware Resource aware Cost aware	SA	A novel method was introduced to solve the VM consolidation problems but the parameters like Network traffic and different network topology left as future work part in this literature
[63]	To improve the resource utilization rate, allocation of resources with steady and capable working of data center	Resource aware	ISA	The proposed method converges faster and improved utilization rate of resources compared with traditional ones. However, some factors such as response time are not considered in this research
[28]	To maximize the revenue and minimize the power cost	Energy aware Cost aware	MVMP	MVMP performs better than all approach in terms of power consumption, execution time and number of servers used and it is scalable too. Dynamic VM Placement is left for future work

Table 6 The summary of artificial bee colony

References	Objectives	Problem addressed	Algorithms	Comments
[64]	In order to stabilize the workload the processing time as well total execution time gets reduced	Resource Aware	HABC	This algorithm improved the efficiency in task scheduling as well in load balancing
[65]	To proposed energy-aware VM consolidation model	Energy aware	EC-VMC	The proposed algorithm exceptional for reduction in power consumption, VM migrations, and improving QoS

Table 7 The summary of firefly algorithm

References	Objectives	Problem addressed	Algorithms	Comments
[66]	To deal with the issues of IaaS platform like side channel attack	Security Aware	DFA-VMP	The related security indices, measured power consumption, and loss of resource at the data center are considered to measure the system security and efficiency

in a similar hub of VMs of pernicious inhabitants with the objective virtual machine and furthermore diminished power utilization and loss of resources at the server.

Tabu Search (TS)

To reduce power consumption and reduction in CO2 emission a very efficient Tabu search heuristic technique [33] was proposed. It solved the Mixed Integer Linear Programming (MILP) model. To handle online and dynamic demands Tabu search a Metaheuristics approach was implemented. The result stated that reduction in Communication delays up to 6 times. CO2 emissions reduced up to 60 times and 30% of power savings [67]. The key idea of the proposed work was to achieve energy-efficient VM Allocation plans utilizing the hypothesis of heartiness and determine a strong Mixed Integer Linear programming (MILP) detailing. The goal of the calculation is to build up a VM-to-PM designation which lessens the power utilization, the quantity of relocations and guarantees strength (Table 7).

Tabu Search is used as base which incorporates a greedy approach. It showed an effective and stable performance than various Metaheuristics algorithms. Various local search algorithms can utilize this algorithm. The exploration guaranteed that the developments indicated the vigorous heuristic can figure most ideal arrangements and beats the notable VM Workload Consolidation Strategy (WCD) heuristic (Table 8).

Cuckoo Search (CS)

In 2018, [68] an Enhanced Cuckoo Search (ECS) was proposed to optimize utilization of power in VMP. The focus of work is to how to narrow down utilization of power along with resources in the cloud data center. The result of the proposed algorithm compared with the existing Genetic Algorithm (GA,) Optimized Firefly Search Algorithm (OFS), and Ant Colony (AC) algorithm and proved that it consumes less energy without violating SLA. For evaluating the performance of the proposed ECS work showed better energy metric with VM selection policies like Minimum Migration Time (MMT) and Minimum Utilization (MU) (Table 9).

Table 8 The summary of tabu search

References	Objectives	Problem addressed	Algorithms	Comments
[33]	To reduce energy consumption and reduction in CO_2 emission	Energy aware Cost aware	Tabu Search	The result stated that reduction in communication delay up to 6 times. CO_2 emissions reduced up to 60 times and 30% of power savings
[67]	The objective of the algorithm is to establish a VM-to-PM allocation which reduces the energy consumption, the number of migrations and ensured robustness	Energy aware	Γ-robust heuristic (Tabu search)	The evolutions showed the robust heuristic can calculate optimal solutions and outperforms the well known VM workload consolidation strategy (WCD) heuristic

Table 9 The summary of cuckoo search

References	Objectives	Problem addressed	Algorithms	Comments
[68]	Reduction in energy consumption and resource utilization	Energy aware Resource aware	Enhanced cuckoo search (ECS)	A real heterogeneous environment is provided with some performance evaluation metrics left as a future work

Memetic Algorithm (MA)

This work [25] presented a Many-Objective Optimization Structure (MaVMP) for solving static means offline problems of virtual machine placement. An interactive memetic algorithm is proposed to solve the formulated MaVMP problem, considering context of many objectives. For the formulation of a many-objective VMP problem objectives like power, cost, security, quality of service, network load balancing are considered. Experimental results proved that it is an effective and capable solution to solve the problem. In [34] an improved genetic algorithm as memetic grouping used for cost-efficient VM placement, namely MGGAVP is proposed in the multi-cloud environment. The research presented an optimization model in the heterogeneous environment with efficient virtual machine placement. The parameters on-demand real-time and topographical situation of apportioned

Table 10 The summary of memetic algorithm

References	Objectives	Problem addressed	Algorithms	Comments
[25]	To solve offline VMP problem	Energy aware Cost aware Resource aware	MaVMP	Experimental results proved that it is effective and capable solution to solve the offline problems of VMP
[34]	To provide energy and cost-efficient VM placement	Energy aware Cost aware	MGGAVP	The proposed algorithm compared and proved better performance in energy saving

resources were considered as the objective of diminishing power cost. The proposed model reduced the number of working PMs as well power consumption of network in distributed data centers. The proposed algorithm compared with CRA-DP, E-aware, and CTPS and proved significantly better performance (Table 10).

6 Discussion

A summary of the optimization methods from the various research articles is demonstrated in different Tables. The fundamental goal of this literature is to examine and checking on a preferred study concerning Virtual Machine Placement in distributed environment utilizing Metaheuristics Algorithms. Energy utilization and resource usage are priority goals to be achieved in the VMP as multiobjective issues. VMP is characterized into certain unique classes including power, resources, security, and cost. According to Fig. 6, all mentioned parameters are regularly studied in research.

Above figure shows that researchers regularly tended to and assessed the VMP Environment using energy consumption as primary factor. In any case, other significant destinations should be viewed as important parameters of VMP like security, dynamic load balancing, network traffic management, resource utilization. The hybrid Metaheuristics approaches may get benefits from different algorithms by considering various parameters in multi-objective way. Hybrid Metaheuristics algorithms can be the possible solution that will help to enhance the performance of VMP. From the reviews, it is observed that Hybrid Metaheuristics algorithms have once in a while been utilized in the VMP. Therefore, there is a future scope to consider multiobjective hybrid metaheuristics algorithms for virtual machine placement.

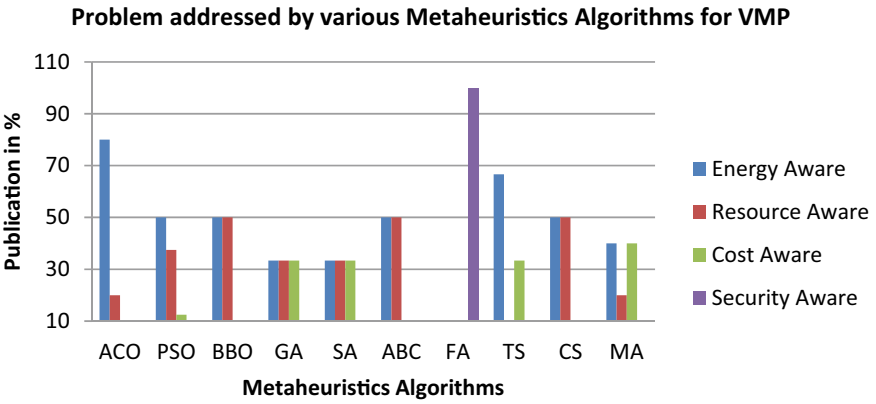

Fig. 6 Problem addressed by various metaheuristics algorithms for VMP

7 Conclusion

Evaluation of Metaheuristics methods for virtual machine placement in the cloud Environment is analyzed in this research work. The investigation of VMP calculations looked at the different advancement strategies and various target capacities. From the analysis, it is observed that most of the research works are introduced to limit the power utilization of data centers. A few researchers have additionally tended to issues identified with the execution and utilization of resources. The primary aim is to reduce the power utilization of DCs without degrading execution or violating SLA limitations. Virtualization has empowered cloud data centers to get cost-effective, flexible, and adjustable to have various undertaking administrations and applications at various scales. With the advancement of virtualization innovation, methods to deploy VMs in the cloud are a hot research subject. Due to the extending size of cloud data centers, the amount of customers and virtual machines (VMs) increases rapidly. The solicitations of clients are engaged by VMs living on physical servers. The dynamic development of internet providers brings about asymmetrical system resources. Resource management is a significant factor for the exhibition of a cloud. Different methods are utilized to deal with the resources of a cloud efficiently. It is a great initiative to think about Multi-objective Virtual machine placement for new structured nature propelled Metaheuristics algorithms as future work objectives considering the parameters like network traffic, load balancing, power utilization, and resource usage. Virtual machine placement can be unraveled for various destinations. So hybridizing advantages of such algorithms can likewise give another vision towards the Virtual machine placement issue.

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Prostate Image Segmentation Using Ant Colony Optimization-Boundary Complete Recurrent Neural Network (ACO-BCRNN)

J. Ramesh and R. Manavalan

Abstract Image Segmentation plays an indispensable role in Computer Aided Diagnosis system to extract the region of interest for diagnosis. Transrectal Ultrasonography (TRUS) is the best imaging technique used mostly by physicians to separate the prostate region from tissues around it and the same used for abnormality detection. The extraction of a region of interest from TRUS images is complex as it contains speckle noise, tracker, low dissimilarity, the fuzzy region between object and background, and also irregular form and size. To resolve these problems, a novel approach Ant Colony Optimization with Boundary Complete Recurrent Neural Network (BCRNN) is aimed to take out an accurate prostate region from the TRUS images. This method comprises two stages such as pre-processing and segmentation. In the beginning stage, Ant Colony Optimization (ACO) method is adopted to eradicate speckle noise from the TRUS prostate image. And, in the second stage Boundary Complete Recurrent Neural Network (BCRNN) method along with shape prioritize and multi-view fusion is employed to draw out the rigorous shape without boundary loss of the prostate. BCRNN comprises of three modules. Firstly, images are serialized into dynamic sequences and Recurrent Neural Network (RNNs) is applied to obtain shape prior to an image. Secondly, multi-view fusion approach is embedded to merge the shape predictions attained from various perspectives. Finally, to refine the details of the shape prediction map, the RNN core method is inserted into a multiscale auto-context. The proposed method is assessed using statistical performance metrics such as Dice Similarity Coefficient (DICE), Jaccard index (JI), Precision, Recall, and Accuracy. From the result analysis, it is found that ACO with BCRNN successfully extracts Region of Interest (ROI) from the image with an accurate boundary that is used for diagnosis. The experiment results clearly revealed that the performance of ACO with BCRNN is superior to BCRNN.

Keywords Ultrasound prostate image · Speckle noise · Image segmentation · ACO · BCRNN

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1 Introduction

Prostate Cancer (PC) is a serious disease found exclusively in the reproductive system of men. Prostate cancer is formed by the continuous deposition of protein in the prostate gland. It is the second leading cause of cancer death in the United States. The American cancer society predicted that there will be 191,930 new cases of prostate cancer with a fatality rate of 19.1% in the year 2019 [1]. Ultrasound imaging is the most widely used technology for prostate biopsy. The segmentation technique is used to segregate an image into meaningful parts with the same properties and features. Relies on the application and image attributes, different segmentation techniques are used for the prostate image. In the medical image segmentation method, the image is categorized into non-covering pixels areas that identify with eminent anatomical structures, such as, malignant growth or cyst. Segmentation techniques are broadly split into three types such as supervised, unsupervised, and interactive. In the supervised method, the manually labeled training data are utilized to extract the ROI [2–5]. In an unsupervised method, separations of an object are done without manual intervention [6]. In the iterative method, images are segmented by a mixture of human experts and machine intelligence. The interactive segmentation plays an important role in various applications like managing tumors identification, assessing tissue volumes, the diagnosis system helped medical procedure, and diagnosing sicknesses. Transrectal Ultrasound (TRUS) is used to scan the prostate and its near tissues. It is also known as Prostate Sonogram or Transrectal ultrasound.

Transrectal Ultrasound (TRUS) is a cost-effective, portable, and quick medical image method offering an instinctive portrayal of the crucial anatomic structure of the body. The reasons for the difficulties in finding the accurate edges in the TRUS image are destitute contrast, speckle noise, and loss of boundary. Hence, the automatic segmentation method is necessary to extract the prostate from the image for diagnosis. Many automated methods have been implemented for the segmentation of prostate from the TRUS image. However, the methods have remained a challenging task. In this research paper, the novel method called automatic ultrasound prostate image segmentation technique using Ant Colony Optimization with BCRNN is proposed. An overview of the proposed framework for TRUS image segmentation is shown in Fig. 1.

The rest of the paper is organized as follows: Sect. 2 briefly describes the materials and methods for prostate segmentation. The detailed description of the proposed methodology is discussed in Sect. 3. In Sect. 4, the experimental analysis using evaluation metrics is presented and the research work is concluded in Sect. 5 with future scope.

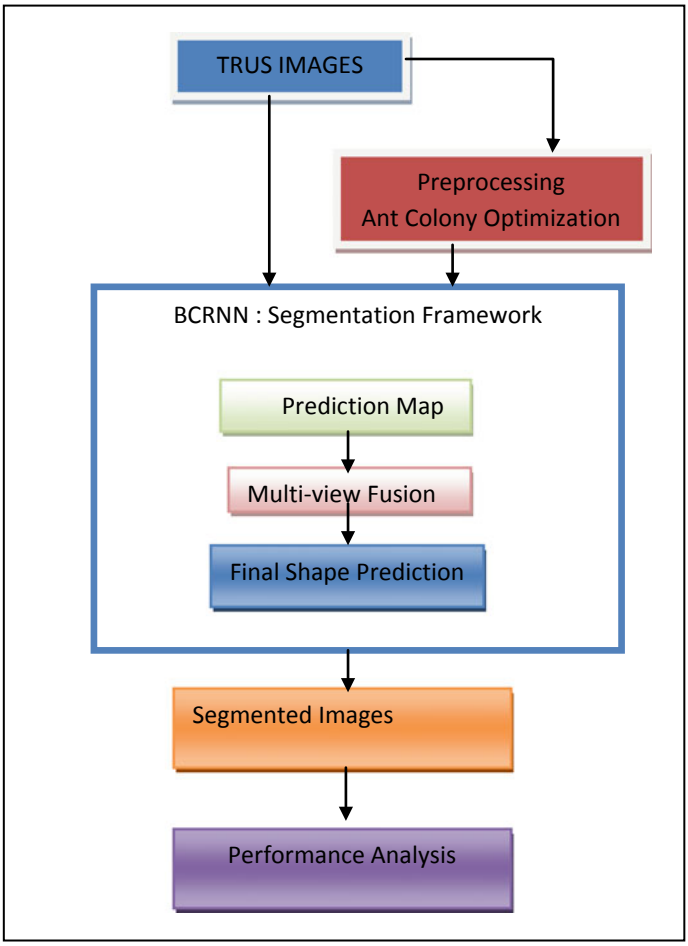

Fig. 1 An overview of proposed framework

2 Materials and Methods

Generally, boundary detection is a very difficult task in TRUS prostate images due to a very low signal-to-noise ratio. The traditional methods of edge detection struggle to determine the exact boundary region. Recently, various image segmentation approaches have been applied to extract the prostate region, and the same are explained hereunder. Shoo et al. [7] furnished an overview of boundary detection methods used for segmentation. Wu et al. [8] applied Genetic Algorithms for acquiring region of interest from prostate image. Bernard Chiu et al. [9] introduced Dyadic Wavelet Transform and Discrete Dynamic Contour for prostate image segmentation. Cruz-Aceves et al. proposed Multiple Active Contours driven by

Particle Swarm Optimization for Cardiac Medical Image Segmentation [10]. Non-parametric multi-level image segmentation technique was developed by Otsu et al. [11] and it was modified by Kapur et al. [12]. Many of the image segmentation methods are not acquiring the boundaries accurately, since, it is based on histogram techniques. Luca and Termini [13] introduced a fuzzy partition technique for image segmentation and Bloch et al. [14] implemented the applications of fuzzy spatial relationship in image process. Zhao et al. [15] applied a multi-level approach by defining three membership functions for three levels thresholding such as dark, medium, and bright. Tao et al. [16] suggested a three-level fuzzy entropy-based method for image segmentation. Cao et al. [17] applied global optimization method Genetic Algorithm (GA) to attain the maximum entropy value. Cootes et al. [18] implemented the Active Shape Model (ASM) to achieve both the shape and information volume of the prostate. Shen et al. [19] proposed ASM with Gabor descriptor for prostate ultrasound image segmentation. Van Ginneken et al. [20] introduced ASM along with Gaussian to extract the image boundary. Rogers et al. [21] is proposed Robust Active Shape Model to reject displacement outliers in the image and the same were also introduced for prostate ultrasound image by Santiago et al. [22]. Ascertaining the low-rank property of similar shapes, an additional reliability constraint is expanded to acquire a shape model without boundary deficiency in ultrasound images proposed by Zhou et al. [23]. Yan et al. [24] introduced the Partial Active Shape Model to find the missing boundaries of the TRUS prostate image. Yang et al. [25] proposed Boundary Complete Recurrent Neural Network (BCRNN) for obtaining the accurate boundary and shape of the prostate ultrasound image (raw image) without any loss. In this research, Ant Colony Optimization (ACO) is hybridized with BCRNN to acquire region and boundary accurately from prostate image. The prostate region and segmentation techniques are explained hereunder.

3 Proposed Methodology

In the proposed novel approach is introduced to segment the prostate region from ultrasound image. The segmentation framework is illustrated in Fig. 1. Each step is explained in the following subsections. The method consists of two stages. (i) ACO method is used to remove the speckle noise from prostate image and (ii) BCRNN method is implemented to gain the complete boundary of the image. A brief introduction of ACO method is as follows.

3.1 Ant Colony Optimization

ACO algorithm was introduced by Colorni et al. [26] in 1991 as computational intelligence technique to solve combinational optimization problem. This algorithm works based on the foraging behaviour of ants. The communications among population of

ants are indirect. The ants were communicated by depositing pheromone (chemical substance) on the ground and find the path between their nest and food source.

ACO algorithm has three phases such as initialization, pheromone update, and solution. After the completion of all the components, the global optimum solution is observed. Initially, all the ants haphazardly seek the best solution area and pheromone quantity is updated by using vicinity search of each ant. After the first iteration, the feasible solution space is minimized and it finds their routes in the limited space. The probability of searching the neighborhood ant is done by

$$b^k(i,\ \mathrm{j}) = \begin{cases} \dfrac{[s\ (i,\ j)]^{\alpha}.[t(i,\ j)]^{\beta}}{\sum\limits_{l \notin V_k} [s(i,\ l)]^{\alpha}.[t(i,\ l)]^{\beta}}, & \text{if} \quad j \notin v_k \\ 0, \text{otherwise} \end{cases} \tag{1}$$

where, $s(i,\ j)$ is the pheromone density, α and β are relative information of the pheromone and v_k is list of the neighbor node which is already visited by the ant. The pheromones are updated as follows.

$$s_{ij} = (1 - \rho)\, s_{ij} + \sum_{k} \Delta s_{ij}^{k} \tag{2}$$

where s_{ij} is the amount of pheromone deposited, ρ is the pheromone evaporation coefficient and Δs_{ij}^{k} is the amount of pheromone deposited by the kth ant. ACO avoids premature convergence due to distributed computation. At each stage of iteration, it acquires suitable solution. It has collective interaction of population of agents. The step-by-step execution of ACO algorithm is exposed in Fig. 2.

The ACO algorithm suppresses the speckle noise and preserves the edge pixel from US image of prostate. It retains the edges with sensible amount of speckle-noise suppression which is more substantial for further analysis. BCRNN method is implemented to improve the boundary of an image and to acquire the Region of Interest (ROI) accurately. The implementation of BCRNN methodology is given in the Sect. 3.2.

3.2 BCRNN Method

The proposed framework is illustrated in Fig. 1. To extract accurate boundary region from the prostate cancer image, BCRNN method is implemented. At first, ACO technique was applied to the enhance TRUS prostate image which is given as input to upcoming levels. The BCRNN serializes the given image into several different perspectives, then conducts shape prediction. All these shape predictions are then merged as a complete inference by a multi-view fusion strategy. Thus, the result

ACO Algorithm for Prostate Ultrasound Medical Image Enhancement

Input : Ultrasound Image with Speckle Noise

Output : Noise free Ultrasound Image

Step 1: Initialize the population of ants.

Step 2: Initialize the pheromone trail.

Step 3: Evaluate fitness of the each ant in the colony by using equation 3.

$$F(x) = \log(\log(E(I(x)))) * \frac{n_edges(I(x))}{M * N} * H(I(x))$$

Step 4: Determine the best optimum solution among all ants in the colony.

Step 5: Update Pheromone trail by using formula

$$s_{ij} = (1-\rho)\, s_{ij} + \sum_{k} \Delta s_{ij}^{k}$$

Step 6: Determine the search direction for further search by the formula

$$b^{k}\ (i, \mathrm{j}) = \begin{cases} \dfrac{\left[s\ (i, j)\right]^{\alpha} \cdot \left[t(i, j)\right]^{\beta}}{\sum_{l \in V_k} \left[s(i, l)\right]^{\alpha} \cdot \left[t(i, l)\right]^{\beta}}, & if\ j \notin v_k \\ 0, & otherwise \end{cases}$$

Step 7: Construct new solution using obtained best optimum solution.

Step 8: Generate new colony. After each iteration the trails of pheromone evaporate

Step 9: Repeat steps 3 to step 8, until it satisfy the maximum number of Iterations

Fig. 2 ACO algorithm for prostate image enhancement

is concatenated with original image and feed into the next level for more shape details. The shape prediction map is primarily set as an even distribution. And, the above process continues until convergence occurs on boundary prediction map. It is depicted in the following section.

3.2.1 BCRNN to Find Shape Inference

In the process of segmentation, to address the incompleteness of boundary in prostate image is most difficult task. The boundary completion of ultrasound image is reviewed in this section. Kimia et al. was implemented Geometric analysis of curvature to achieve the complete boundary detection of an image [27, 28] and Yosef et al. [29] proposed visual curve completion method to identify the missing parts of the boundary and to complete the gap in the boundary. Based on these methods, memory-guided inference procedure is proposed to complete the boundary of the image. So, it is identified that Recurrent Neural Network (RNN) is suitable for the above process and it was termed as Boundary Complete RNN (BCRNN).

3.2.2 Serialization and Deserialization Process

The ultrasound image is transformed into an interpretable sequence by using polar coordinate system around the image centre to generate a serialization process as

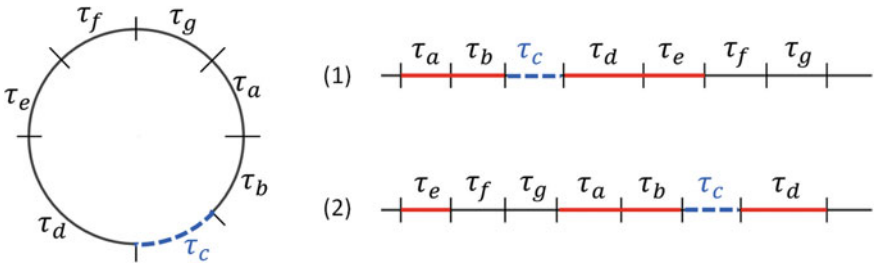

Fig. 3 Serialization manner with different starting points

shown in Fig. 3. It is circle-wise manner of manual delineation. The serialized images are evenly partitioned into T consecutive bands, which form the sequence as $x = (x_1, x_2, \ldots, x_T)$ and straightened version of x is given as sequential input to the BCRNN process. Deserialization is the reverse process of serialization. In training process, all the segmentation label images are also serialized into sequence form.

3.2.3 Recurrent Neural Network

Given an input sequence of an image as R, hidden state vector $h = (h_1, h_2, \ldots, h_T)$ and output vector $S = (S_1, S_2, \ldots, S_T)$ and time step as $t = 1$ to T. The following equations are iterated for the time step

$$h_t = \xi(W_{Rh}R_t + W_h h_{t-1} + b_h) \tag{3}$$

$$S_t = W_{hS}h_t + b_y \tag{4}$$

where, W denote recurrent neural network weight matrices, b denotes bias vector and ξ is hidden layer function. Hidden state vector h_t summarizes the information from previous h_{t-1} and current input R_t, it can be exploited to infer current prediction S_t. In this process, the hidden state vector h_t is considered as shape knowledge of the prostate image which is accrued from previous time steps. And, h_t is used to deduce the boundary location for current time step t by taking an extra input R_t.

It is difficult to access long-range context in RNNs. Since the information stored in hidden layers take more time and consequently loses impact on future inference. Therefore, Long Short-Term Memory (LSTM) module is used to enhance hidden layer by controlling the flow of information in the network memory.

In estimating the missing parts of the boundary information are critical since it is from multiple directions. A single LSTM stream can make information from only one direction. For that reason, Bidirectional LSTM (BiLSTM) technique is implemented to control missing parts of the boundary and content of information of an image. Graves et al. [30] proposed BiLSTMmethodto acquire information from

both directions with two separate hidden layers and these are forwarded to the output layer. The computational of a BiLSTM at time step t are illustrated in the following equations (Eqs. 5–7).

$$\overrightarrow{h_t} = \xi\left(W_{x\overrightarrow{h}}R_t + W_{\overrightarrow{h}\overrightarrow{h}}\overrightarrow{h_{t-1}} + b_{\overrightarrow{h}}\right) \tag{5}$$

$$\overleftarrow{h_t} = \xi\left(W_{x\overleftarrow{h}}R_t + W_{\overleftarrow{h}\overleftarrow{h}}\overleftarrow{h_{t-1}} + b_{\overleftarrow{h}}\right) \tag{6}$$

$$S_t = W_{\overrightarrow{h}S}\overrightarrow{h_t} + W_{\overleftarrow{h}S}\overleftarrow{h_t} + b_y \tag{7}$$

where, $\overrightarrow{h_t}$ is a forward hidden states and $\overleftarrow{h_t}$ is a backward hidden state by iterating the forward layer from $t = 1$ to T and backward layer from $t = T$ to t respectively. The combinations of forward and backward hidden state are shown in Eq. 7. BiLSTM can combine with serialization and deserialization and formed BCRNN to yield accurate boundary trace from various directions. Thus, BCRNN can obtain incomplete boundary of prostate ultrasound images.

3.2.4 Multiple View Point Combination

While serializing the image from different starting points will create various shape predictions. Thus, the serializing from different starting points may change the relative distances between context-dependent sequence elements and it brings about slight difference in predictions. Figure 3 shown serialization with different starting points.

As shown in the above figure, consider τ_c is the missing boundary scrap then need indications from both τ_{a-b} and τ_{d-c} scrap to recuperate it. In the first step of serialization, it conserves the relative spatial relationship among three scrap. In the second step, destroys the continuity between τ_e and τ_d then τ_e has more distance from τ_c. In the next step, BiLSTM needs to keep the τ_e information much longer time in the memory to achieve τ_c. To overcome this problem, the original images are serialized from three view points and merge the complementary boundary predictions generated by BCRNN into a shape prediction. Thus, observing of an object in multiple viewpoints is noted as multiple view point fusion.

3.2.5 Refinement by Multiscale Auto-Context

It is further embeded BCRNN with Multiscale Auto-Context scheme [31] to gain consecutive refinement on the initial prediction by exploring the boundary information from neighbors. In BCRNN, level $k - 1$ was merged with prediction map

generated by original image and it is an input for level k. After the training of level $k-1$ and level k is trained in BCRNN model. Standard classifiers embed into Auto-Context scheme to collect-related information [31, 32] and to control context information from near or far ranges.

Thus, BCRNN model has the inbuilt ability to flexibly leverage context information from near or far ranges. This capability benefits from memory are retained dynamically by BiLSTM. BCRNN along with Auto-Context scheme and multiscale mechanism are implemented to obtain informative maps with strong guidance for each level. For this process, iterative steps exploited to carry out multiscale Auto-Context scheme are shown in Eq. 8.

$$y^k = \kappa\left(\left(x^k; y^{k-1}\right), s^k\right) \tag{8}$$

where, κ is model function of BCRNN, y^k is the shape predication map from level k, s^k is the scale used by BCRNN in level k to generate the sequence of x^k. Finally, BCRNN along with multiscale Auto-Context scheme recovered the missing boundaries of the image. The step-by-step implementation of BCRNN algorithm is exposed in Fig. 4.

The experimental analysis of the proposed techniques is depicted in the following section.

BCRNN Algorithm for Prostate Ultrasound Image Segmentation

Input : De-speckle Ultrasound Image

Output : Segmented Image

Step 1: Convert image into polar coordinate

Step 2: Serialized images are partitioned into consecutive bands as

$x = (x_1, \ldots, x_T)$

Step 3: Segmented label images are also serialized into sequence form

Step 4: Recurrent Neural Network, the equations are iterated for the time step as $t = 1$ to T

$$h_t = \xi\left(W_{Rh} R_t + W_h h_{t-1} + b_h\right)$$

$$S_t = W_{hS} h_t + b_y$$

Step 5: In BiLSTM, at time step t the following equations are executed

$$\vec{h}_t = \xi\left(W_{x\vec{h}} R_t + W_{\vec{h}\vec{h}} \vec{h}_{t-1} + b_{\vec{h}}\right)$$

$$\overleftarrow{h}_t = \xi\left(W_{x\overleftarrow{h}} R_t + W_{\overleftarrow{h}\overleftarrow{h}} \overleftarrow{h}_{t-1} + b_{\overleftarrow{h}}\right)$$

$$S_t = W_{\vec{h}S} \vec{h}_t + W_{\overleftarrow{h}S} \overleftarrow{h}_t + b_y$$

Step 6: Multi-view point combination are executed, as in the figure 3

Step 7: Multiscale Auto-context is implemented by the formula

$$y^k = \kappa\left(\left(x^k; y^{k-1}\right), s^k\right)$$

Step 9: Repeat steps 4 to step 7, until it satisfy the maximum number of Iterations

Fig. 4 Implementation of BCRNN algorithm

4 Experimental Results

The various categories of TRUS prostate images are examined. The proposed method is evaluated and analyzed using parameters. The performance is measured by Dice Similarity coefficient, JI, Accuracy, Precision, Recall, and Boundary Error. The detailed explanation of experimental analysis and implementation are depicted in the following section.

4.1 Experimental Analysis

For experimentation, 200 ultrasound prostate images with the size of 468 $\times$ 356 are used to assess the performance of TRUS image segmentation method. Initially, Ant Colony Optimization (ACO) method is used to remove the speckle noise and enhance the fine details in the US images. The preprocessed image is applied in BCRNN method to acquire exact shape of the image. The implementation details are depicted in the following section.

4.2 Implementation Details

BCRNN has been trained with a many-to-many manner, in which direct mapping was constructed between input intensity sequence and the boundary label sequence. Long Term Short Memory (LSTM) was used and it consists of forward and backward streams with 500 hidden memory units. A Euclidean distance-based objective function has been used for training BCRNN and the network parameters are updated with Root Mean Square Propagation (RMSProp) [33] optimizer using the Back Propagation Through Time (BPTT) algorithm. The learning rate was set as 0.001 for all levels. All computational were conducted on a computer with Intel Core i5-5200U CPU@2.20 GHz processors.

5 Performance Evaluation

The results of the proposed method are shown in Fig. 5. The method obtains the shape of the prostate boundary without loss for some extends. It also conquers the best shape of the boundary than the manual segmentation.

Quantitative Analysis

Performance of the proposed work ais evaluated by evaluation matrices such as Dice Similarity Coefficient (Dice), Jaccard Index (JI), Precision, Recall, Accuracy,

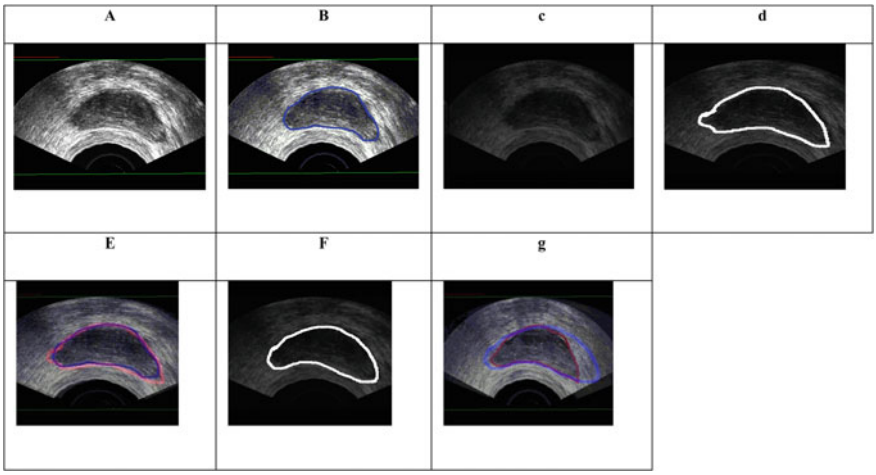

Fig. 5 Qualitative result of the various methods. **a** Original image, **b** ground truth image, **c** enhanced Image using ACO, **d** BCRNN, **e** BCRNN with ground truth and **f** ACO_BCRNN, **g** ACO_BCRNN with ground truth

and Boundary Error. The quantitative results produced by the method BCRNN and BCRNN with ACO for various numbers of TRUS images are tabulated in Table 1.

The average of various performance measures of the proposed segmentation model is exposed in Table 2. From the Table 2, it is observed that the Dice Similarity Coefficient (Dice) of the BCRNN_ACO is 0.9801, which is 0.11% higher than BCRNN. The pictorial representation of Dice similarity earned by BCRNN and ACO with BCRNN is shown in Fig. 6.

The BCRNN with ACO showed superior performance in terms of accuracy, since the accuracy of ACO _BCRNN method is 0.1622% higher than accuracy earned by BCRNN method. The comparison chart is revealed in Fig. 7.

The performance of ACO with BCRNN is also validated by Jaccard Index (JI). BCRNN with ACO yielded JI of 0.9996, which is 0.0002 is lesser than the BCRNN method. Its graphical representation is shown in Fig. 8.

The precision of BCRNN is 95.95%, which is 0.2% lower than ACO with BCRNN approach. The pictorial representation of precision measure is shown in Fig. 9.

The Boundary Error (BE) of proposed method is 4.0841while BCRNN method earned 4.3255. It is observed that ACO with BCRNN method achieved less error, which is 0.2414 lesser than ACO. It proves that the proposed method achieved more boundary pixels. The comparison chart of the Boundary Error is shown in Fig. 10. The recall of the proposed method and BCRNN is exposed in Fig. 11. It clearly proved that both the methods yielded similar performance. The recall of ACO and ACO with BCRNN is 99.96%. From the above experimental analysis, it is absorbed that the proposed ACO_BCRNN method yields a better result that proves for better segmentation.

Table 1 Quantitative results of segmentation methods

	Evaluation metrics											
No. of images	Dice		JI		Acc		Precision		RECALL		BE	
	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO
10	0.9822	0.9808	1.0000	1.0000	96.6168	96.3761	0.9654	0.9628	0.9996	0.9996	3.6340	3.9162
20	0.9827	0.9798	1.0000	1.0000	96.7080	96.1903	0.9664	0.9608	0.9996	0.9996	3.5283	4.1335
30	0.9828	0.9811	1.0000	1.0000	96.7324	96.4236	0.9666	0.9633	0.9995	0.9995	3.4999	3.8610
40	0.9827	0.9806	1.0000	1.0000	96.7080	96.3486	0.9664	0.9625	0.9995	0.9995	3.5282	3.9485
50	0.9829	0.9810	1.0000	1.0000	96.7532	96.4078	0.9668	0.9631	0.9995	0.9995	3.4757	3.8794
60	0.9835	0.9819	1.0000	1.0000	96.8617	96.5703	0.9680	0.9649	0.9995	0.9995	3.3527	3.6935
70	0.9840	0.9825	1.0000	1.0000	96.9425	96.6863	0.9689	0.9661	0.9995	0.9995	3.2612	3.5606
80	0.9843	0.9830	1.0000	1.0000	96.9995	96.7760	0.9695	0.9671	0.9995	0.9995	3.1965	3.4580
90	0.9845	0.9834	1.0000	1.0000	97.0482	96.8431	0.9700	0.9678	0.9995	0.9995	3.1414	3.3811
100	0.9847	0.9837	1.0000	1.0000	97.0838	96.8962	0.9704	0.9684	0.9995	0.9995	3.1010	3.3202
110	0.9848	0.9838	1.0000	1.0000	97.0923	96.9203	0.9705	0.9686	0.9995	0.9995	3.0911	3.2920
120	0.9848	0.9839	1.0000	1.0000	97.0927	96.9338	0.9705	0.9688	0.9995	0.9995	3.0902	3.2759
130	0.9846	0.9838	1.0000	1.0000	97.0593	96.9116	0.9701	0.9685	0.9995	0.9995	3.1289	3.3014
140	0.9847	0.9839	1.0000	1.0000	97.0706	96.9326	0.9703	0.9688	0.9995	0.9995	3.1158	3.2771
150	0.9847	0.9839	1.0000	1.0000	97.0735	96.9439	0.9703	0.9689	0.9995	0.9995	3.1123	3.2637
160	0.9840	0.9832	1.0000	1.0000	96.9562	96.8153	0.9690	0.9674	0.9995	0.9995	3.2510	3.4229
170	0.9831	0.9820	1.0000	1.0000	96.7992	96.6193	0.9672	0.9652	0.9996	0.9996	3.4481	3.6724
180	0.9812	0.9808	0.9999	0.9998	96.4973	96.4121	0.9638	0.9629	0.9996	0.9996	3.8453	3.9343
190	0.9795	0.9801	0.9998	0.9997	96.2058	96.2983	0.9604	0.9616	0.9996	0.9996	4.2291	4.0763

(continued)

Table 1 (continued)

	Evaluation metrics											
No. of images	Dice		JI		Acc		Precision		RECALL		BE	
	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO	BCRNN	BCRNN with ACO
200	0.9790	0.9801	0.9998	0.9996	96.1266	96.2888	0.9596	0.9615	0.9996	0.9996	4.3255	4.0841

Table 2 Relative quantitative results of segmentation method

Methods	Dice	JI	ACC	Precision	Recall	BE
BCRNN	0.9790	0.9998	96.1266	0.9596	0.9996	4.3255
ACO_BCRNN	**0.9801**	**0.9996**	**96.2888**	**0.9615**	**0.9996**	**4.0841**

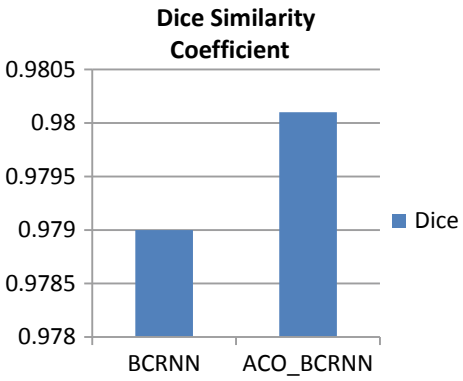

Fig. 6 Dice similarity co-efficient result

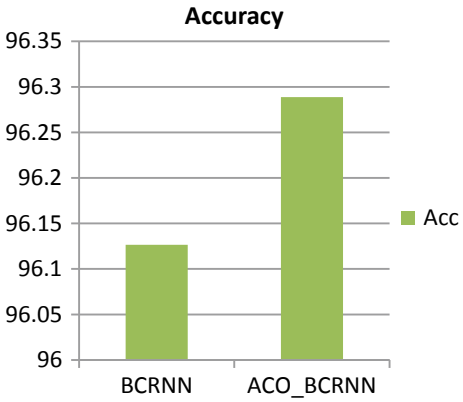

Fig. 7 Accuracy result

6 Conclusion

Segmentation framework for prostate ultrasound images is proposed in this paper. The TRUS image was first enhanced with Ant Colony Optimization (ACO) method to remove the speckle noise. Subsequently, the boundary of the image was extracted without loss by using Boundary Complete Recurrent Neural Network (BCRNN). The expected boundary and region of interest of the prostate in TRUS image are obtained using the proposed method. The performance of the segmented framework is evaluated by evaluation metrics. The experimental result clearly showed that the performance of the proposed segmented method ACO with BCRNN is superior

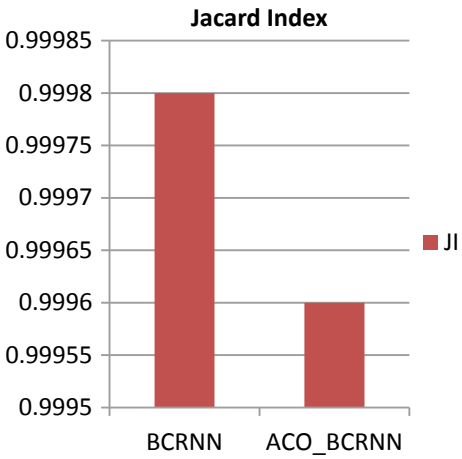

Fig. 8 Result of Jacard index

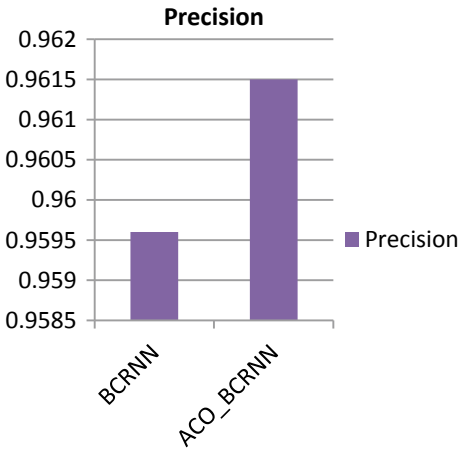

Fig. 9 Result of precision

compared to BCRNN in terms of Dice Similarity Coefficient, Jacard Index, Accuracy, Precision, Recall, and Boundary Error. Thus the quantitative result also proves that ACO_BCRNN is an outstanding tool for prostate image segmentation.

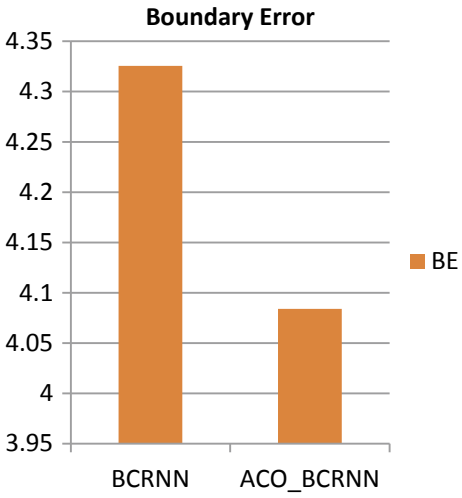

Fig. 10 Performance of boundary error

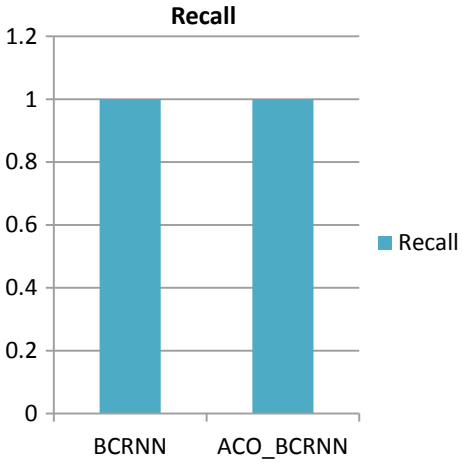

Fig. 11 Result of recall

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A Deep Learning Approach to Detect Lumpy Skin Disease in Cows

Gaurav Rai, Naveen, Aquib Hussain, Amit Kumar, Akbar Ansari, and Namit Khanduja

Abstract Diseases in cows are an influential point for human concern. There are some diseases in animals identified in the early phases that can be diagnosed and cured in the early phases of the disease itself. The effect of lumpy skin disease can cause large capital losses in the farm animal industry if it is not taken care of properly. The main reason for this disease is the lumpy skin virus, and this virus is a part of the Poxviridae family. The major symptom of lumpy skin disease is the Neethling strain, and other symptoms are a few mild forms of circumscribed skin nodules. These symptoms also include mucous membranes of internal organs like respiratory organs and reproductive organs. By the infection of such disease, animals like cattle get their skin permanently damaged. Some of the detrimental outcomes of this disease in cows are reduction in milk projection, infertility, poor growth, abortion and sometimes death. In this research work, an architecture using machine learning techniques to detect the disease is proposed. This architecture employs the pre-trained models like VGG-16, VGG-19 and Inception-v3 for feature extraction and then followed by multiple classifiers. The work is tested on our manually collected dataset, and the extracted features were further classified using the classifiers like kNN, SVM, NB, ANN and LR. Using this methodology, the state-of-the-art solution obtaining a classification accuracy of 92.5% over the test dataset.

Keywords Feature extraction · Dataset collection · Deep learning · Lumpy skin disease · Neural network (NN)

1 Introduction

Skin is an important part of an animal body. Lumpy skin disease (LSD) is a vigorous disease in cows extended by biting insects. LSD is an acute noxious defect of cows

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of all ages. The LSD disease is identified by large skin knots covering all parts of the body leading to fever, nasal discharge, spread lymph nodes and lachrymation. Lumpy skin disease is generally found in Africa, Russia, Egypt, Oman and India. At first, it was identified in Egypt. This disease was earlier contained in Africa and went outside it in 1984. This disease has now moved to Madagascar and now in countries like the Arab Gulf Peninsula and the Middle East. The countries (Jordan, Syria, Lebanon, Turkey, Iran, and Iraq), which earlier did not have any cases of this disease, are now also suffering economic losses [1]. Soon after this, the lumpy skin starts to develop over the whole body or sometimes only develops around the neck, limbs and genitals region. These lesions are first seen around circumscribed areas around erect hairs. Around the normal skin, these lesions are found. The narrow rings formed around these lesions are haemorrhage. These lesions cover epidermis and adjacent subcutis [2]. The main reason for the infection is lesions on skin, but viruses can also spread through various secretions from the body like excretions and semen. Thereby, the potential targets of the virus are majorly targeted by physical means from hematophagous arthropods, and this involves bites from mosquitoes and flies and ticks [1, 2]. Transcendence and transmission capabilities of types of ticks are also possible. Characteristic disease lesions erupt after the incubation period of a couple of weeks after the infection under the testing circumstances, while it takes up to 2–5 weeks in ordinary cases [3]. Unluckily, there are no particular antiviral drugs convenient for the rectification of LSD. The auxiliary care is the only medication available for cows. It is essential to think about the rectification of skin lesions using wound care, sprays and the use of antibiotics to avoid secondary skin infections and pneumonia [4]. There are various parts of the paper in which Sect. 1 is introduction, Sect. 2 is data collection, Sect. 3 is the proposed approach, Sect. 4 is result, and Sect. 5 is conclusion [5]. Cow images infected from lumpy disease and normal cow image (uninfected) are given in Fig. 1.

Fig. 1 Images of lumpy skin and normal skin in cows

Table 1 Image dataset of cows

Types of cow	Number of images
Infected from lumpy disease	132
Normal images of cow	199

2 Data Collection

The collection of dataset is an important phase because there is no dataset available of lumpy skin disease in cows. So, we created an image dataset of cows around 300–400 images that is shown in Table 1.

Since the problem with the dataset is that it can be biased due to lack of proper dimensions and resolution; but in this dataset, we have chosen only high resolution and proper pixel images [6].

3 Proposed Approach

In this framework, we used deep convolutional neural networks. For extracting features from the images, we have used the pre-trained models like VGG-16, VGG-19 and Inception-V3. VGG-16 is a model composed of 16-convolutional layer, 5 max pooling layers. After this, we have applied all three properly associated layers, and RELU activation is then projected to all hidden layers. VGG-19 contains 19 layers which comprise 16 convolution layers and three fully connected layer, one softmax layer and five MaxPool layers. Inception-V3 is a CNN model which has 48 layers. The pre-trained model Inception-V3 is trained on more than 1 Million images of ImageNet database [4]. It can classify more than thousand object classes. We take an image as input, process it and classify it in various categories [6]. In this process, it consists of many layers in which the first layer is a convolution layer that operates the feature extraction by using filter or kernel. Since the images are nonlinear, so to remove the linearity of images, we used rectifier linear unit (ReLU) function [7]. Here, patches created for convolution operation and then converted in dimensional array. In this convolution process, all the layers are connected, and it has 1D inputs. Continue to the convolution process, linear transformation takes place, and the following derivatives are backward propagation process applied fully connected convolution layer [5].

$$E = \left(y' - O\right)^2/2$$
$$\frac{\partial \boldsymbol{E}}{\partial \boldsymbol{O}} = -\left(y' - O\right)$$
$$\frac{\partial \boldsymbol{O}}{\partial \boldsymbol{Z}2} = (O)(1 - O)$$

$$\frac{\partial \boldsymbol{Z}2}{\partial \boldsymbol{O}} = A1$$

Chain rule obtains the overall modifications in error with respect to the weight. The weight matrix depends on the gradient value.

$$W_\text{new} = W_\text{old} - lr * \frac{\partial E}{\partial W}$$

Weight matrix covers the backward propagation and that applied in connected layers and updated filters as follows:

$$\begin{aligned}
\frac{\partial E}{\partial f} &= \frac{\partial E}{\partial O} \cdot \frac{\partial O}{\partial Z2} \cdot \frac{\partial Z2}{\partial A1} \cdot \frac{\partial A1}{\partial Z1} \cdot \frac{\partial Z1}{\partial f} \\
\frac{\partial E}{\partial O} &= -\left(y' - O\right) \\
\frac{\partial O}{\partial Z2} &= (O)(1 - O) \\
\frac{\partial Z2}{\partial A1} &= W^T \\
\frac{\partial A1}{\partial Z1} &= A1(1 - A1) \\
\frac{\partial Z1}{\partial f} &= X
\end{aligned}$$

The step by step working of CNN is shown in Fig. 2.

The weights, which are negative, show inhibitions in connection; meanwhile, the weights, which are positive, show excitation in connections. The following activity of the neuron cell is shown by our model [8]. All the inputs are added and are then updated by weights. This is linear combination. The amplitude of our function is then calculated by our activation function. For example, the most generic output ranges between 0–1 and −1 to 1. This step is described mathematically here in Fig. 3.

From this model, the interval activity of the neuron can be shown to be:

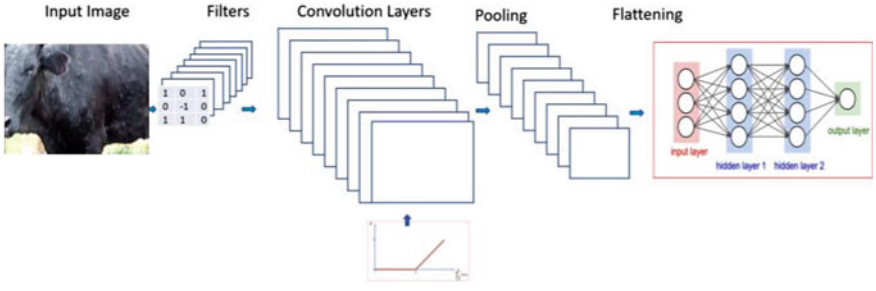

Fig. 2 Working of convolutional neural network

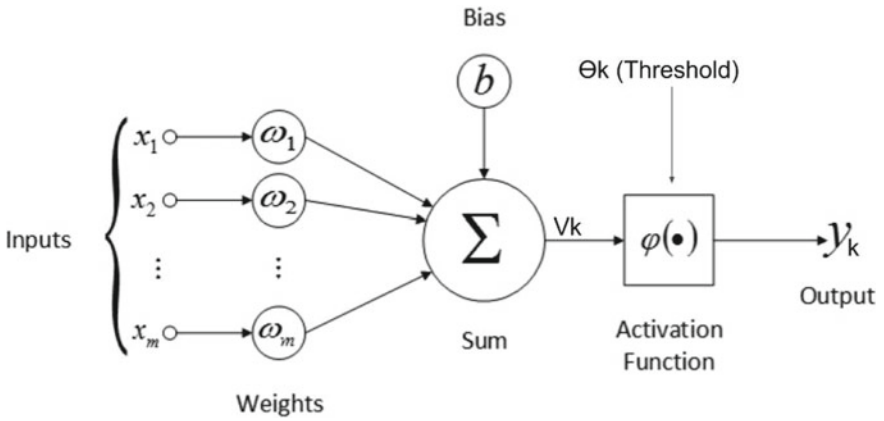

Fig. 3 Working of artificial neural network (ANN)

$$v_k = \sum_{j=1}^{p} w_{kj} x_i$$

Activation functions

The yield of the neuron (y_k) would be the same as the output on the data input of v_k on the activation function. As earlier studied, activation function works the same way as a compressing function, that is the yield of the neuron in the NN among assured values generally 0 and 1, or −1 and 1. Commonly, we have three ways in which activation function works, represented by Φ(.). The first function is known as threshold function which gives output 0 if the input is less than zero and gives output 1 if the input is greater than or equal to zero [9].

$$\phi(v) = 1 \quad \text{if} \quad v \geq 0$$
$$\phi(v) = 0 \quad \text{if} \quad v < 0$$

Secondly, the linear function takes in input in the range of 0 or 1, but sometimes, it takes values dependent upon the amplification factor inside the region of linear operation.

$$\phi(v) = 1 \quad \text{if} \quad v \geq \frac{1}{2}$$
$$\phi(v) = v \quad \text{if} \quad -\frac{1}{2} > v > \frac{1}{2}$$
$$\phi(v) = 0 \quad \text{if} \quad v < -\frac{1}{2}$$

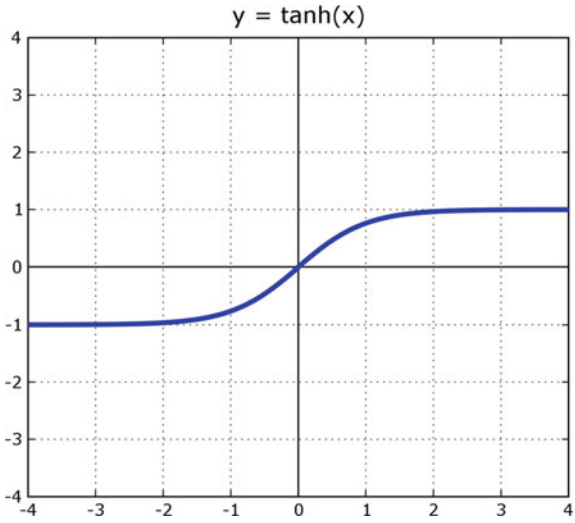

Fig. 4 Graph of hyperbolic tangent function

Thirdly, the sigmoid function can vary between 0 and 1, and sometimes between −1 and 1 range is more useful.

$$\phi(v) = \tanh\left(\frac{v}{2}\right)$$
$$\phi(v) = \frac{1 - \exp(-v)}{1 + \exp(-v)}$$

The ANN represented by us consists of all variations on the parallel assigned processing idea. The design of every neural network established on much alike building blocks which accomplish the processing. In next, we will discuss these processing units and various neural network topologies (Fig. 4).

Image embedder uses different models such as VGG-16, VGG-19 and Inception-V3 for feature extraction. We split the dataset into 75% as training data and rest 25% as testing data [6].

We evaluate the ROC curve for the calculation of performance on our framework. On *X*-axis "Specificity" is defined, and on *Y*-Axis, "Sensitivity" is mentioned. Figure 5 represents the ROC curve on lumpy skin disease, and Fig. 6 represents the ROC curve on normal cow images [9].

4 Results

In this section, we come up with the final result achieved by the tests done in the above section. In this project, we have used three scenarios. In the first scenario, Inception-v3 is used for feature extraction, and then with the help of various classifiers like

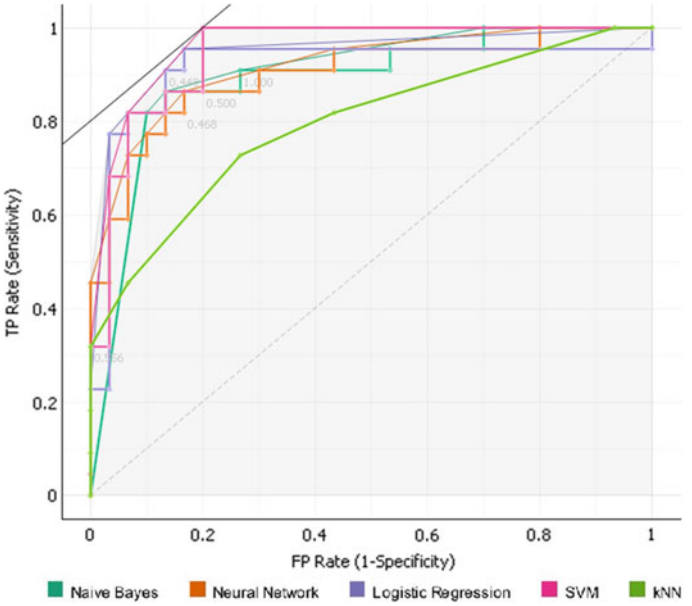

Fig. 5 ROC curve on lumpy skin disease

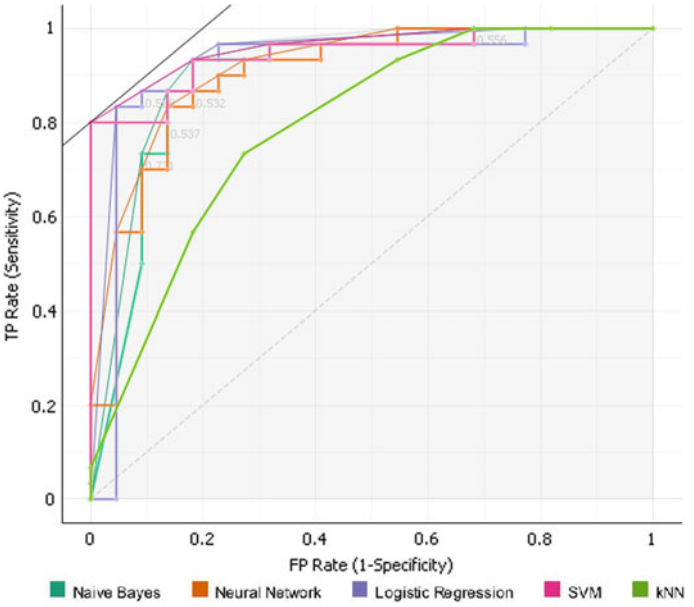

Fig. 6 ROC curve on normal cow images

Table 2 Accuracy assessment

Feature extractor	Model	Accuracy	AUC	Precision
Inception-v3	SVM	0.830	0.876	0.830
	KNN	0.698	0.848	0.738
	Neural network	0.925	0.955	0.926
	Naïve Bayes	0.717	0.783	0.720
	Logistic regression	0.887	0.947	0.887
VGG-16	SVM	0.848	0.889	0.857
	KNN	0.848	0.906	0.854
	Neural network	0.864	0.859	0.862
	Naïve Bayes	0.833	0.863	0.831
	Logistic regression	0.879	0.830	0.877
VGG-19	SVM	0.765	0.842	0.807
	KNN	0.765	0.882	0.780
	Neural network	0.838	0.870	0.838
	Naïve Bayes	0.882	0.867	0.882
	Logistic regression	0.853	0.876	0.853

KNN, SVM, ANN, LR and NB, artificial neural network gives the maximum possible classification accuracy of 92.5% as shown in Table 2. In the second scenario, we have used VGG-16 for feature extraction and achieved a maximum possible accuracy of 87.9% with the help of logistic regression among all classifiers used. In the third scenario, a 19-layer convolutional neural network (VGG-19) is used for extracting the features and achieved the maximum possible accuracy of 88.2% with the help of Naive Bayes among all classifiers used. By observing all the three scenarios, we perceived the best combination is of Inception-v3 with artificial neural network giving us the highest possible classification accuracy of 92.5% over the test dataset. The accuracy assessment table is given (Table 2).

5 Conclusion

Deep convolutional neural network is proposed in this research work to predict lumpy skin and normal skin in cows. The results demonstrate that for a given dataset, the proposed model attains an accuracy of 92.5%. Since there is no standard dataset available, there are many problems that can arise; but in this research work, standard quality of the image dataset is used, due to which the proposed model attains better performances. This model can be used in different fields of medical science like to detect skin cancer in animals and other diseases. Moreover, it can help veterinary surgeons to figure out animal disease problems in early stages that do not require much manual work.

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Prediction of Influenza-like Illness from Twitter Data and Its Comparison with Integrated Disease Surveillance Program Data

Monica Malik and Sameena Naaz

Abstract The social networking sites are currently assisting in delivering faster communication and they are also very useful to know about the different people's opinions, views, and their sentiments. Twitter is one of the social networking sites, which can help to predict many health-related problems. In this work, sentiment analysis has been performed on tweets to predict the possible number of cases with H1N1 disease. The data will be collected country wise, where the tweets lie between four ranges on which the further analysis will be done. The results show the position of India based on the frequency of occurrence in the tweets as compared to the other countries. This type of disease prediction can help to take a quick decision in order to overcome the damage. The results predicted by sentiment analysis of Twitter data will then compared with the data obtained from the 'Ministry of Health and Family Welfare-Government of India' site. The data present at this site gives the actual number of cases occurred and collected by Indian Governments "Integrated Disease Surveillence Program". Comparison with this data will help in calculating the accuracy of the sentiment analysis approach proposed in this work.

Keywords Influenza · Swine flu · H1N1 · Decongestants · Rapivab · Tamiflu · Relenza · Flomist · Zanamivir

1 Introduction

The internet is one of the vital assets that can help in the prediction of illness outbursts. It provides a chance for low-cost time-sensitive bases to be demoralized in order to increase the existing surveillance systems. In India, surveys are most prevalent strategies in various fields to gauge the public sentiments with respect to diseases. Survey-based systems are expensive and tedious process and are not reasonable for a transferable pandemic. One of the conceivable answers to beat this issue is

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utilization of web-based social networking sites which permits quick trade of ideas, thoughts, and data utilizing web-based applications. Online networking has been an essential focal point of the data recovery and content mining field from the beginning, since it produces enormous unstructured textual data and presents users relations progressively. There are a rising number of online networking tools and a quickly developing client base over all socioeconomics. Social networking sites have turned out to be quick and less expensive that empowers brisk and simple access to open data among potential clients.

There are many social networking sites which are being used worldwide and is huge a platform for everyone to communicate like Facebook, Quora, Twitter, and Instagram (where the emotions and views are expressed via photos and captions). Talking about Twitter, it is one of the leading social networking sites of twenty-first century. It's a free of cost networking plus micro-blogging platform that allows its huge number of users to share their views and exchange views and tweets. Twitter has around 330 million active users every month where 500 million tweets are tweeted per day and around 200 billion tweets per year are encountered. Useful information about events happening around the world, the news, and everything is posted by the users on this micro-blogging site. Social media is producing huge amount of data. People share their views, experiences, and opinions on many different topics. Users share their reviews on the products that they have ordered or they have used, they share their views on current affairs, if a group wants to advertise their events and/or campaigns then that is done by socializing on Twitter via tweets, the users tell their opinions about the movie they have watched, they share their experiences like the customers who have faced problems using a particular product and the problem wasn't resolved on multiple phonic conversations then they can post their complaint on Twitter by mentioning their problem and the company's name on a tweet.

Individuals look for wellbeing data for any number of reasons: worry about themselves [1], their family [2] or their companions [3]. Some quests are just because of general intrigue, maybe affected by a news report or a current logical production, and postponements in identifying the beginning of an irresistible plague brings about a major harm towards a society. Therefore, there is solid enthusiasm for decreasing these postponements. One approach to achieve this is through a surveillance framework, which emphasizes the use of the real-time data analysis [4] which recognize and describes unfamiliar action for further public health issues [5, 6] With the increase in the usage of online networking sites [7, 8], for example, Twitter, screening of the pandemic H1N1 infection has been done in [9].

In their work [10] proposed a novel procedure considering dynamic watchwords from RSS channels which are utilized to recover tweets. Conclusion examination and tally construct system relate to informational indexes to look at essential issues identified with Influenza-A (H1N1) pandemic. The approach used in their paper focuses on various parameters to locate the important data towards a specific sickness and the general mindfulness towards it. Twitter information has been utilized to quantify political assessment in [11], used to forecast stock returns [12], national assumption (i.e., joy) in [13], people's sentiments about outdoor game 'Lawn Tennis' in [14] and to screen the effect of seismic tremor in [4]. Comparison of traditional epidemiology has been made with computational epidemiology in [15].

The organization of rest of the paper is as follows: Sect. 2 discusses some of the similar work reported in the literature. The approach proposed in this work is discussed in Sect. 3. Section 4 gives the results and discussions which is followed by conclusion in Sect. 5. At the end limitations of the work and future scope is discussed in Sect. 6.

2 Related Work

Twitter is a free informal communication and a blogging platform that empowers its huge number of clients to exchange each other's "tweets" constrained to 140 characters. Clients decide if their tweets can be viewed by the overall population or are limited to some predefined viewers only. The platform has more than 190 million enrolled clients and produces around 55 million tweets every day. A current investigation of the "Twitter stream" uncovered that a generous extent of tweets contains general discussion about various aspects of life. Despite a huge amount of data that is not of much relevance, the Twitter stream contains helpful data [16]. Numerous current news items have been reported utilizing Twitter directly from clients at the site [17]; Examples being US Airways flight 1549 arriving in the Hudson River [18] or road riots amid Iran's 2009 presidential decisions [19]. Since tweets are regularly sent from handheld devices, they pass on more promptness than other interpersonal interaction methods.

In the current years, there has been a considerable amount of research in the area of online networking information. There is a restricted report towards the general wellbeing data framework. A few authors [20] worked in the field of general public health issues utilizing web-based social networking information.

Authors in [9, 10] proposed a technique amid the H1N1 pandemic utilizing Twitter-based data with particular keywords. Other authors likewise utilized some different procedures or techniques for discovering queries and keywords like Google web search queries connected with flu epidemic. The clustering of Twitter messages by subject and extraction of important intelligible marks for each group is utilized by [21]. Some researchers utilized content examination and relapse models to quantify and screen open concern and levels of infection amid the H1N1 pandemic in the United States [22]. Some different sicknesses like [19] cholera is additionally explored to discover the cholera flare-up. The creators additionally built up a system that gave a measure of clients influenced by flu (swine influenza) within a group or gathering. Machine learning procedures like SVM have been used in [23]. Flu pandemic has been tracked by monitoring the social web in [20]. Tweets related to dental pain have been analyzed in which may help dentists to disseminate dental health-related information. 1000 tweets related to use of antibiotics have been analyzed in [7] to discover sign of misinterpretation or misapplication of antibiotics. 60,000 tweets about cardiac arrest and resuscitation collected during 38 days via a set of 7 search terms have been analyzed in [24]. Twitter data is very useful in the study of a wide range of health-related problems [25–28]. The unstructured data obtained

from Twitter has to be preprocessed before it can be used for any type of analysis. Authors in [29] have done text normalization by using Deep Neural Network approach. Predictive modeling has been used by authors in [30] for prediction of cases, deaths, and recoveries due to COVID 19.

3 Analysis Techniques for Twitter Data

Data extracted from Twitter can be used for analysis and prediction in various disciplines such as medicine, engineering, biology economics, forensics, etc. [31]. Various aspects can be measured from the tweets based upon the aims and objectives of the work being carried out. Tweets could be analyzed for carrying out sentiment analysis, for the detection of objects, for prediction or may be for content analysis [1]. Content analysis and sentiment analysis deals with text analysis of the tweets to arrive at some useful results. In content analysis, the text which is extracted is generally a word related to the area of study which is used for some sort of prediction [13, 32], whereas in sentiment analysis the words extracted generally represent the emotions of the people [8]. Several tools can be used for sentiment analysis. They can be broadly classified as lexicon-based tools and machine learning based tools. A "dictionary" of words with their sentimental meanings is required in lexicon-based tools so that the keywords can be categorized as positive, negative or neutral [33]. Two frequently used dictionaries are Linguistic Inquiry and Word Count (LIWC) [34] and Affective Norms for English Words list (ANEW) [35]. This lexicon-based approach is simple to implement, but suffers from low recall if the size of lexicon is very small or if very few numbers of lexicon words are present in the text. Another limitation is that this method can classify the sentiment only into three categories: positive, negative, and neutral; but in the real-world sentiments other than these extremes also exist.

Machine learning approaches for text analysis are probabilistic in nature. In this approach initially, a training dataset is provided which consists of sample dataset with known positive or negative sentiment. This dataset is first used to develop a model and then this model is further applied for text analysis of the new data items that are the tweets. WEKA, Microsoft NLP Toolkit, and SciKitLearn are some of the popular ML-based sentiment analysis tools.

4 Proposed Approach

The proposed strategy analyzes the data from web search queries and tweets. The first step here is the recognition of queries and tweets that are pertinent to the presence of influenza, influenza symptoms, and medication for influenza. Some important and relevant keywords from tweets used in this work are: Influenza, Swine flu, H1N1, Decongestants, Rapivab, Tamiflu, Relenza, Flomist, Zanamivir, etc. These tweets have been used to find out that how many people use Twitter in different countries

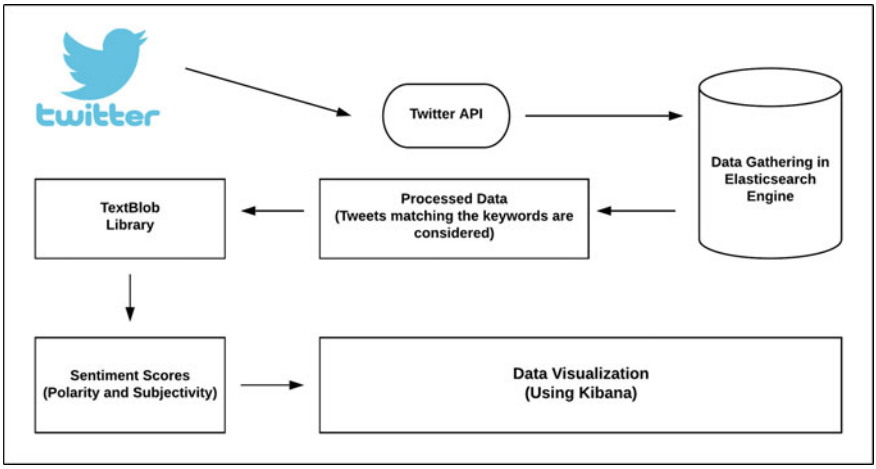

Fig. 1 Proposed approach

to share their experiences on the same. This helps to find out how these diseases are being managed by people without going to the hospital and how it can be useful for other users. Later, using IDSP data and Twitter data a comparison has been carried out for the analysis of the number of cases in both the scenario. This might be of great help to analyze how social networking sites help the patients to encounter the starting symptoms of the disease and help to cure it. Based on this study the average number of cases of the disease that have been resolved in India without going to the hospital has been estimated. Also, the analysis of where India stands when it comes to Twitter data and what is the scenario of Influenza in other countries has also been studied and the visualization of the results obtained is presented.

Sentiment analysis is a task of NLP which is the subfield of AI (Artificial Intelligence) which is used to help the machines to deal with the human languages. Naive Bayes and Decision Tree are the best machine learning algorithms and are used in this work too. Firstly, perfect data is collected from Twitter for training and testing, this is done using the keywords which are mentioned in the python code which include Influenza, H1N1, Decongestants, Rapivab, Tamiflu, Relenza, etc. Secondly, Textblob is used, it is a python package that is used to do a lot of NLP tasks. It is used for polarity and subjectivity. Polarity lies between the range of $[-1, 1]$, discussed later in Sect. 5 and subjectivity refers to the personal opinion, emotion, or judgment. In the third step, the extracted tweets were stored in Elasticsearch Engine in the JSON (JavaScript Object Notation) format for better results as the data is a lot, which needs to be maintained in the proper format for better visualization. Also, as data is very huge and in different languages, only English language tweets were taken out of all the tweets. Later in the fourth step, the stored data was then visualized in Kibana, which is an open-source data visualization and exploration tool. Kibana is used for searching, viewing, and visualizing data indexed in the Elasticsearch and later for

Table 1 Hashtags

#cold	#H1N1	#Decongestants
#Flu	#Influenza	#influenzavaccine
#virus	#flushot	#influenzab

analyzing the data via pie charts, histograms, bar charts, tables, and maps. Figure 1. Explains the steps of the proposed approach in a flow diagram.

A detailed explanation of the various tools and techniques is given below.

4.1 Data Gathering

Tweepy API has been used here to collect the tweets related to H1N1 in order to understand the opinion of Twitter users about this disease. In order to do this firstly an account was created on Tweepy API and this was then linked to our Twitter account. 33,120 tweets were extracted in this manner and they were stored in a database. Some of the hashtags used to retrieve the tweets are given in Table 1.

4.2 Data Preprocessing

The first step in preprocessing was removal of all the irrelevant data such as stop words, URL's, special characters, symbols white spaces, etc. The second step was removal of all the words which were not English language words, as the current research work is working only for English words.

4.3 Generation of Polarity

The data obtained from the Tweets are an unstructured data. The words present in these Tweets is used to determine its polarity which has numerical value associated with it between −1 and 1. Negative value implies negative sentiment, positive value implies positive sentiment, and a value of zero means neutral sentiment. Subjectivity is another parameter which has its value in the range of 0–1. A value near 0 means that the tweet is based on factual data, whereas a value near to 1 means that it is mostly based upon public opinion. Textblob Python library has been used in this work to calculate the polarity and subjectivity.

4.4 Machine Learning Model

The final step involved is classification using Machine Learning approach. Naïve Bayes and decision tree supervised learning techniques have been used here. The pre-processed dataset was used to build a model using tenfold cross-validation for the two classifiers and the performance of the two was measured using accuracy as the parameter.

After prediction using the above approach, the results were compared with the data available at IDSP. The IDSP data is easily accessible from the 'Ministry of Health and Family Welfare-Government of India' site, i.e., www.idsp.nic.in. The key motive of this web portal is to maintain and strengthen the decentralized laboratory-based IT facilitated disease surveillance for the rampant prone disease to observe the trends of the disease and to detect and respond to the epidemics in the initial stage via Rapid Response Team (RRTs). This data is updated every month and provides previous year data also in the pdf format. In this work, first this data has been converted into CSV format using python code and then has been visualized using POWER BI. In both the cases it has been observed that there is a huge difference between the number of cases encountered in twitter data and IDSP data.

5 Results and Discussions

This work is done to predict Influenza, when a person is suffering from Influenza or who has recovered, let's say posts something on Twitter which might include the symptoms, precautions, or the medication then the tweet is very useful. If something bad is written in the tweet it shows the tweet is negative polarity and a person is/was infected. If something good is written then it shows the tweet is positive and a person has recovered from the illness and the tweet might include the precautions, cure, and medication also.

The program was run for approximately 30–32 h which means one and a half-day and the number of tweets/cases encountered were 33,120 in total. The number of Tweets remaining after preprocessing was 14,530. The polarity was sub-divided into four ranges and the number of tweets encountered in these four ranges is shown in Table 2.

Table 2 Sentiment assignment to various tweets

Polarity Range	Count
−1 to −0.5	1273 (8.95%)
−0.51 to 0	5461 (38.38%)
0.1–0.5	6331 (44.49%)
0.51–1.0	1165 (8.19%)

Table 3 Number of cases (approx.) encountered per day using Twitter and IDSP data

S. No.	Cases per day by Twitter data	Cases per day by IDSP data
1	43	21

The performance of the classifiers was evaluated and it was found that Naïve Bayes achieved an accuracy of 89.36% and Decision Tree achieved an accuracy of 92.49%. Hence, it can be said that Decision Tree has performed better than Naïve Bayes.

Furthermore, out of the total tweets 65 of them were encountered in India. Based on this result the average number of cases per day has been estimated as 43 using the sentiment analysis approach. As per IDSP data, the number of cases from 1st January 2018 to 22nd April 2018 (81 days) was 1678. This results in an average of 21 cases per day.

It can be seen from here that there is huge difference between the results obtained from both method. This is depicted in Table 3.

5.1 Visualization of Twitter Data Using Kibana

Figure 2 shows the polarity ranges of the tweets within the range of –1 to 1. Which is further sub-divided into 4 ranges like between –1 and –0.5, –0.51 to 0, 0.1–0.5 and 0.51–1. But here, the proposed research work has intended to use 2 ranges –1 to 0 and 0.1–1. As the analysis is about negative and positive tweets only.

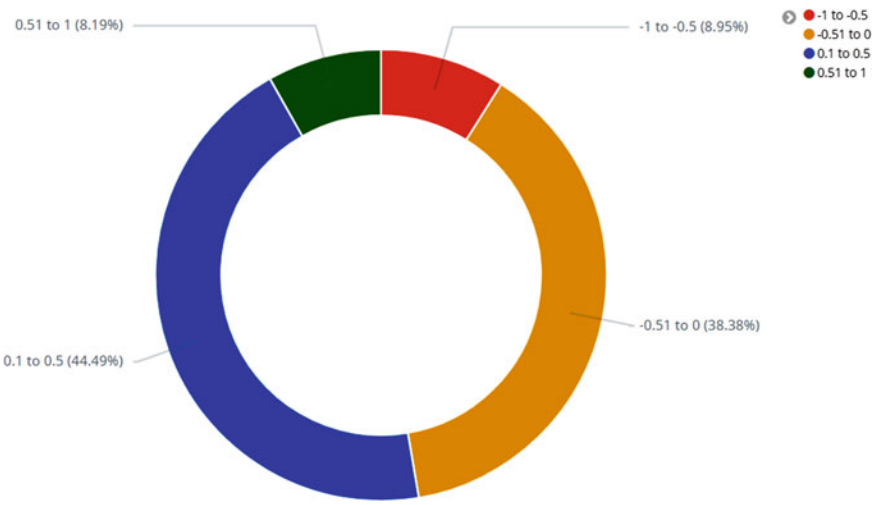

Fig. 2 Number of Counts in the polarity range table

The ranges are the sentiments obtained from the tweets. For more accuracy, the data has been classified into four ranges here. The sentiments here are classified based on the views of the people in the tweets.

Figure 3 shows the number of counts based on the locations where the tweets were posted. The counts are in the tabular form and the data is further visualized on the graph.

Figure 4 shows location-wise Bar Graph depicting the number of counts based on the location world-wide. As it can be seen here the number of counts in India is 65 and is on 21st position.

Table Request Response Statistics

Location	Count
United States	317
FART	231
London	182
London, England	157
Los Angeles, CA	142
New York, NY	124
England, United Kingdom	105
Lagos, Nigeria	102
Chicago, IL	101
United Kingdom	101
UK	100
Washington, DC	100
California, USA	97
Canada	97
Nigeria	91
Houston, TX	80
USA	79
France	72
Florida, USA	69
Seattle, WA	66
India	65
Malaysia	65
Atlanta, GA	61

Fig. 3 Number of counts based on the location

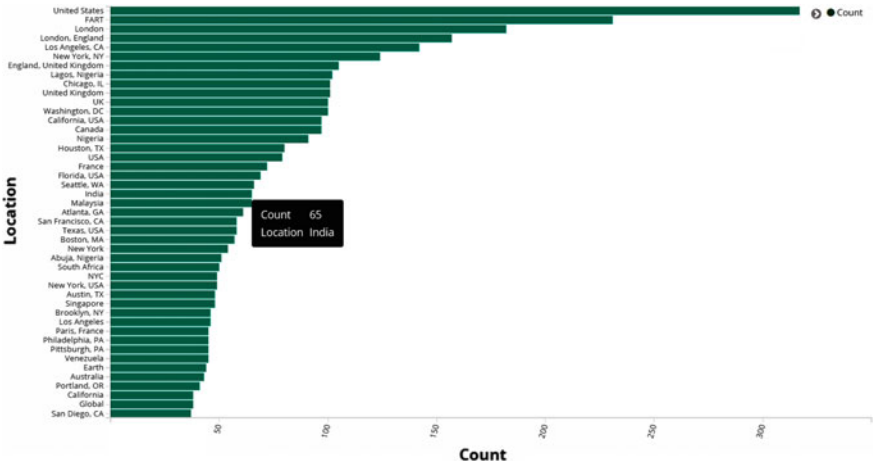

Fig. 4 Location wise bar graph

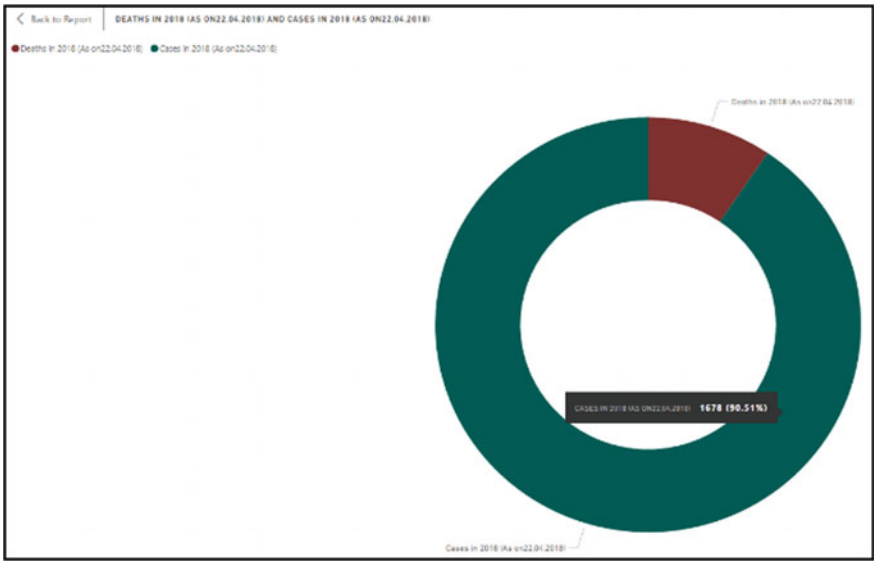

Fig. 5 Overview of number of total cases to number of total deaths in INDIA

5.2 Visualization of IDSP Data Using Kibana

Figure 5 depicts the number of total cases to the number of total deaths in the period of 81 days in India. The cases registered under IDSP were found to be 1678 and number of total deaths was 176. The data was of 29 states and 7 union territories from 1st January 2018 to 22nd April 2018.

Figure 6 shows the number of cases state/UT wise. In Telangana state it has 16 cases which is 0.95% of total cases as on 22nd April 2018. The maximum number of cases were encountered in Rajasthan. This shows that the one of the most affected parts of India when it comes to influenza is Rajasthan. The number of cases encountered in Rajasthan is 1343 but analysis of Twitter data shows that there would be a greater number of cases in the future. To overcome this a strict step should be taken to minimize the problem in the coming days.

Figure 7 shows the number of cases state/UT wise. In Uttar Pradesh state it is seen it has 3 death cases which are 1.7% of total deaths as on 22nd April 2018. Again, the number of death cases in Rajasthan is maximum as the cases encountered here were maximum. It's a matter of serious concern for India. The facilities should be provided, and medications should be provided as soon as possible to reduce this number.

Figure 8 Depicts the results presented in Table 1 in the form of a graph. The results obtained from the analysis show that there is a huge difference between IDSP data and Twitter data. Results obtained from Twitter data show approx. double the number of cases as reported by IDSP. The difference depicts how the Twitter data

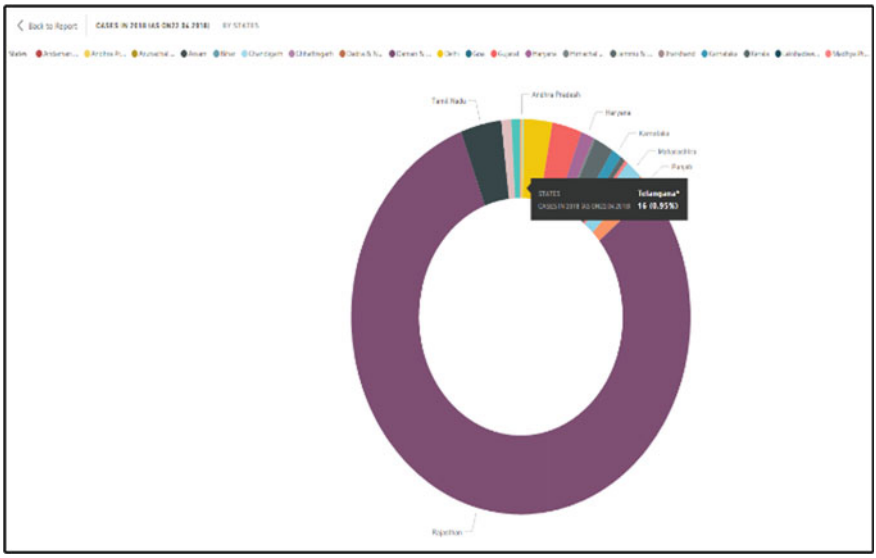

Fig. 6 State/UT wise count of cases

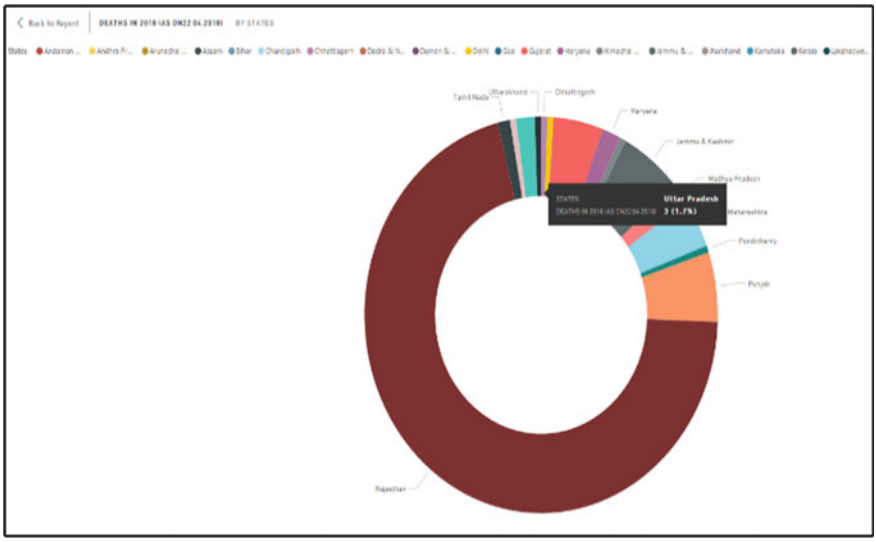

Fig. 7 State-wise count of deaths

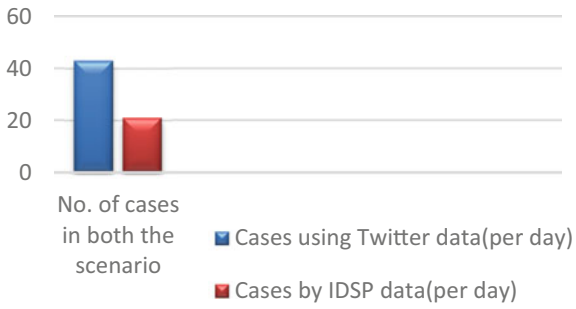

Fig. 8 Number of cases encountered in Twitter data and IDSP data

can be beneficial in providing quick review and feedback on influenza-like illness without going to hospitals. Similarly, if anyone had posted anything about COVID-19 in early stages there is a possibility that it could have been very beneficial in taking preventive measures more efficiently and in making medication for it

6 Conclusion

Twitter offers a platform for various discussions and opens doors for observation of general wellbeing of the people. In this work, people's opinions were studied about H1N1. The sentiment analysis of Twitter data was carried out and the accuracy obtained using Naïve Bayes and Decision Tree was 89.36% and 92.49%, respectively. A comparison of the IDSP data for seasonal influenza in India from 1st January 2018 to 22nd April 2018 with the twitter data is done. The results obtained here can give quick feedback or reviews on side effects for swine influenza, prevention strategies used by the users and their reviews about the drugs or medications they took. This data and result could be used for taking preventive measures from the disease prediction by government and health organizations by giving more supply in a particular region which will enhance their business too. Also, the outcome supports that the utilization of online networking for the following disease will be used for knowing the public health in the society more accurately and will be able to resolve the problem in a shorter period.

7 Limitations and Future Scope

The results obtained in this work are very interesting and encouraging. As mentioned, web was used and found the views of the people and their perceptions for certain diseases via their tweets. Tweets were extracted which matched to the defined keywords. But in different regional languages the flu may be called something else and the users might have mentioned the disease in their own language. As this research

did not look for those keywords therefore those tweets were not extracted, so this research is limited for language English only. Another limitation is, the tweets are limited to specific length and that is maximum 140 words. The tweets don't have relevant information in 140 words, the data in the tweet contains very less facts/figures and doesn't offer much data to work upon.

As mentioned above two limitations were observed. One limitation was regarding the extraction of the data from the Twitter which is being posted in some other language which doesn't match the mentioned keywords. So, one of the future scopes of the work is to have more accurate and relevant data, and for that one needs to have a surveillance system that detects such tweets also, and one can look forward in the future to work upon this for better results. The second limitation was about how the tweets are limited to 140 characters and are not relevant enough for the more accurate analysis purpose. So, another future scope is, the detections could be improved with simple grammatical analysis along with other recognized classification techniques. Last year, Twitter also said they will be extending the length of the characters in the tweet. That might be very helpful to work upon and extract more relevant data.

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Review of Denoising Framework for Efficient Removal of Noise from 3D Images

Anand B. Deshmukh and Sanjay V. Dudul

Abstract An image is a distributed amplitude of colors on a plane. An image may be in the form of two-dimensional image or three-dimensional image. Such images are compiled using optical sensors like camera and are processed using various image processing tools for better visualization. Purpose of the image processing is not limited for better visualization, but it is extended to remove noise from the captured image. Noise is a random variation of brightness, contrast and color pallets in an image. In the present discussion through review of denoising framework for efficient removal of noise from 3D images, different filters which are used so far for removal of noise are discussed. The research work is further extended by designing novel denoising framework for efficient removal of noise from the 3D image.

Keywords Denoising · Gaussian filter · Impulse filter · Spectral filter · Rician filter · Synthetic image · Gray scale image and color image

1 Introduction

An image is collection of number of rows and columns of pixels. Pixel is the smallest element in the image. They are represented by 1's or 0's in binary image or small integer value if it is gray image or color image. Accordingly images are two-dimensional and three-dimensional.

Images are either acquired using optical sensors like camera during which noise signal gets added in an image. On the other side, the images are transferred through possible media like wired or wireless transmission using different communication protocol which again causes noise introduction. Introduction of noise signal causes degradation in quality of an image. To recover maximum original information in an image, it is significant to use effective methodology for removing noise signal from an image. Technique used to remove unwanted signal from an image is known as denoising technique.

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There are different types of noise added into an image with different level. In the present research work, exhaustive review is carried out on various noises such as speckle noise, impulse noise, Gaussian noise and Rician noise along with an innovative approach for noise removal from an image is disclosed.

1.1 Understanding the Noise

Noise is generally represented as a random variation of color and brightness information in an image [1]. There are different sources of noise from which it can be added into an image like in case while acquiring through optical sensors like camera or scanner. Other possible source of noise in an image is at the time of processing an image for transmission like compressing, encoding and other significant steps or at the time of transmission of an image using a different communication protocol [2].

Noise signal exists in different levels. Noise can range from almost imperceptible pixel spot to a radio astronomical image which remains completely noisy from which very small amount of information or even sometimes no information can be retrieved.

Gaussian Noise

The Gaussian noise arises mostly during image acquisition. Significant reasons for Gaussian noise are heat, random illumination and electronic circuit noise. Primarily the optical sensors used for image acquisition tends to heat up due to the surrounding temperature and due to the amount of current they draw from battery source for own operation, this causes loss of information in an image. Poor illuminating conditions at the time of image capturing cause inherent noise in an image. The third significant reason is that electronic circuit noise. It is caused due to internal and external sources. External sources include radio frequency transmitters and receivers, nearby conductors, ignition system and many other possibilities. Internal reasons include faulty components, age of the component like lens and many other significant things [3].

Gaussian noise is uniformly distributed over an image. It causes each pixel on an image to be a sum of pixel value and Gaussian noise signal value. Mathematically, Gaussian noise can be represented as

$$\mathcal{P}G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$$

where

$\mathcal{P}$ is the probability density function,
z represents the gray level,
μ mean value,
σ standard deviation [4].

Impulse Noise

An image is captured using optical sensors. When light signal misaligns with the sensors it creates a noise. Whenever an image is transmitted on communication channel, due to the external noise, image becomes noisy. Such type of noise is called as impulse noise. Due to imperfection in converter designs might introduce impulse noises [5]. Impulse noise can be seen unsubstantially as white spots of pixel in dark area of the image or dark spot of pixel in bright area of the image. Whenever a positive spike arrives having value greater than the value of surrounding pixels then that pixel appears as white spot. On the other hand, if the noise spike has value smaller than the value of surrounding pixel, then that pixel appears as dark spot [6]. For effective removal of impulse noise median filter [7] or morphological filter, [8] can be used.

Mathematically, impulse noise can be represented by

$$y_{ij} = \begin{cases} \text{smallest impulse vale or highest impluse value} \\ (x_{ij}) \end{cases}$$

where

y_{ij} noisy image pixel,
x_{ij} uncorrupted image pixel [9].

Speckle Noise

Noise is random variation in pixel values, and this adjust the actual content of the image. Addition of such pixels in an image leads to form a noisy image. Out of the different categories of the noises, the noise which occurs due to environmental conditions is speckle noise. It occurs at the time of procurement while capturing the image [10]. Speckle noise is generally observed in medical images and RADAR images.

Mathematically, speckle noise can be represented as,

$$G = e + n * e$$

where

G speckle noise,
e input image,
n uniform image noise with mean and variance [11].

Rician Noise

Rician noise occurs in low signal-to-noise ration regions and it is a signal dependent noise. Rician distribution occurs when an image is exposed to resonance. Due to this, random fluctuations are observed. It also causes signal dependent which may reduce the contrast of an image. Wavelet and other different methodologies and algorithms are used to eliminate the Rician noise.

2 Recapitulating Image Denoising

Noise is the random variation in amplitude of pixel in an image, as compared with the neighborhood pixel values. This corrupts the information which an image is carrying with it. For optimized working and perfect investigation of an image, true image quality with zero noise inclusion is required. The process of extracting the false contents in an image to restore the original image quality is called as denoising. Various authors have reported various novel algorithms, filtering techniques and methodologies for denoising.

Gaussian Denoising
Manyu Wang and Shen Zeng proposed an image denoising method based on Gaussian filter. The proposed algorithm learns from the weighted average thoughts of particle filter. In the novel technique of noise removal instead of considering only gray information of the image, gray information along with image structure information is also considered for denoising which gives enhanced denoising [12]. Figure 1 discloses the outcome of the proposed method, as reported by the authors.

Tanzila Rahman et al. proposed a reduced the Gaussian noise using fuzzy filter in their research work. A 3×3 filtering window with 8 neighboring pixels are used to calculate the input image. In this to calculate the percentage of corruption of an image, the input image is divided by 8. Because of this, 8 neighboring pixels can be easily calculated. For color image instead of directly processing, the individual color

Fig. 1 Experimental results for the proposed method

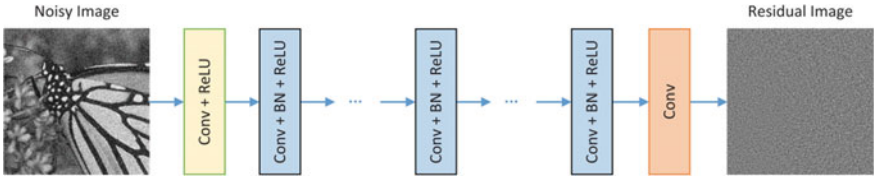

Fig. 2 Architecture of the proposed system

components R, G and B are processed separately and finally concatenated to get the final output image [13].

Kun He et al. proposed a technique to remove the Gaussian noise completely than to reducing it. Further, in the proposed technique, the pixels are categorized based on the local continuous smoothing in the image, into three classes, on noise point, on noise edge and in the local texture. At the second stage, according to the local continuity and the texture property, edge information and the texture information are extracted. This helps to locate the noise point precisely. In the final stage of denoising Gaussian noise, adaptive neighborhood is used to eliminate the noise point [14].

Kai Zhang et al. investigated the development of feed forward denoising CNN model to remove the noise. Improvised training process and denoising performance residual learning and batch normalization techniques are adopted. Through the proposed algorithm removes the buried clean image due to which it can denoising super-resolution and deblocking can be handled. Further authors claimed to have architecture capable of blind Gaussian denoising [15] (Fig. 2).

Florian Luisier, Thierry Blu and Michael Unser proposed an optimal methodology for thresholding algorithms to remove the Gaussian and Poisson noise. In this methodology, the denoising process is considered as linear expansion of the threshold which is optimized by mean squared which is obtained through non-Bayesian approach [16].

Muthukumar et al. propose a restoration algorithm for color image suffering from Gaussian noise and impulse noise. In this technique, median filters with architectural data are used to identify impulse noise pixel. Gaussian noise is removed by utilizing the total variation minimization algorithm. The proposed method is claimed as effective technique for restoring an image while retaining the structural information and visual details [17].

Takayuki Hara and Haike Guan disclose an algorithm for denoising color image without degrading the information content in an image at promising speed. Research work utilized maximum posterior prediction is used which is based on Gaussian model. The correlation in the color components is reduced along with computational complexity due to non-iterative filtering and matrix operations [18].

Dinh-Hoan Trinh et al. reported the issues due to Gaussian and Poisson noise in medical images and introduced patch-based learning approach for noise removal. Regression model is used for denoising which removes noise based on nearest neighbors of an infected pixel group. A set of k-nearest neighbors is used to learn the

regression model and performs denoising effectively in highly noise affected images [19].

Mrs. C. Maithili and Dr. V. Kavitha suggested a filtering technique by considering three primary colors to be filtered separately followed by gain adjuster unit to compensate the overall gain and then combine the three module outputs together to form an image [20].

Impulse Denoising

Hemant Kumar Aggarwal and Angshul Majumdar disclosed denoising technique for hyperspectral images. The optimization problem is framed for the noise function in the hyperspectral images and it is removed using spatial correlation between the images. The other optimization issues are resolved using Split Bregman technique, and the denoised hyperspectral image is claimed to be superior than previously reported techniques [21].

Hakran Kim, Seongjai Kim proposed diffusion-based denoising method to deal with impulse noise. A novel impulse moving anisotropic diffusion filter is designed which regulates the impulses and max and mins without disturbing neighboring pixel amplitudes [22].

Nasar Iqbal, Kashif Ahmad and Waleed Shah Jehan disclosed a technique to denoise an image using adaptive median filtering in which the infected pixel is replaced by median value of 3×3 window. Technically, the clean pixels are used to calculate the median values and it is used to replace the noisy neighbor pixel. Outcomes are claimed to give optimized mean square error, peak signal-to-noise ratio and universal quality index [23]. The subsequent Fig. 3 discloses the relation between PSNR and noise density which is reported in the research work experimental analysis.

Bo Xiong, Zhouping Yin discussed universal denoising framework based on nonlocal means filtering. Denoising is pursued in detection and filtering stages. For detection of the impulse infected pixel, outlyingness ratio is used which is followed by dividing all pixels into four clusters depending on outlyingness ration value. Subsequently, to precisely detect the infected pixels iterative model and fine coarse to fine strategy are utilized. To filter the impulses, a reference image is introduced to extend the NL means. Outlyingness ratio and NL means are combined and proposed as a denoising and restoration model. The proposed technique claimed to achieves high peak SNR and improved image quality by efficiently removing impulse, Gaussian and mixed noise [24].

Snigdha Tariyal et al. utilized interband spectral correlation along with intraband spatial redundancy in their research work in transform domain as a thin representation. Set of transform coefficients are used to represent the intraband spatial redundancy and rank deficient matrix is used to model the interband spectral correlation. Proposed work achieved better optimization performance by utilizing Split Bregman technique [25].

Dev R. Newlin, C. Seldev Christopher discussed denoising technique for impulse noise affected image through adaptive weighted interpolation along with edge sensing

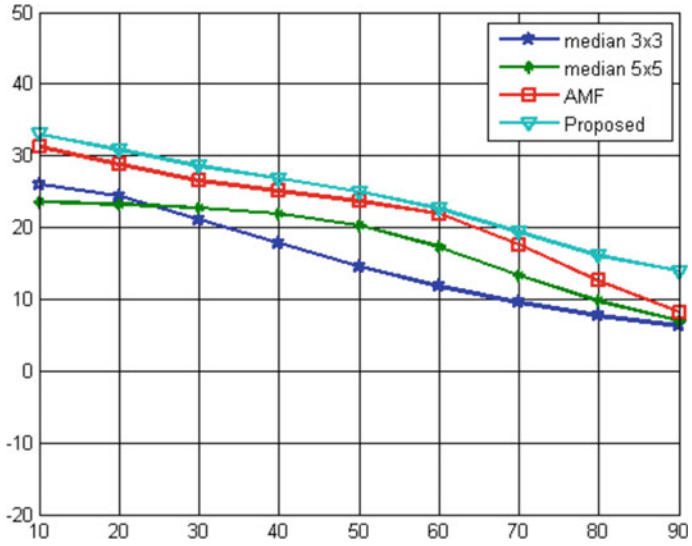

Fig. 3 Relation of PSNR and noise density

and adaptive window size. The claimed architecture promises better restoration when the performances are compared with existing filtering models [26].

S. Indu and Chaveli Ramesh denoise an image using image fusion technique. In this technique, multiple images are fused together while retaining the information contents of the individual image. To denoise an impulse, the uncorrupted pixels of a noisy image from different sensors are combined together [27].

Angshul Majumdar et al. address the issue in noise affected hyperspectral images. Joint-sparsity promoting dictionary and blind compressed sensing framework dictionary is suggested in the research work for denoising [28].

Speckle Denoising

Meenal Gupta and Amit Garg discovered a technique to preserve the edges and to minimize the speckle noise. The technique reported in the research work is built using detail preserving anisotropic diffusion and optimized Bayesian non-local mean filters. The outputs of the filters are combined using homogeneity map, which differentiates homogeneous and edge region of the image. Through the proposed technique improved SNR and edge keeping index are claimed [29].

Latha Parthiban and R. Subramanian uncover speckle denoising using contourlets to attain improved SNR performance. Contourlet transform is the two-dimensional transform developed for image processing in discrete and continuous domain. This algorithm helps to restore the images to the level that makes diagnostically relevant image content. Using the proposed technique, superior performance in terms of speckle suppression and edge preservation is achieved [30].

Amit Garg and Vineet Khandelwal discovered a method for speckle denoising using combined approach of bilateral filter and detail preserving anisotropic diffusion. The local coefficient of dispersion which is estimated through flexible window is used to frame a binary classifier map in the research work. The superiority of the proposed technique is modeled around PSNR, SNR and EKI parameters [31].

Celia Barcelos, Luciana Vieira disclose a method which identifies the noise pixel and its location using a function which controls the smoothness velocity and adjusts the fidelity [32].

Mohammad Rahman, Mithun Kumar, B. Borucki, K. S. Nowinski uncover a novel technique for speckle denoising of ultrasound images. The proposed technique uses vector triangular formula as an extra energy reduction function. In this technique, the energy of pixel is considered for identifying noisy pixels, if the energy of pixel which is calculated using vector triangular formula. Noise pixels are observed if the calculated pixel is less than that pixel in terms of distance energy. By optimizing the additional energy for functional operation the noise pixel energy is balanced [33].

Tsuyoshi Murakami, Koichi Ogawa disclose a technique for speckle denoising of optical coherence tomography (OCT) images. In this technique, wavelet transform is used for image restoration. The signal-to-noise ratio is claimed to be increased to 25 dB [34].

Somkait Udomhunsakul and Pichet Wongsita disclose a method for restoring an image infected from speckle noise using combine approach of Weiner filter theory and wavelet transform while maintaining the information contents. In this technique, 2D discrete transform of logarithmic image is calculated followed by Weiner filtering over sub-band areas. Subsequently, inverse wavelet transform and inverse logarithm are computed. For parameter evaluation, MSE and EP are used [35].

Raul Malu Gan, Romulus Terebeu, Christian Germain, Monica Bordal, Mihaela Ciulariu proposed classical signal processing technique that is independent component analysis method for speckle denoising. In this technique, sparse code shrinkage algorithm based on independent component analysis is applied. Inverse of the unknown mixing matrix is estimated using fast ICA algorithm. This is followed by application of shrinkage operator for each determined component [36].

Celia Barcelos, Luciana Vieira reveal the use of variational method to suppress speckle noise. In this technique, location of noisy pixel is detected by a function controlling the smoothness and adjusts the fidelity. The proposed model claimed to be faster and perfectly remove the speckle noise while retaining the image quality [37].

Rician Denoising

Debajyoti Misra, Subhojit Sarker, Supriya Dhabal and Ankur Ganguly disclose the use of genetic algorithms for the use of denoising an image suffering Rician noise. The speckle noise is arising mainly due to low SNR, and genetic algorithm is used in the proposed rectifies the real and imaginary data before magnitude image construction. Crossover and adaptive mutation are combined in the experimental model which attains better convergence and robustness [38].

Robert D. Nowakuncover's wavelet domain filtering method to denoise Rician noise from in image addressing to the random variations in the signal and noise. Through this approach, random fluctuations in the contrast occurrences in an image can be regulated efficiently [39].

Herng-Hua Chang et al. disclose a post-acquisition denoising algorithm to regulate the random fluctuations and suppress bias introduced due to the Rician noise. The proposed filtering technique considers median, radiometric and geometric components to replace the intensity values of neighboring pixels. An entropy function is associated with the neighboring pixels along with parameter automation scheme to balance the interferences through FMFs [40].

Efstathios Sotiriou et al. report the issues due to magnetic resonance images which swiftly outperforms Rician denoising high resolution images. This approach is attained by designing hardware architecture of the proposed algorithm. The images are segmented and processed in pipeline. Due to this novel approach, the non-infected pixels can be bypassed from the processing steps [44].

Xinji Liu and Tao Dai proposed principal component analysis (PCA) with local pixel grouping (LPG)-based denoising model focusing on low noise levels of image. Authors have introduced a guide image and addressed the issues of robustness and high noise through PCA transform estimation. Block matching is performed between noise image and guide image for PCA transform estimation [41].

Erik Bochinski et al. proposed a sparse image representation model through regularized gradient decent training of steered mixture of experts. Instead of Gaussian mixture model trained by expectation maximization, gradient descent optimization is used as primary training object in the proposed model provided better performance in terms of sparsity and robustness [42].

Han Guo and Namrata Vaswani have reported the issues in video denoising through dynamic video layering. Proposed work introduced a novel layering denoising which reduces the noises and corrupted videos using sum of low rank matrix plus a sparse matrix. Authors further claimed that better performance can be achieved if the video is first decomposed into two layers, and the denoiser is applied on each layer separately [43].

3 Proposed Denoising Technique

Through the literature survey, it is evident that most of the techniques promising to have denoising framework are considering cases in which an image is contaminated by single noise signal. However, it is found that in practice, an image is contaminated with multiple noise type. To address this issue, a novel technique of denoising an image contaminated with multiple sources is disclosed. In this initiative, speckle noise, impulse noise, Rician noise and Gaussian noise are considered. Considering the characteristic of the noise signals Gaussian filter and impulse filter are grouped together while Rician and speckle filters are grouped together. While filtering an

image, noisy pixels contaminated with individual noise or mixed noises are processed by the filter.

To demonstrate the effectiveness of the algorithm, different noise signals are added from 10 to 60% as individual and mixed noise signal. The filtering is performed on color, synthetic and gray image.

4 Conclusion

In this research work, the review of various filtering techniques is presented. Different filtering techniques, algorithms and hardware approaches are proposed to restore the images contaminated with different types of noises like speckle noise, impulse noise, Rician noise and Gaussian noise. It is observed that different reported techniques are giving solutions to the individual or double noise component. However, an image can be contaminated with multiple noises. To address this issue, a novel filtering framework is proposed which considers the possibility of an image contaminated with different noises at a time. To demonstrate the robustness of the noise signal, different filters are operated in different combinations. Through the proposed technique, significant parameters like MSSIM, SSIM, MAE, execution time and PSNR can be appreciably optimized.

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Algorithmic Trading Using Machine Learning and Neural Network

Devansh Agarwal, Richa Sheth, and Narendra Shekokar

Abstract Machine learning models are becoming progressively predominant in the algorithmic trading paradigm. It is known that a helpful data is taking cover behind the noisy and enormous information that can give us better understanding on the capital markets. There are multiple issues, which are prevalent as of now by including the overfitting model, irrelevant/noisy data used for training models due to which the efficiency of the existing models fail. In addition to these problems, the existing authors are facing issues with the dispersion of daily data, poor presentation, and the problems faced with too much or too little data information. The main objective in this undertaking is to discover a technique that choose gainful stocks ordinarily by mining the public information. To accomplish this, various models are assembled to foresee the everyday return of a stock from a lot of features. These features are built to be more dependent on the cited and outside information that is accessible before the forecast date. Numerous sorts of calculations are utilized for anticipating/forecasting. When considering machine learning, regression model is implemented. Neural networks, as a wise information mining strategy and profound learning methods are valuable in learning complex types of information by utilizing the models of regulated learning, where it progressively learns through datasets and experience. Because of high volumes of information produced in capital markets, machines would master different designs, which in turn makes sensibly great predictions. In the current proposed venture, LSTM model is utilized through RMS prop optimization for anticipating future stock estimations. Also, feed forward multi-layer perceptron (MLP) is utilized along with recurrent network to foresee an organization's stock worth by depending on its stock share price history. The cycle in the

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financial exchange is clearly with a ton of vulnerability, so it is profoundly influenced by a great deal of numerous elements. Nonetheless, the outcomes acquired show that the neural networks will outperform the existing one-dimensional models.

Keywords Algorithmic trading · Machine learning · Neural networks · Multi-layer perceptron (MLP) · Recurrent network · Overfitting models · LSTM

1 Introduction

A trader can "play" the stock exchange by utilizing the forecast models over an assessment period. The financial specialists will utilize a technique educated by the given model with which they would then be able to compare the straightforward methodology of purchasing and holding the stock over a whole period. Development of the stock market can likewise be anticipated by technical analysis [1]. The two fundamental parts of technical analysis are cost and volume, and based on that two information, the entire securities exchange can be anticipated. Stock market development is only a blend and match of mathematics and human brain science, and technical analysis is mainly about these two attributes. When the market moves positive individuals contribute expecting a further sure development, however, when little downtrend is seen individuals book benefits expecting, little produced benefits would be lost. At the point when the market goes down, individuals hold feeling that they would exit if the market falls further. They normalize it out and accordingly increment their misfortunes. The right route is to cut the misfortunes by putting right plug misfortunes and include more stocks with the benefits while keeping up following stop misfortunes.

Trading requires a ton of consideration and sensitivity to the market. Experienced brokers depend on numerous wellsprings of data, for example, news, verifiable information, yearly reports, and insiders. Risk is high and many are factors should have been thought of [2]. Hence, some financial organizations depend simply on machines to make trades. Stock value developments are to some degree monotonous in nature in the time arrangement of stock prices. The expectation highlights of the framework attempt to foresee the stock return in the time arrangement esteem via preparing the model or investigating the graphs pattern of specialized indicators, which includes delivering a yield and rectifying the mistake that implies a machine with rapid web associations can execute many trades during a day making a profit from a little distinction in prices. Machine learning in account has become more conspicuous as of late because of the accessibility of huge measures of information and more moderate computing power. It challenges existing acts of displaying and model use and drives an interest for pragmatic answers for how to deal with the intricacy relating to these techniques. Machine learning includes giving data samples to an algorithm, normally obtained from previously valid samples. The information tests consist of factors called indicators, just as target variables, which is a normal outcome. The calculation utilizes the indicator factors to foresee the objective variables. Leading

banks and other organizations are sending AI to smooth out their cycles, advance portfolios, decline risks, and guarantee advances in addition to other things.

Neural networks have been utilized progressively in various business applications, including anticipating and promoting research arrangements. In certain zones, for example, risk prediction or fraud detection, they are the unquestionable pioneers. The significant fields in which neural networks have discovered application are monetary activities, venture planning, trading, business analysis, and maintenance of products. Neural networks can be applied beneficially by a wide range of traders, so in case you are a trader and you have not yet been acquainted with neural network, this paper will take you through this technique for specialized investigation and tell you the best way to apply it to your trading style. Neural networks are cutting edge in software engineering. They are basically trainable algorithms that attempt to imitate certain parts of the working of the human mind. This gives them a remarkable, self-training capacity, the capacity to formalize unclassified data, and, above all, the capacity to make gauges dependent on the authentic data they have at their disposal. A significant confusion is that neural networks for an anticipating tool that can offer counsel on the proper behavior in a specific market circumstance. Neural networks do not make any estimates. Rather, they investigate value information and reveal openings. Utilizing a neural network, you can settle on an exchange choice dependent on completely analyzed information, which is not really the situation when utilizing customary specialized investigation strategies. For a genuine, thinking trader, neural networks are a cutting-edge device with incredible potential that can identify unobtrusive non-direct interdependencies and examples that different techniques for specialized investigation cannot reveal.

Conventional strategies, for example, logistic regression and classification, are based on linear models, while neural networks are self-changing techniques dependent on training information, so they can tackle the issue with a little information about its model and without compelling the forecast model by including any additional assumptions. Also, neural networks can discover the connection between the information and yield of the framework regardless of whether this relationship may be extremely convoluted on the grounds that they are general function approximators.

One of the major problems faced while implementing the machine learning algorithms was the overfitting problem. Overfitting refers to a model that models the training data too well. It happens when a model learns the detail and noise within the training data to the extent that it negatively impacts the performance of the model on new data [3]. This suggests that the noise or random fluctuations within the training data are picked up and learned as concepts by the model. The matter is that these concepts do not apply to new data and negatively impact the model's ability to generalize. Overfitting is more likely with nonparametric and nonlinear models that have more flexibility when learning a target function. This problem can be considerably solved using the classical and modern deep learning approach [4]. The principal objective of the venture was to consider and apply neural networks that are more productive in anticipating the cost of a stock when contrasted with many machine learning algorithms [5]. An attempt to use six learning algorithms on tata consultancy services dataset, three machine learning models consisting of support vector machine

(SVM) and linear, logistic regression versus two deep learning models including multi-layer perceptron (MLP), Elam recurrent network and long short-term memory (LSTM) is used. The paper has proposed a prescient model based on neural networks for foreseeing stock market changes. Tests show that the prediction error of this model is around 1.5%. The structure of the paper is organized thusly. Related documents and studies are presented in Sect. 2. The process of building the dataset and dataset evaluation is described in Sect. 3. In Sect. 4, it is shown how to apply linear, logistic regression and SVM, MLP, recurrent network, and LSTM for this task. The experimental stock prediction results are analyzed in Sect. 5. Conclusion and future work are deduced in Sect. 6.

2 Related Works

Paper name	Author	Advantages	Limitations	Inference
Introduction to financial forecasting [6]	1. Yaser S. Abu-Mostafa 2. Ammir F. Atiya	The linear models act well. The linear classification model and linear regression give comparative outcomes here. The regression approach and classification approach both can catch the basic differences	The supporting vector machines do not act alright. One potential explanation is that for these incredibly loud information, direct basic models can act better. SVM classifier's presentation is particularly awful	It exhibits the utilization of hints calculation for foreign trade exchanging over a time of 32 months It additionally talks about the fundamental methodology for gauging information and examines the loud idea of financial information

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Paper name	Author	Advantages	Limitations	Inference
Predicting stock market returns with machine learning [7]	1. Alberto G. Rossi	Boosted tree regression outperforms those created by benchmark models as far as both mean squared mistake and directional precision. They additionally create gainful portfolio assignments for mean-change financial specialists even at the point when market erosions are represented	Number of questions with respect to their precision as the greater part of the regressors considered are extremely diligent, making measurable deduction not exactly clear. Data snooping around might be a wellspring of concern if specialists are trying for a wide range of model particulars and report just the factually critical ones	A semi-parametric technique known as boosted regression trees (BRT) is used to gauge stock returns and unpredictability at then month to month recurrence based on enormous arrangements of molding data without forcing solid parametric presumptions, for example, linearity or monotonicity. Results recommend that the connection between indicator factors and the ideal portfolio allotment to unsafe resources is exceptionally non-straight

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Paper name	Author	Advantages	Limitations	Inference
Predicting stock prices using data mining techniques [8]	1. Qasem A Al Radaideh 2. Adel Abu Assaf 3. Eman Alnagi	The resultant classification exactness from the decision tree model is not exceptionally high for the preparation information utilized, and it fluctuates from one organization to another. Organization's presentation in the financial exchange is influenced by news about the organization, money related reports, the general presentation of the market, political functions, and political choices	The resultant classification exactness from the decision tree model is not exceptionally high for the preparation information utilized, and it fluctuates from one organization to another. Organization's presentation in the financial exchange is influenced by news about the organization, money related reports, the general presentation of the market, political functions, and political choices	To choose the better planning for purchasing or selling stocks dependent on the information extricated from the authentic costs of such stocks, choice is taken dependent on decision tree classifier . The CRISP-DM strategy is utilized over genuine authentic information of significant organizations
Neural networks, financial trading, and efficient markets hypothesis [9]	1. Andrew Skabar 2. Ian Choete	Free from data snooping. Incorporated exchanging cost of 0.1% per exchange, which is at present the estimated commission for web-based exchanging	These boot-strapped tests contain similar dispersion of day by day returns as the first arrangement, however, do not have any sequential reliance present in the first.	Centrality of the profits accomplished is finished utilizing bootstrapping strategy An exchanging technique reliant on recorded value information can be utilized to accomplish returns in a way that is better than those accomplished utilizing a purchase and hold procedure.

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Paper name	Author	Advantages	Limitations	Inference
Neural network forecasts of Canadian stock returns using accounting ratios. [10]	1. Dennis Olson 2. Charles Mossman	Neural network outperforms relating conventional regression strategies. It selects only most noteworthy, positioned stocks, or those with the most elevated likelihood of having returns	There are drawbacks from introducing either an excess of data (OLS assessment models) or too little information (binary logit models)	The backpropagation neural network, which considers non-direct connections among information and yield factors, outperforms the best regression options for both point assessment and in ordering firms expected to have either high or low returns
Artificial neural network approach for stock price and trend prediction [11]	1. Nasimul Hasan 2. Risul Islam Rasel	Two assessment measures, mean average percentage error (MAPE) and root mean square error (RMSE) and proposed models—1 day ahead, 5 days ahead, and 10 days ahead are utilized in this investigation to expand precision and limit mistake	Just windowing administrator was utilized in this research for information preprocessing step, and the examination was planned dependent on just the New York stock exchange	Artificial neural network (ANN) is utilized alongside windowing administrator which is profoundly proficient for working with time arrangement information for anticipating securities exchange cost and pattern. With his technique, it can create a reasonable outcome with a small error

3 Methodology

In the setup, the anticipation of the pattern of the stock in a particular day is attempted. Also, one can foresee the specific return of a stock in regression setup. For straightforwardness, the first attempt is using direct models as follows: classification model using the logistic regression and the regression model using the linear regression.

At that point, actualize SVM models (classifier and regression) for implementing conceivable nonlinear conventions which use kernel. Anyway, used model is dynamic instead of fixed, contingent upon the date at which a return is to be anticipated.

Analysis of regression starts with an historical dataset in which the objective qualities are known to create the valuation work. After the valuation capacities are resolved, they would then be able to be applied to the dataset as a piece of the forecast. Linear regression aims at modeling a relationship between two variables to predict a pattern. In this model, the TCS dataset is loaded and picked the target variable. Once the target variable is picked, training and validation process is performed. A specific ratio is used for this process. After this, the linear regression algorithm is used to predict the stock price. This is confirmed using the validation close and the prediction close values.

Logistic regression is a strategy for making predictions when the needy variable is polarity, and the independent factors are ceaseless and additionally discrete. The upside of logistic regression is that through the expansion of a suitable connection capacity to the typical direct relapse model, the factors may either be persistent or discrete or any mix of the two kinds, and they do not really have ordinary distributions. The stock qualities are then anticipated utilizing the produced model from the training dataset. The yield is given as a likelihood score which has range from 0 to 1. If the anticipated likelihood score is more than 0.5 in this investigation, at that point, those stocks are considered to have a rising pattern and make a benefit in future [12]. Therefore, as a result, if the stock has a high probability, go long on it.

The SVM utilizes a gaussian part and was improved over sigma and the edge classifier utilizing cross validation. The preparation of the SVM requires three boundaries: C-cost of misclassification, lambda, and a kernel [1]. When the calculation cycle begins, the information is taken care of to the model. The assessment of this model returns two vectors: the determined appropriate activity for each assessed day and the level of having a place for every one of the dissected classes (being just two: a buy or a deal). Joining these two yields restores a vector of qualities from the reach $[-1, 1]$ that assigns the chosen request for each testing day. This vector is advanced utilizing the improvement module. In the optimization cycle, it is observable that the SVM will in general have better outcomes in anticipating the down moving periods, anyway the wonders get returned in the up moving one [13].

Multi-layer perceptron neural networks are the Levenberg–Marquardt error back propagation, wherein the organization learns the variation in the informational collection and uses gradient as well as Jacobean for performance measure to legitimize loads of the networks the converse way concerning the slope vector of error work which is generally a regularized entirety of squared error [14]. It uses gradient as well as Jacobean for performance measure.

For anticipating the direction of changes of the qualities in the following day, none of these techniques are superior to the basic straight regression model. But the error of the forecast of the measure of significant worth changes utilizing MLP neural organization is less than linear regression strategy [14]. Also, when the feed forward MLP neural organization predicts the heading of the progressions effectively, the measure of progress is totally near the genuine one.

Recurrent neural networks (RNNs) unlike the multi-layer perceptron (MLP) take contributions from two kinds of sources, one is from the present and the other is from the past [1]. To prepare Elman organization, the error backpropagation with momentum and adaptive learning rate is utilized. The loads of the organization in this calculation are changed by slope (with momentum), past change in the organization loads, and learning rate [14]. Data obtained from such sources is to be utilized for displaying networks response to the fresher arrangements of input information. This is conceivable with criticism loops wherein yield at any case can be taken as a contribution to its resulting example. This implies RNN needs memory. Each contribution with its gigantic heaps of information should be put away in certain layers of RNNs. This stored information or data is recursively utilized in the organization as it will be swept forward for managing more current models.

Long short-term memory (LSTM) is just a model of recurrent neural networks; these networks are more grounded in recognizing just as learning in longer term conditions. Ordinary RNN includes a straightforward organization alongside feedback circles, while LSTM comprises memory squares or cells instead of a solitary organization layer. Each cell comprises three gates just as a cell state machine which controls information moves through such cells [1]. The LSTM model can be tuned for different parameters, for example, changing the quantity of LSTM layers, adding dropout esteem, or expanding the quantity of epochs to further identify whether the stock price will go up or down.

4 Proposed Model

In this paper, two sorts of strategies, linear regression and LSTM recurrent network, are utilized to foresee an organization's stock price dependent on its stock share value history. The test results show that the use of LSTM recurrent network is more encouraging in anticipating stock worth changes instead of linear regression technique.

The model which is proposed has a block diagram as shown in Fig. 1.

Figure 1 comprises of stacking a dataset, choosing an objective variable, preparing and approving the dataset, applying the Linear regression/LSTM recurrent network, and subsequently making the stock forecast.

Stacking the dataset is the beginning measure for this cycle. For this undertaking, tata consultancy services (TCS) dataset is utilized, considering its stock cost from November 2013 to March 2020. The dataset comprises of the accompanying credits: date, open, high, low, close, adjusted close, volume, and the normal of high and low cost of the day.

The open and close segment shows the beginning and the consummation estimation on that specific day. High and low section represents the most noteworthy and the least noteworthy which the stock has reached on that specific day. Volume segment speaks to the quantity of shares exchanged.

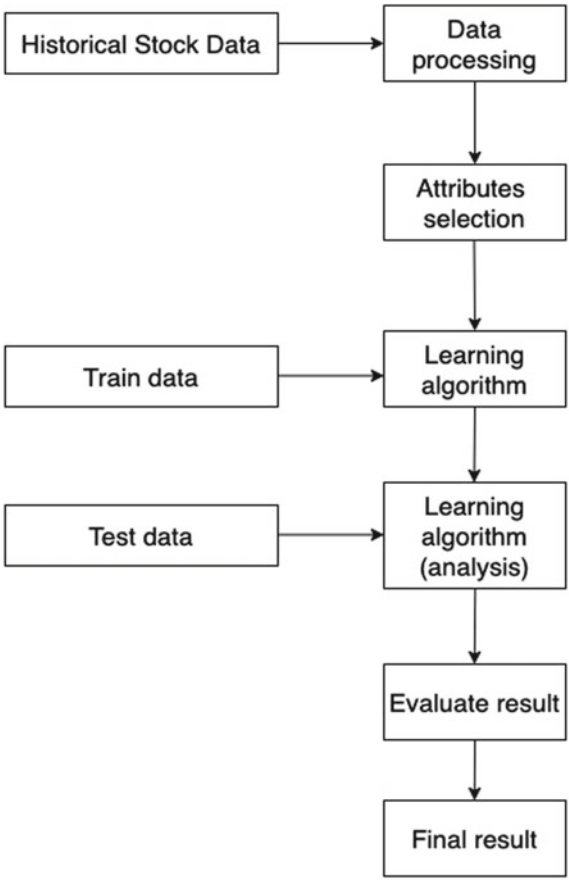

Fig. 1 Flow of proposed model

The subsequent stage is choosing an objective variable. Since all the benefit and damage count is normally founded on the shut value, close is picked as objective variable. Once the dataset is stacking and the objective variable is fixed, the dataset is prepared and approved.

The regression model returns a condition that decides the association between the independent factors and furthermore the variable quantity. The condition for regression is composed as:

$$Y = \theta_1 x_1 + \theta_2 x_2 + \cdots + \theta_n x_n$$

In the equation above,$x_1, x_2, \ldots, x_n$ represent the independent variables while the coefficients, $\theta_1, \theta_2, \ldots, \theta_n$ represent the weights. The dataset is arranged in an ascending order and afterward made a different dataset with the goal that any new component does not get influenced by the main information. After this, the linear

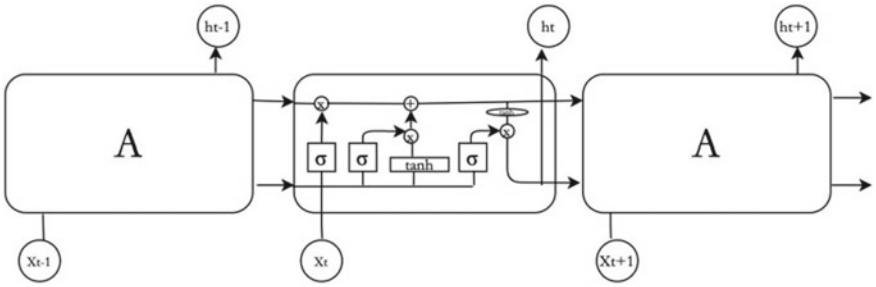

Fig. 2 Illustration of LSTM model

regression model is utilized, and forecasts are made. Presently, the subsequent model is the neural organization LSTM model for foreseeing stock cost.

Figure 2 shows the basic architecture of LSTM model which has been used in this project. Our justification is because LSTM can store past information that is remarkable and ignore the information that is not. LSTM can add or take out information to the cell state, obliged by structures called gates. Gates are used for, then again, letting information through. Passages are made of a sigmoid neural net layer and a point-wise duplication movement.

This model, LSTM has three entryways:

- The input gate: The information entryway adds data to the cell state.
- The forget gate: It wipes out the information that is not, now required by the model.
- The output gate: At LSTM, it chooses the data to be appeared as yield.

Sequential is utilized for presenting the neural organization, and this model incorporates the LSTM layer, dropout for thwarting overfitting with dropout layers, and dense to incorporate an associated related neural association layer.

For information normalization to scale the readiness dataset, estimator scale is used with numbers some place in the scope of zero and one. The LSTM layer is incorporated with the going with contentions: 50 units are the dimensionality of the yield space, whether to return the last yield in the sequence is fundamental for stacking LSTM layers, so the following LSTM layer has a three-dimensional arrangement input, and information shape is the condition of the planning dataset. To mastermind the model, the Adam optimizer is used for learning parameters and set the loss as the mean squared error. From that point forward, the model is fitted to run for 20 epochs (the ages are the events the learning count will work through the entire planning set) with a batch size of 32.

Prior to predicting future stock costs, the test set is adjusted by solidify the train set and the test set on the 0 pivot, set 60 as the time step again, use estimator scale, and reshape data. By then, inverse transform places the stock expenses in a regular significant affiliation.

Henceforth, this model is utilized to anticipate stock cost and furthermore can be tuned for different limits, for instance, changing the amount of LSTM layers, including dropout regard, or expanding the quantity of epochs.

5 Experimentation

In this project, two algorithmic models were implemented, LSTM and linear regression.

Algorithm 1 Pseudo code for algorithmic Trading using LSTM model

Input: x_train, y_train, x_test, y_test

Output: Accuracy

1. Procedure: LSTM MODEL (x_train, y_train)
2. Parameters: batchSize = 32; num_epochs = 20; verbose = 2
3. Model = Sequential ()
4. Two hidden layer Stacked LSTM-Regardless of whether to restore the last yield in the output sequence or the full sequence
   model.add(LSTM(100, return_sequences = True))
   model.add(LSTM(units = 50))
5. Dense Layers-This layer is connected to the LSTM layers of the model and is often used to output the prediction.
   model.add(Dense(1))
6. Compile Function-It is an effectiveness step. The optimizer calculation is used to prepare the organization and the loss work is used to assess the organization that is limited by the optimization calculation.
   model.compile(loss = 'mean_squared_error', optimizer = 'adam')
7. Fitting a model
8. Model Evaluation
9. End Procedure

Above is the pseudo-code for the algorithm used. The environment on which the code was run is google colab (jupyter notebook environment) in addition to the libraries sklearn and keras.

6 Result Analysis

Here, 70/30 ratio for splitting the data into training and validation set is used, that is, 70% of the data will be used to train the model, and 30% will be used to validate. More training data is essential since it implies the model sees more models and accordingly

ideally finds a superior solution. This method is adopted since the dataset used is enormous, and it covers the data for the past 7 years.

In Figs. 3 and 4, the orange line depicts the close values for the training dataset, the blue line shows the validating close values, and the yellow line depicts the predicted close value for the same validating close dataset. Linear regression is a basic method and very simple to decipher, yet there are a couple of clear hindrances. One issue in utilizing regression calculations is that the model overfits to the date and month segment. It can clearly be seen that the predicted close value for the LSTM model is much more accurate than that of the linear regression model. This can further be confirmed using the rms values for each.

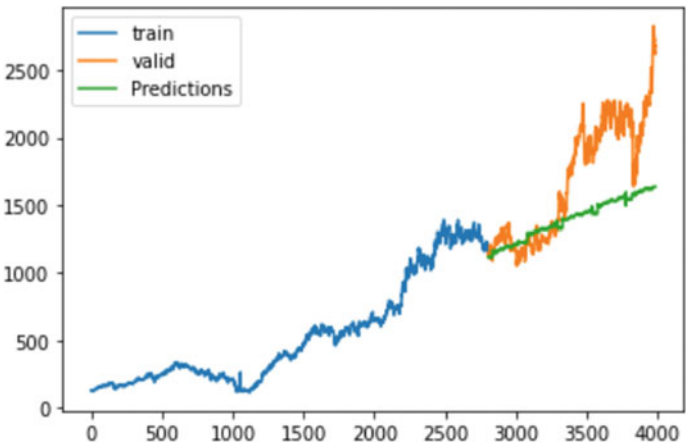

Fig. 3 Regression model prediction

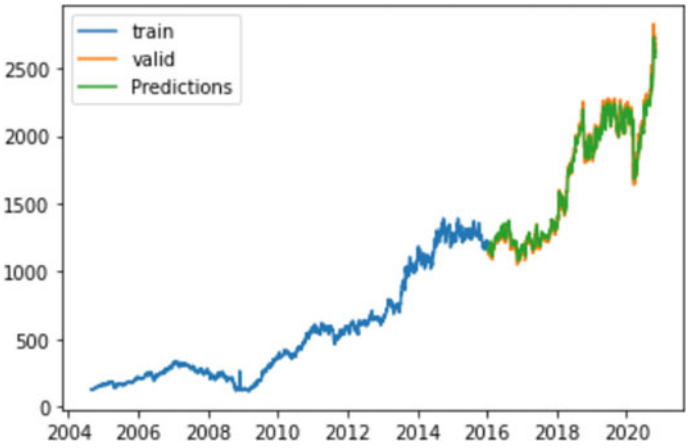

Fig. 4 LSTM model prediction

```
preds = model.predict(x_valid)
rms=np.sqrt(np.mean(np.power((np.array(y_valid)-np.array(preds)),2)))
rms
```

```
426.4024276628599
```

Fig. 5 RMS linear regression

```
rms=np.sqrt(np.mean(np.power((valid-closing_price),2)))
rms
```

```
48.66518525086109
```

Fig. 6 RMS LSTM model

Figures 5 and 6 show the root mean square of both the models. First one being the linear regression model and the second one being the LSTM model. The RMS value of the linear regression model is 426 in comparison to the 48 RMS of the LSTM model. Since, the RMS value of the LSTM model is much lesser than that of linear regression model, once again it is proved that the neural networks model is much more accurate than the linear regression model.

7 Conclusion

The proposed model considers two algorithms, which can be used for algorithmic trading, liner regression, and long short-term memory (LSTM). It has been successfully shown that the LSTM model gives promising results in comparison with the linear regression model. The major merit of this work is that major speculations in the market can be curbed down by using these algorithms. Since, the proposed model uses a machine to learn from the past data and hence it predicts the stock prices, where it can do a better job at it, as compared to humans.

8 Future Scope

Later on, an attempt to discover strategies that give more steady forecasts can be performed. The proposed research work intends to apply other recently proposed techniques of machine learning and deep learning models, which are more current in the field of AI research and professed to have great speculation capacity because of the use of enormous edge ideas. From the point of view of machine learning, it strives at blending various models on the train models with more information

consistently. From a neural network perspective, different models can be coordinated on the equivalent dataset. Moreover, subsequent to getting the outcomes from every implemented model, it may be well-demonstrated with which models are remaining as the most productive. Further, after the thorough comparison of machine learning and neural network models, it is desired to segregate and come up with sector-wise algorithms.

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Analysis on Intrusion Detection System Using Machine Learning Techniques

B. Ida Seraphim and E. Poovammal

Abstract Intrusion detection system [IDS] is a significant base for the network defence. A huge amount of data is generated with the latest technologies like cloud computing and social media networks. As the data generation keeps increasing, there are chances that different forms of intrusion attacks are also possible. This paper mainly focuses on the machine learning (ML) techniques for cyber security in support of intrusion detection. It uses three different algorithms, namely Naïve Bayes classifier, Hoeffding tree classifier and ensemble classifier. The study is performed on emerging methods and is compared with streaming and non-streaming environment. The discussion on using the emerging methods and challenges is presented in this paper with the well-known NSL_KDD datasets. The concept of drift is induced in the static stream by using the SEA generator. Finally, it is found that the ensemble classifier is more suitable for both the environments with and without concept drift.

Keywords Intrusion detection · Cyber security · Data mining · Machine learning · Naïve bayes · Hoeffding tree · Ensemble classifier

1 Introduction

With the tremendous increase in the usage of Internet, network security is remaining as the need of the hour. The traditional security techniques like firewall, user authentication and data encryption will provide the first security defence line [1]. This first line of security will not be enough to provide the required security. The second line of security is recommended and that can be provided by the intrusion detection system (IDS). The combination of these two lines of security enhances the overall network security.

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An intrusion detection system (IDS) is a device or software that is used to detect or monitor the existence of an intruder attempting to breach the network or a system [4]. The security and the communication of digital information in a secure manner are more important due to the tremendous growth and usage of the Internet. The major issue of the industry, government and commerce worldwide is the intrusion. An IDS that provides a fast and precise alert to the intrusion is the need of the hour.

Security information and event management (SIEM) system centrally collects and alerts the network administrator about the malicious activities or policy violations. An IDS monitors the network or system for the intrusion. The output is combined using SIEM from multiple sources, and the false alarm filtering method is used to differentiate between malicious attack and false alarm.

Intrusion detection system scope ranges from simple antivirus software to hierarchical systems that monitor the entire network's traffic. An IDS is classified into two types based on architecture as a host-based intrusion detection system (HIDS) or network-based intrusion detection system (NIDS) [4]. HIDS identifies intrusion by analysing system calls, application logs and file system modifications. NIDS identifies intrusion by analysing and examining network traffic, network protocols and network data for suspicious activities. Based on the detection mechanism, an IDS can be classified into two types as anomaly-based IDS and signature-based IDS. Signature-based detection identifies the attack by observing the patterns, signatures and comparing those patterns and signatures with the already stored signatures. A signature is a pattern that describes the attack or exploits that are well known [3]. The new signatures need to be updated regularly in the databases. The signature-based detection technique is not suitable for novel attacks.

Anomaly-based detection identifies malicious events by finding the deviation of the monitored traffic from the normal profile. The previously unseen (legitimate) system behaviours may be considered anomalies because there is an increase in the false alarm rate (FAR). This is the main weakness of the anomaly-based detection technique. Three main limitations contribute to network security challenges [2]. 1. The volume of the network data is huge. 2. Monitoring must be in-depth to improve efficacy and accuracy. 3. The diversity of data navigating through the network, and the number of different protocols is used. Figure 1 shows the basic workflow carried on to detect the intrusion in the data.

The NSL_KDD dataset is taken for the analysis. It is the benchmark dataset taken from Canadian institute of cyber security. The dataset has 41 attributes, and the final attribute is the class attribute that shows whether the instance is normal or anomaly. The dataset is uploaded to the massive online analysis framework, and the whole dataset is split into test and train data. Then, the chosen machine learning techniques are applied in non-steaming and streaming environment. In streaming environment, the algorithms are applied to stream with and without concept drift. Finally, the performance measure like accuracy, kappa and time is evaluated.

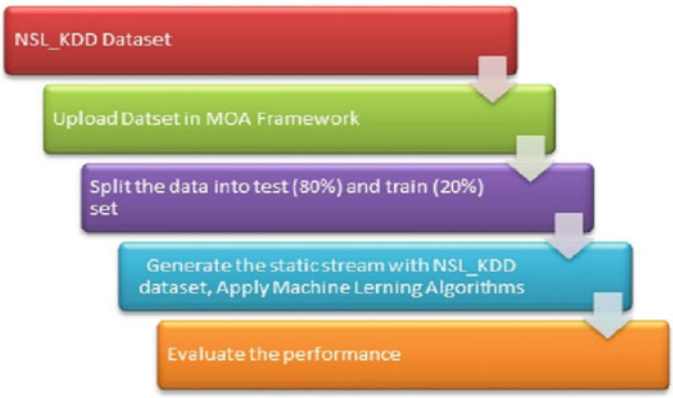

Fig. 1 Basic workflow diagram

2 Related Work

The main aim of an intrusion detection system (IDS) is to find the abnormal behaviours inside and outside the network.

Authors	Title of the paper	Algorithms used	Dataset	Remarks
Asmah Muallem et al. (Jounal of Information Security, 2017)	Hoeffding Tree Algorithms for Anomaly Detection in Streaming Datasets: A Survey	Hoeffding tree Restricted Hoeffding tree Accuracy Updated Ensemble	KDD Cup'99 NSL-KDD	Handling anomalies in stream environment [10]
Prof. Dr. P. K. Srimani et al. (Wseas Transactions on Computers, 2016)	Mining Data Streams with Concept Drift in Massive Online Analysis Framework	Naïve Bayes classifier	Synthetic dataset generator algorithms Benchmark dataset electricity, airline and forest cover dataset.	Naïve Bayes gives less accuracy. Kappa values are less, and time consumption is more [16]

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Authors	Title of the paper	Algorithms used	Dataset	Remarks
Preeti Mishra et al. (IEEE Communication Surveys & Tutorials, 2018)	A Detailed Investigation and Analysis of using Machine Learning Techniques for Intrusion Detection	Decision Tree ANN Naïve Bayes Classifier SVM Genetic Algorithm.	NSL-KDD	Challenges 1. Requires lot of data for training and classification 2. Complexity in training huge amount of data 3. High performance hardware required for training [4]
Yasir Hamid et al. (International Journal of Network Security, 2018)	Benchmark Datasets for Network Intrusion Detection: A Review	K-NN Classifier	Full KDD99, Corrected KDD, NSL-KDD, 10% KDD, UNSW, Caida, ADFA Windows, UNM Dataset	Ensemble algorithms can still improve the accuracy [17]
Ketan Sanjay Desale et al. (IEEE International Conference on Computing Communication Control and Automation, 2015)	Efficient Intrusion Detection System using Stream Data Mining Classification Technique	Accuracy weighted Ensemble Naïve Bayes Hoeffding Tree Accuracy Updated Ensemble	NSL-KDD	1. Hoeffding Tree gives less accuracy in less time. 2. Accuracy Weighted Ensemble gave high accuracy but took more time [8]
Ngoc Tu Pham et al. (ACMW, Brisbane, Australia, 2018)	Improving Performance of Intrusion Detection System using Ensemble Methods and Feature Selection	Bagging and Boosting combined with tree-based algorithms (such as J48, Random Forest, Random Tree, REPTree	NSL-KDD	1. Single dataset was used to evaluate the classifiers. 2. Accuracy can be improved further [7]
Lidong Wang (Journal of Computer Networks 2017)	Big Data in Intrusion Detection System and Intrusion Prevision System	Reviewed different data mining and machine learning techniques	KDD Cup'99	Biggest challenge is the Real time monitoring [18]

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Authors	Title of the paper	Algorithms used	Dataset	Remarks
Kai Peng et al. (Special Section on Cyber Physical Social Computing and Networking, IEEE Access, 2018)	Clustering Approach Based on Mini Batch K-means for Intrusion Detection System Over Big Data	K-Means Mini Batch K-means	KDD Cup'99	1. K-means cannot effectively determine which K value is best. 2. PMBKM – effective when both K value is small and big [6]

3 Machine Learning (ML) Techniques

There are two different categories of machine learning (ML) techniques, namely supervised and unsupervised learning. Supervised learning is that in which labelled instances are used for training the model. Supervised learning uses an input variable (x_1) and an output variable (y_1), and it uses a classification algorithm to learn the mapping function between input and output [9]. Equation 1 shows the mapping of the input and output function.

$$y_1 = f(x_1) \tag{1}$$

Supervised learning problems are further classified into classification and regression problems. Classification models are those in which the class label is known. The classification model tries to learn the inference from the set of labelled instances used for training. The classification models are trained with the labelled instances; the new instances' class is predicted using that trained model when a new instance comes. Naïve Bayes algorithm and random forest are some of the examples of classification algorithms.

Another category of the machine learning algorithm is the unsupervised learning technique. In unsupervised learning, training takes place in the unlabelled data. Unsupervised learning uses only the input variable (x_1), and it has no corresponding output variable [9]. Based on the similarity of patterns, the outcome is predicted. Clustering is a kind of unsupervised learning technique. K-means algorithm and DBSCAN algorithm are some of the examples of unsupervised learning algorithms.

3.1 Classification Techniques

Classification is a supervised learning algorithm. Naïve Bayes algorithm and Hoeffding tree algorithm are some of the supervised learning algorithms that are used for the comparison in streaming and non-streaming environment. The classification model tries to learn the inference from the set of labelled instances used for training. The pre-trained model is used to predict the class label of the new instance.

3.2 Naive Bayes Classifier

Naïve Bayes algorithm is a kind of supervised machine learning classifier. It is the simplest and the popularly used classifier algorithm that is based on Bayes theorem. Naïve Bayes classifier assumes the occurrence of a particular feature in a class that is completely independent of the presence of any other feature. Naïve Bayes classifier is very simple and easy to build, and it is mainly very useful for larger datasets. It is called Naïve because it simplifies the assumptions on the attributes. The Naïve Bayes algorithm is called a probabilistic algorithm, and it is given by Eq. (2).

$$p\left(\frac{c_j}{x_j}\right) = \frac{p(x_j/c_j)p(c_j)}{p(x_j)} \tag{2}$$

$p\left(\frac{c_j}{x_j}\right)$ = Posterior probability gives the probability of c_j occurring when given the evidence that x_j has already occurred.

$p(c_j)$ = Prior probability of the class means that probability that c_j occurs.

$p\left(\frac{x_j}{c_j}\right)$ = Prediction probability of a class means that probability of x_j occurring given the evidence that c_j has already occurred.

$p(x_j)$ = prior prediction probability of a class means that probability that x_j occurs.

The error rate in the Bayes classifier is comparatively low when compared to other sophisticated models.

3.3 Hoeffding Tree Classifier

Hoeffding tree classifier is a kind of decision tree classifier. The decision tree algorithm is the most widely used algorithm. A decision tree is a tree structure that contains a root node, branches and leaf node that is used to predict the unlabelled instances. Hoeffding tree classifier is an incremental decision tree classifier that is capable of handling the massive data streams. In the traditional decision tree, the entire dataset is scanned to find the splitting criteria.

In the Hoeffding tree algorithm, instead of looking into the previously-stored instances, it waits and receives enough instances and then decides the splitting criteria for the root node [10]. Hoeffding tree entropy is given by Eq. (3)

$$\varepsilon = \sqrt{\frac{R^2 \ln / \delta}{2n_i}} \tag{3}$$

The parameter R is the range of the random variable, δ is the desired probability of the estimate not being within ε of its expected value and n is the number of instances collected at the nodes [15].

3.4 Ensemble Classifier

Ensemble learning is used to improve the efficiency of the machine learning techniques by combining several base learners. This model gives a better efficiency when compared to the single classifier models. The ensemble technique is a kind of meta-algorithms that combines several ML techniques into a single predictive model that is used to decrease the variance, bias, and to improve the prediction accuracy of data [13]. The ensemble classifiers come under any one of the two categories, such as bagging or boosting. Resampling techniques are used to get different training samples for each classifier [14]. Bagging uses the concept of bootstrap samples, so it is named bootstrap aggregating. Bagging is used to generate multiple classifiers that are independent of one another [14]. In contrast, boosting assigns weights to the samples generated by the training dataset. Figure 2 shows the generalized ensemble model.

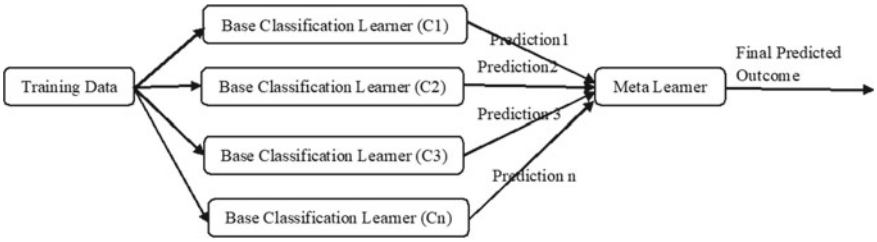

Fig. 2 General ensemble classifier model. *Source* Wikimedia Commons

4 Attack Type Classification

Network and host-based attacks are becoming more prevalent nowadays. Hackers try to bypass security by misusing the already existing weaknesses in the network. The hackers disturb the network's normal functioning by sending a huge number of packets that floods the network, and they scan the network for vulnerabilities [4]. The attacker tries to find out the vulnerability in the network protocols or security devices like firewalls, intrusion detection systems and access to the network. The attackers can access the network or a host system by using sophisticated tools such as Nmap, Scapy, Metasploit, Net2pcap, etc. [4]

4.1 Data Description

The dataset used for the analysis is the NSL_KDD dataset, the extended version of the KDD CUP 99 dataset. In the NSL_KDD dataset, all the duplicates are removed. Figure 3 shows the taxonomy of attack classification. This NSL_KDD dataset contains 41 features, of which 10 features are basic, while the next 12 features are called content features, and the rest 19 features are called traffic features [11].

Table 1 gives name of the attack and corresponding type of attack that are present in the NSL_KDD dataset based on the categories. Even though there are four different categories of attacks, namely denial of service (DOS) attack, probe attack, user to root (U2R) attack and remote to local (R2L) attack [12]. The NSL_KDD dataset has only two classes, normal or anomaly. The anomaly class encompasses the instances from all the four categories of attack.

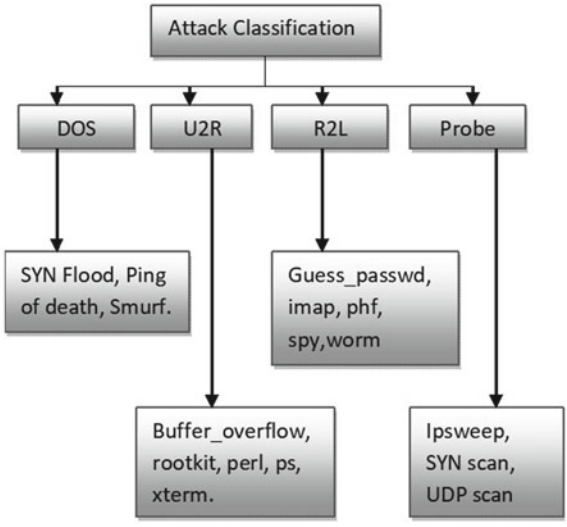

Fig. 3 Taxonomy of attacks. *Source* Preeti Mishra [4]

Table 1 List of attack based on attack categories

Name of the attack	Type of attack
back	DOS attack
buffer_overflow	U2R attack
ftp_write	R2L attack
guess_passwd	R2L attack
imap	R2L attack
ipsweep	Probe attack
land	DOS attack
loadmodule	U2R attack
multihop	R2L attack
neptune	DOS attack
nmap	Probe attack
perl	U2R attack
phf	R2L attack
pod	DOS attack
portsweep	Probe attack
rootkit	U2R attack
satan	Probe attack
smurf	DOS attack
spy	R2L attack
teardrop	DOS attack
warezclient	R2L attack
warezmaster	R2L attack

4.2 Denial of Service (DOS) Attack

DOS attack makes the resources unavailable to the legitimate users by denouncing access to the information or services provided [5]. For example, a hacker can send several requests to access a specific resource or any running service instance. The server is flooded with several service requests and fails to offer genuine users the needed services. Smurf attack, ping to death attack, mail-bomb and SYN flood attack are examples of DOS attacks [4].

4.3 Probe Attack

Probe attack on scanning gets to know the information about the network or a system. A probe attack is also called a scanning attack. Probe attack is one of the major issues in cyber security. The attacker uses the known vulnerabilities and sends a

large volume of scan packets to gain complete information about a network or a host. The attacker uses specialized tools such as Nmap, satan, saint, etc., to gain the information [4]. Depending on the way of gathering information, scanning can be active scanning or passive scanning. Ipsweep, SYN scan, UDP scan and reset scan are some of the examples of probe attacks.

4.4 User to Root (U2R) Attack

User to root attack in which the exploits are used to gain the root access to the system by the unprivileged local user. Buffer overflow attack, Ffbconfig attack, Perl attack and Rootkits are some of the examples of the user to root attack. Rootkits give a hidden way for the hackers to escape the root privileges provided by the system. Rootkits allow hackers to hide suspicious processes by installing software, namely sniffer, keylogger, etc. [4]

4.5 Remote to Local (R2L) Attack

Remote to local attack uses the group of exploits to get unauthorized access to the local machines. There are many ways in which the attacker gains legitimate privilege to the system. Dictionary/Guess password attack, FTP write attack, Xlock attack and Imap attack are some of the examples of remote to local attack [4].

5 Performance Evaluation

The algorithm's efficiency is measured using the performance measures like accuracy, precision, recall, and false alarm rate (FAR). An instance in an intrusion detection system can belong to either normal or anomaly. The confusion matrix is an N by N matrix used to measure the efficiency of machine learning classification models. The N specifies the number of instances in target classes. The actual targeted values are compared with the values predicted by the machine learning models. Figure 4 displays the confusion matrix used for the performance evaluation of the classification techniques.

The confusion matrix is given by four different values like true positive (TP), false positive (FP), false negative (FN) and true negative (TN).

True Positive (TP): It is the number of actual attack instances that are appropriately classified as attacks.

False Positive. (FP): It is the number of normal instances that are wrongly classified as an attack.

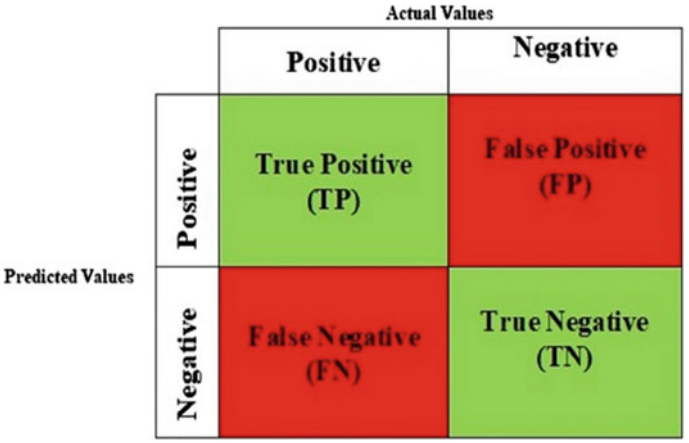

Fig. 4 Performance evaluation using confusion matrix. *Source* Analytics Vidhya

True Negative (TN): It is the number of normal instances that are appropriately classified as normal.

False Negative (FN): It is the number of attack instances that are wrongly classified as normal.

Accuracy (A)

Accuracy is one of the performance measures used in machine learning techniques. Accuracy tells the number of instances correctly classified as normal or anomaly by an algorithm. Accuracy is given by Eq. (4).

$$A = \frac{\mathrm{TP} + \mathrm{TN}}{\mathrm{TP} + \mathrm{FP} + \mathrm{TN} + \mathrm{FN}} \tag{4}$$

Precision (P)

Precision is one of the performance measures used in machine learning techniques. Precision tells how many of the correctly predicted instances actually turns out to be positive. Precision is given by Eq. (5)

$$P = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FP}} \tag{5}$$

Recall (R)

A recall is also one of the performance measures used in machine learning techniques. Recall tells how many of the actual positive cases can be predicted correctly by the model. The recall is given by Eq. (6)

$$R = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{6}$$

False Alarm Rate (FAR)

False alarm rate is also one of the performance measures used in machine learning techniques. FAR tells how many correct instances are classified incorrectly as malicious instances. FAR is given by Eq. (7)

$$\text{FAR} = \frac{\text{FP}}{\text{FP} + \text{TN}} \tag{7}$$

6 Analysis of Machine Learning (ML) Techniques Performance on Intrusion Detection

The experiment is performed using the NSL_KDD benchmark dataset. The experiment is performed using the massive online analysis (MOA) framework, an open-source framework written in JAVA. MOA is mainly used to handle large data streams. MOA is mainly used to perform the analysis of static and dynamic data streams. The machine learning algorithms like Naïve Bayes and Hoeffding tree algorithm are used for the analysis. The performance of these algorithms is compared in both streaming and non-streaming environment. The performance metrics like accuracy, time and kappa values are compared, and inference is drawn.

The NSL_KDD dataset contains four different categories of attacks. All these categories are classified under a class called an anomaly, and another class is called normal. Figure 5 shows the number of instances under the normal and anomaly class. From the figure, it is clear that there is a balance between the normal and anomaly instances. This shows that the dataset used is not biased.

The heat map is the two-dimensional matrix representation of information. The colours are used to represent that information. A heat map is mainly used to represent both simple and complex information. The heat map helps visualize values concentration in finding the patterns and getting a deep perspective about the instances. The heat map is generated for all the feature variables. This is a powerful way to visualize the relationship between the variables in the high-dimensional space. Figure 6 shows the correlation heat map of the NSL_KDD dataset. This shows the relationship between the feature variables that are present in the NSL_KDD dataset. Darker colour takes higher values, and lighter colour takes lower values. This shows the correlation among the features in the dataset. The values in the heatmap range from -1 to 1. The value is close to 1 when the features are highly correlated, and value close to -1 shows the features are less correlated. The negative values in the heatmap show the features are negatively correlated, and the positive values are positively correlated. As the colour intensity increases that shows how strongly the variables

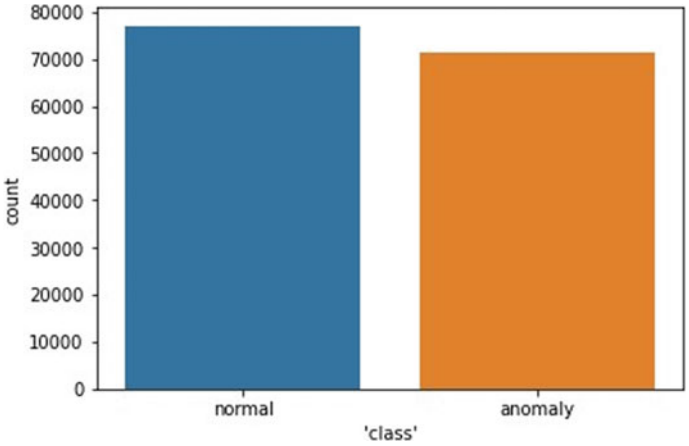

Fig. 5 Counts of normal and anomaly instances of a dataset

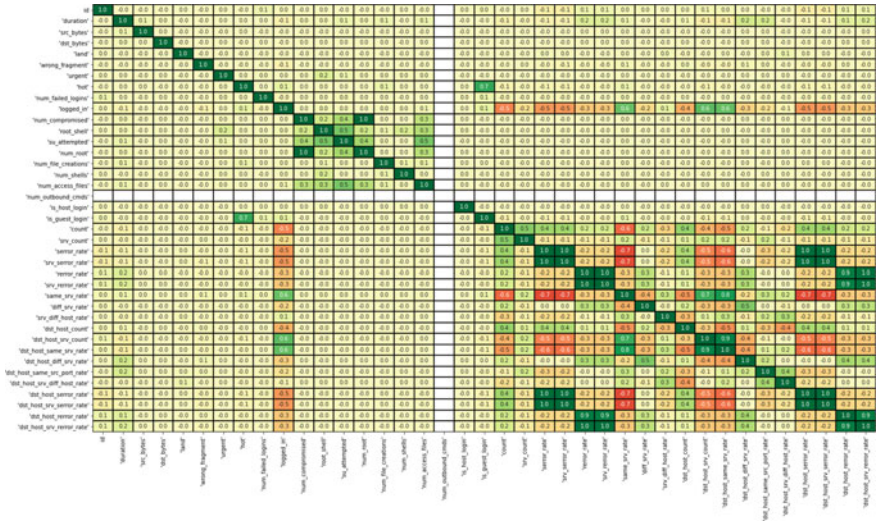

Fig. 6 Heat map of NSL_KDD dataset

are correlated either it can be positively or negatively corelated. In Fig. 6, the feature 'num_outbound_cmd' shows empty white boxes with no values this means that removing this feature has no impact on others. The diagonal values of the matrix carry 1 except 'num_outbound_cmds and there are correlations between the same columns. Thus, from the heatmap, it is more evident that all the features are important in constructing the model.

The experimental setup uses the NSL_KDD dataset in a non-streaming and streaming environment. The static stream is generated using the MOA framework.

MOA is an open-source GUI-based framework designed in JAVA [15]. MOA handles stream data from static and evolving data streams. The comparison is made with three different categories of algorithms. The Naïve Bayes classifier is a probabilistic classifier, Hoeffding tree is a kind of decision tree classifier, and the Ensemble classifier. The whole dataset is divided into an 80:20 ratio. 80% of the data is used for training, and 20% of the data is used for testing. The algorithms are applied for the static dataset, static stream with and without concept drift. The comparisons are made based on performance generated by these algorithms. Figure 7 shows the sample screenshot of MOA environment that runs task concurrently and compares the results. MOA displays the results at the bottom of the GUI. It compares two different tasks. The red colour represents the current task, and blue colour represents the previous task.

The first scenario in which the accuracy of the dataset is compared between the three algorithms. It is found that the Hoeffding tree gives consistent accuracy in all three environments. From the graph in Fig. 8, it is clear that even in the streaming environment with concept drift, Hoeffding tree algorithm adapts to the change in the data and gives good accuracy. On the other hand, Naive Bayes performs well in the

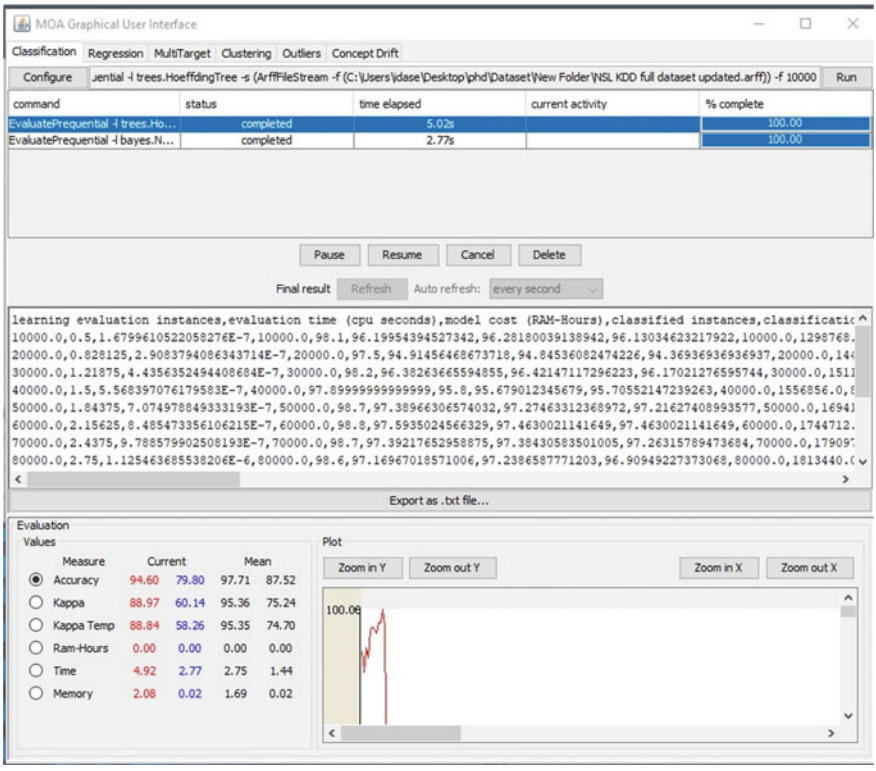

Fig. 7 Snapshot of sample MOA framework

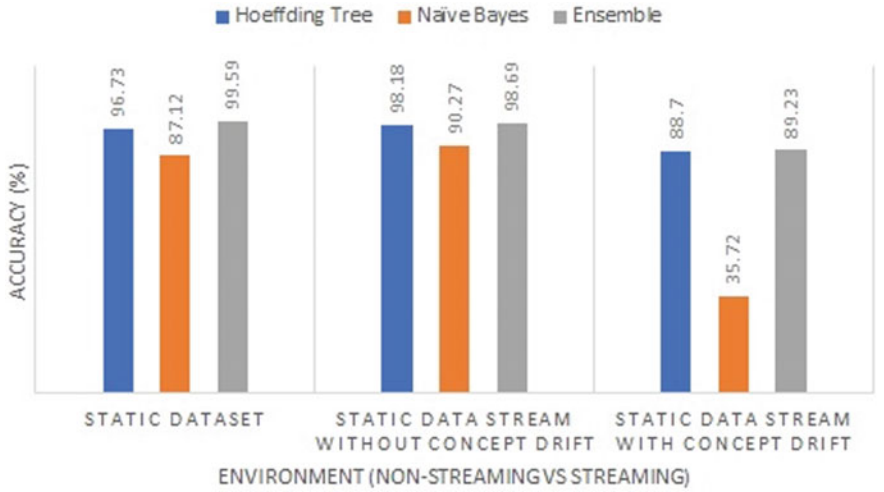

Fig. 8 Accuracy in streaming and non-streaming environment

first two environments, but when the concept drift is induced in the static stream, it cannot withstand and adapt to the change. The detection accuracy of the Naïve Bayes classifier in the drifting stream gets drastically decreased. Compared to the Hoeffding tree and Naïve Bayes, ensemble classifiers give the highest accuracy in both streaming and non-streaming environments. This shows that ensemble classifiers are more suitable for stream data with and without concept drift. Figure 8 and Table 2 show the accuracy percentage obtained in both streaming and non-streaming environment. Table 2 shows that in a streaming environment with concept drift, the accuracy of Naïve Bayes is drastically reduced to 35.72%. This shows Naïve Bayes classifier is not able to adapt to the sudden changes that take place in the data. Hoeffding tree classifier and the ensemble classifier can adapt to the change and produce the detection accuracy of 88.7% and 89.23%. Even though the Hoeffding tree and ensemble classifier adapt to the drift, it gives more accuracy in the streaming environment without drift.

The second scenario in which the dataset time is taken to evaluate the instances is compared using three different algorithms: Hoeffding tree, Naïve Bayes and ensemble classifier. Figure 9 shows that the ensemble classifier takes more time

Table 2 Accuraccy percentage in three different environment

Accuracy (percentage)	Static dataset	Static data stream without concept drift	Static data stream with concept drift
Hoeffding tree	96.73	98.18	88.7
Naive bayes	87.12	90.27	35.72
Ensemble	99.59	98.69	89.23

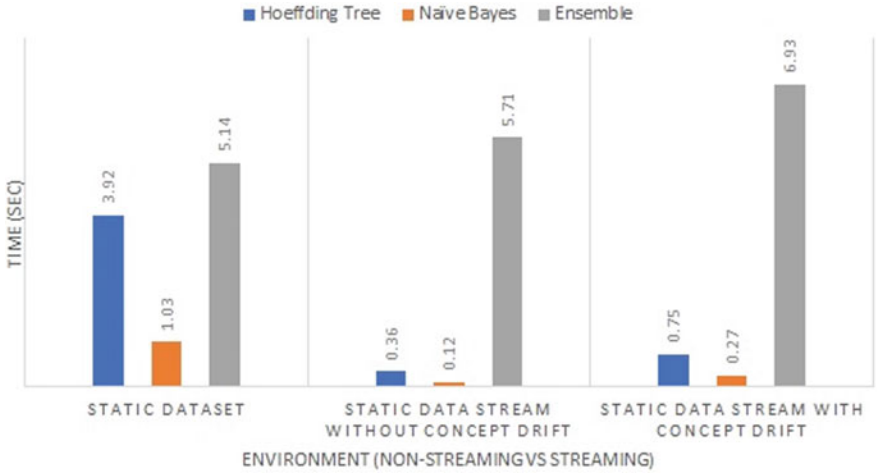

Fig. 9 Time taken in non-streaming and streaming environment

than the Naïve Bayes algorithm and the Hoeffding tree algorithm. Ensemble classifiers use multiple algorithms and generate predictions that are combined to make the final prediction. It replaces the worst performance classifier and replaces it with a new classifier to improve the performance. Secondly, the Hoeffding tree takes more time because it is a kind of incremental algorithm. It waits for enough instances to perform the classification. Figure 9 and Table 3 show the time taken in the non-streaming and streaming environment. Table 3 shows that the Naïve Bayes classifier takes less time to give its outcome in all three environments. The ensemble classifier takes a maximum of 6.93 s in a streaming environment with concept drift. Naïve Bayes and Hoeffding tree classifier take 0.27 and 0.75 s. It is evident that ensemble classifier takes more time for computation but gives more detection accuracy.

In the third scenario, the dataset is taken, and the kappa value given by the three different algorithms in both the environments are compared. From Fig. 10, it is found that the ensemble algorithm gives more kappa value when compared to other algorithms. It shows that the agreement level between the raters is more in the ensemble classifier algorithm. When the accuracy is more automatically, the kappa value produced increases. In the Naïve Bayes classifier, the kappa value is zero. When the Kappa value is zero, it is obvious that there is no agreement among the

Table 3 Time taken in three different environments

Time (S)	Static dataset	Static data stream without concept drift	Static data stream with concept drift
Hoeffding tree	3.92	0.36	0.75
Naive bayes	1.03	0.12	0.27
Ensemble	5.14	5.71	6.93

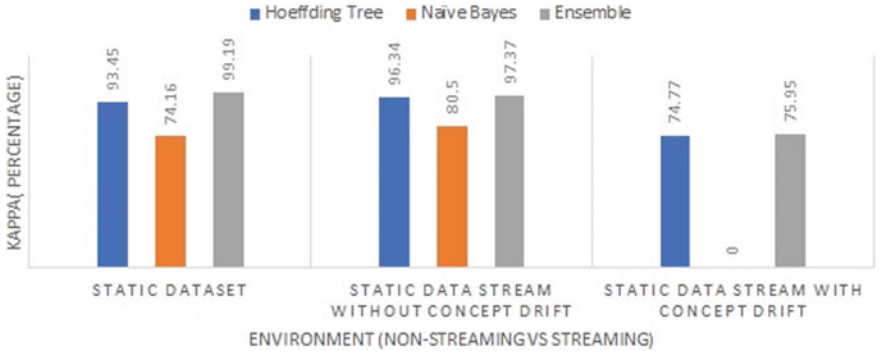

Fig. 10 Kappa value in non-streaming and streaming environment

Table 4 Kappa values in three different environment

Kappa (percentage)	Static dataset	Static data stream without concept drift	Static data stream with concept drift
Hoeffding tree	93.45	96.34	74.77
Naive bayes	74.16	80.5	0
Ensemble	99.19	97.37	75.95

raters. Naïve Bayes' accuracy gets drastically reduced; thereby, it reduces the kappa values. If the kappa value is less than or equal to zero, there is no adequate agreement among the raters. Figure 10 and Table 4 show the kappa value given by the three algorithms in all three environments. Table 4 shows that Naïve Bayes classifier kappa values are less in all three environments than the Hoeffding tree and ensemble classifier. It is very clear from the table that Naïve Bayes produces zero in a streaming environment with concept drift. This shows that as the accuracy reduces drastically, the kappa value also reduces. Zero kappa values show that there is no agreement between the raters. Kappa values produced by the Hoeffding tree and ensemble classifier in the drift stream environment are 74.77 and 75.95%. Kappa value is more in non-streaming and streaming environments without concept drift. If the kappa value is less than 60%, it indicates an inadequate agreement among the raters.

7 Conclusion

This paper discusses the performance of three different algorithms that are used in three different environments like non-streaming, streaming with concept drift and streaming without concept drift. The Naïve Bayes classifier is a kind of probabilistic classifier. The Hoeffding tree classifier is the kind of decision tree incremental classifier and ensemble classifiers. The three different classifiers used for the comparison

found that ensemble classifiers give consistent performance in all three environments than other algorithms. The time consumed to give the outcome is more in ensemble classifiers. The competitive study shows that the Naïve Bayes classifier, the probabilistic classifier, is not suitable for the streaming environment with concept drift. This means that the Naïve Bayes classifier cannot adapt to the changes induced in the concepts. On the other hand, Hoeffding tree and ensemble classifiers can adapt to the concept drift induced in the stream. The concept drift is induced in the static stream by using SEA generator. Thus, from the competitive study is performed, ensemble classifiers are found to be more suitable in non-streaming and streaming environments. Though ensemble classifier is more suitable in all the tree environment, still the detection accuracy in drift stream is less. In future, the detection accuracy in drift stream environment can be improved.

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Content Related Feature Analysis for Fake Online Consumer Review Detection

Dushyanthi Udeshika Vidanagama, Thushari Silva, and Asoka Karunananda

Abstract Due to the advancements of Internet, majority of people will prefer to buy and sell the commodities through e-commerce websites. In general, people mostly trust on reviews before taking the decisions. Fraudulent reviewers will consider this as an opportunity to write fake reviews for misleading both the customers and producers. There is a necessity to identify fake reviews before making it available for decision making. This research focuses on fake review detection by using content-related features, which includes linguistic features, POS features, and sentiment analysis features. Ontology-based method is used for performing the aspect-wise sentiment analysis. All the features of reviews are calculated and incorporated into the ontology, and fake review detection is also accelerated through the rule-based classifier by inferencing and querying the ontology. Due to the issues related with labeled dataset, the outliers from an unlabeled dataset were selected as fake reviews. The performance measure of the rule-based classifier outperforms by incorporating all the content-related features.

Keywords Ontology · Rule-based classifier · Outliers · Content-related features

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1 Introduction

With the vast advancements of Internet, majority of people are preferring online shopping. As there is no limitation or user restriction over the Internet and E-commerce, anyone can do buying and selling through e-commerce websites and write opinions against the products/services itself. These opinions highlight positive or negative aspects of online product/services which can be used for further purchasing decisions and product improvement decisions. But most of the time people do not read the whole reviews, but just look at the individual rating, overall rating or aspect-wise summaries of the particular product/service. Hence, people are highly focused on automatic analysis of reviews by deploying sentiment analysis rather than manual reading.

Sentiment analysis is very essential for producers and service providers as it monitors the reviews for numerous aspects, which led them to enhance product quality and service improvements. Some fraudulent reviewers consider this as an opportunity to write fake/spam reviews for misleading customers and producers as those will affect the sentiment produced by the reviews. Fraudulent reviewers may write fake positive reviews to promote or fake negative reviews for demote product's reputation. Customers may get negative impression on product/services if they were deceived by fake reviews. Henceforth, it is very essential to detect fake reviews before applying sentiment analysis techniques. This research uses the terms 'opinion spam,' 'fake reviews,' and 'spam reviews' interchangeably. The fake review detection can be considered as a significant process of sentiment analysis. It is a challenging task which has a close relationship with sentiment analysis.

The reviewers can express their opinions within the body of the review as well as they can express the overall sentiment about the product/service as a rating. But most of the time, the rating does not clearly represent the sentiment orientation of the review. It is argued that user rating should consistent with the tone of the review text published by the same user [1]. According to the observations regarding the rating score, the content of the reviews indicated the existence of large number of reviews whose rating and the sentiment score are inconsistent [2, 3]. Therefore, it can be argued that the content of the review is more important than the rating of the review. The major contribution of this paper is to incorporate sentiment orientation and sentiment of the reviews along with some other review content-related features for fake review detection. Although there are different methods for deceptive review detection, this research mainly focuses on sentiment orientation and sentiment of the review. So, it is important to find the sentiment orientation and total sentiment of the reviews using feature-based sentiment analysis methods.

The rest of the paper is organized as follows. Section 2 discusses the related research work in the area of fake review detection. Section 3 includes the proposed approach of feature-based sentiment analysis method for fake review detection. Section 4 includes the experiment and evaluation of the fake review detection method on the Amazon unlocked mobile review dataset. Finally, Sect. 5 concludes the paper with conclusion and future research directions.

2 Related Work

The sentiment analysis is to represent the attitude of the reviewer with respect to a certain aspect or overall polarity of the review. The basic task of sentiment analysis is to categorize the polarity of the review at sentence level, document level, or aspect/feature level into positive, negative, or neutral [4]. The aspect level sentiment analysis considers the related aspects of each sentence and determines the overall polarity of the review. Features or its synonyms are explicit features, while the implicit features are not directly appear in the review, but may contain some aspect about the product. Ngoc [5] used a conditional probabilistic model combined with the bootstrap technique to extract important aspect words. The core aspects are then enlarged by inserting words that have high probability to appear in the same sentences that they occur. Fang and Zhan [6] proposed the sentiment polarity categorization by negation phrase identification and sentiment score computation. The sentiment polarity categorization was performed at sentence level and review level. The sentiment score of sentiment phrases was calculated based on the number of occurrences of each sentiment token in each star rating separately. Zhang et al. [1] also used aspect-based sentiment analysis method where the aspects of the products are grouped into categories. The semantic-based method was used to identify explicit aspects, and point-wise mutual information (PMI)-based statistical method was used to identify the implicit features by calculating the co-occurrence frequency of potential feature and actual feature. Apart from these methods, some research work used ontology-based methods for feature level sentiment analysis [7–9].

Since all the reviews are not genuine, it is essential to detect fake reviews before having the sentiment analysis and summarization. The review spams are categorized into three types including untruthful reviews (type 1), brand only reviews (type 2), and non-reviews (type 3) [10]. Generally, the non-reviews contain unwanted content such as advertisements, links, email addresses, phone numbers, prices, etc. The high percentage of entities from brand only reviews belong to product name, manufacturer name, distributer, country names, etc. The type 2 and type 3 kind of spam reviews can be easily detected and remove before the summarization. The type 1 kind of untruthful reviews need to be analyzed carefully for identification. This research focuses on detecting all the three types of fake reviews before making the sentiment summary.

The review content-related features, reviewer behavior applied using machine learning techniques, and lingustic patterns are used by using supervised learning algorithms [11]. Rout et al. [12] demonstrated how the popular semi-supervised learning approaches such as expectation maximization algorithm, co-training algorithm, label propagation, and this used for the linguistic applications. For unsupervised learning methods [13, 14] used Bayesian clustering method in which their model adopted the spamming degress of authors and reviews using latent spam model (LSM). Further, [15] used the unsupervised K^{th} nearest neibour (KNN) method, and this method mainly focused on the detection review outliers and its features. Apart from these machine learning approaches, Wang et al. [16] used review graph-based approach which helps to capture the fake reviews.

Further [17] introduced an approach that maps the singleton review spam detection problem to an abnormally correlated temporal pattern-detection problem. Li et al. [18] also considered meta-data patterns, both temporal and spatial when detecting untruthful reviews. Apart from these methods, some authors used outlier detection methods to categorize the reviews as spam or truthful [12, 19].

Feature extraction is always considered as a critical step in the process of identifying opinion spam. The effectiveness and accuracy of any algorithm depend on the input features provided to that algorithm [20]. Many authors investigated for linguistic features, POS styles, writing patterns when detecting deceptive reviews [21–23]. Apart from linguistic features, most of the researchers proposed spam detection by incorporating rating deviation, content similarity, and inconsistency among rating and the sentiment [3, 24, 25].

Most of the supervised and semi-supervised approaches used for fake review detection may have the following limitations [26]. Firstly, the manual labeling dataset with fake and non-fake reviwes always cannot be considered as authentic. Secondly, the scarcity of labeled spam review data for model learning. Also it was proved that fake reviews which are generated through crowd sourcing mechanisms or pseudo fake reviews may not be valid training data because the models do not generalize well on real-time test data [14, 20]. Due to limitation of labeled dataset creation, it is necessary to find a mechanism to create a gold standard dataset with fake reviews without using manual labeling dataset for model training.

3 Proposed Methodology

The proposed methodology for detecting fake reviews is shown in Fig. 1. It consists with three main modules: (1) Pre-Processing (2) Extraction, (3) Ontology Management, and (4) Spam Detection. This approach can be used by any E-commerce-related website to detect fake reviews at the time of posting a review. When a new review is posted, it can be gone through these modules and finally resulted whether the particular review is fake/truthful. The following subsections explained each module in advance.

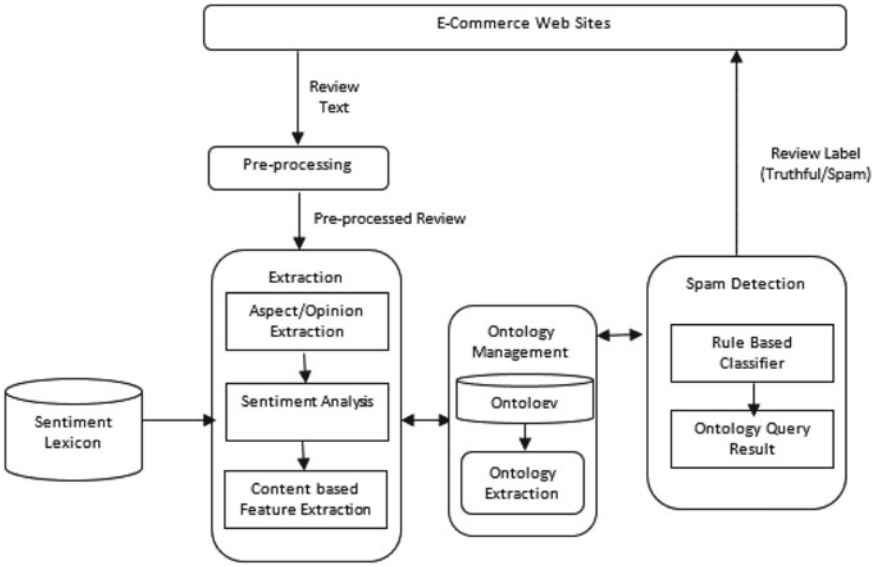

Fig. 1 Proposed fake detection model

Pre-processing module is responsible for removing unwanted words and characters, sentence splitting, spell correction, stop words removal, tokenization, POS tagging, lemmatization, and dependency parsing. The pre-processed text which is the output of this module is important for the extraction module. The Python libraries are used for the tasks of this module.

The aspect extraction process is accelerated by mapping the extracted aspects with the aspect-related concepts of a domain ontology. The purpose of the ontology is to identify the fake reviews in a specific domain. The sentiment analysis and filtering of fake reviews are done through the ontology in the specific domain. By replacing the ontology, the fake reviews can be filtered in any domain. The ontology is developed in Protégé software. This ontology consists with some concepts like feature, OpinionWords, review, product, and sentence. The feature class consists with subclasses of specific features of the product itself. It has a data property on sentiment expectation of each aspect which contains an integer of either −1 or 1. OpinionWords class contains the instances of opinion words. Review class contains the instances of reviews. Sentence class contains the instances of sentences of the reviews. All the classes have object properties and data properties for different purposes. The ontology can be updated with newly identified features for accurately perform the sentiment analysis. The instances and related properties are updated according to the arrival of new reviews.

The extraction module comprises with two processes: Aspect and opinion extraction and content—based feature extraction.

3.1 Aspects and Opinion Extraction

Every time people express their opinion on a product/service aligned with the aspects of the product/service. The associated aspects and the opinions are extracted within this process. Always the aspects may be a noun or a noun phrase [11]. By following a rule-based strategy which are derived using the dependency parsing and POS tag patterns, the candidate aspects and candidate opinions can be extracted. All the extracted candidate aspects are nouns/noun phrases, but most of the extracted candidate nouns/noun phrases may not related to the domain. Therefore, to reduce the number of candidate aspects which are going to map with the ontology, an aspect score value is calculated (1). The aspect score value is calculated using an existing domain specific corpus of reviews. Here, x is the candidate aspect, y_i is the existing aspects of the ontology, $f(x, y_i)$ is the number of times that the feature x and y_i are co-occurred in each sentence, $f(x)$ is the number of sentences in the corpus where x appears, and N is the total number of sentences in the corpus.

$$\text{Aspect} - \text{Score} = \sum_i \frac{f(x, y_i)}{f(x) f(y_i)} * N \tag{1}$$

For the candidate aspects who have the aspect score value greater than one can be selected as appropriate features, if not the candidate aspect is disregarded. Firstly, the selected candidate aspects are mapped with the aspect concepts of the ontology. Secondly, if such an aspect cannot be mapped with the ontology concept, all the possible synonyms are to be extracted from WordNet database [27] and map the synonym with the ontology concepts. Thirdly, if any selected candidate aspect which cannot be mapped to ontology concept from first and second method, then that aspect needs to be updated under a selected subcategory which has gain high PMI value among all the subcategories (2). Here, x is the candidate selected feature, S_i is the ith subcategory among the features of the ontology, and N is the number of review sentences.

$$\text{PMI}(x, S_i) = \log_2 \frac{\text{GoogleHitsCount}(x, S_i)}{\text{GoogleHitsCount}(x) \times \text{GoogleHitsCount}(S_i)} \times N \tag{2}$$

The opinions are expressed against the aspects of the product/service. After extracting the aspects from the reviews, the opinion extraction process has to follow a rule-based strategy based on the POS tag pattern and the type of the dependency relation which is identified from Stanford Dependency Parser [28]. Mostly the opinion may be an adjective, verb, or adverb. Then the extracted candidate opinions are compared against the SentiWordNet [29] for existence and selected as relevant opinion words associated with the aspect (ex: very, quickly, extremely, slowly, etc.) or negation words (ex: no, never, nothing, without, etc.) or conjunction words (ex: but, and, or, etc.) which may change the sentiment of the opinion. These kinds of adverbs

```
Input: For each aspect-opinion pair - Aspect (A), Opinion (O), Adverb (adv), number of negation
words (n), Sentiment Score of opinion word - SC(O)
Output: Sentiment score of aspect – opinion pair – SS(A-O)
If adv does not exist, Then
 SS(A-O) = (-1)^n * SS (O) * SE (A)
Else
  If SS (adv) > 0, then
     SS(A-O) = (-1)^n * min {1, SS (adv)+SS(O)} * SE (A)

  If SS (adv)< 0, then
     SS(A-O) = (-1)^n * max { -1, SS (adv)+SS(O)} * SE (A)

End If
```

Fig. 2 Algorithm for sentiment-score calculation for aspect-opinion pairs

are used to modify a verb, adjective, or another adverb. The next process of the extraction module is to calculate the sentiment value of each extracted aspect-opinion pair and aggregate them to generate the overall sentiment of each review.

The sentiment score of each aspect-opinion pair is calculated using the algorithm in Fig. 2. The sentiment score of the opinion word is retrieved from the sentiment lexicon database, SentiWordNet. As there are three score values of each synsets of SentiWordNet, the maximum out of the positive or negative score is retrieved as the sentiment score value of the opinion word. After calculating all the score values of pairs in each review, the overall positive sentiment score and overall negative sentiment score are calculated using (3) and (4).

$$\text{Sentiment}_{\text{Positive}}(\text{review}) = \min\left\{1, \sum_{i}^{n} \text{SS}_i(A - O)\right\} \tag{3}$$

$$\text{Sentiment}_{\text{Negative}}(\text{review}) = \max\left\{-1, \sum_{j}^{m} \text{SS}_j(A - O)\right\} \tag{4}$$

where n is the number of positive aspect-opinion pairs and m is the number of negative aspect-opinion pairs. The overall sentiment of the review is generated using (5).

$$\begin{aligned}\text{Sentiment (review)} = {} & \text{Sentiment}_{\text{Positive}}(\text{review}) \\ & + \text{Sentiment}_{\text{Negative}}(\text{review})\end{aligned} \tag{5}$$

The general rating value of five-point polarity system is then normalized into [−1, 1] as the calculated sentiment polarity value is aligned with a scale where −1 represents extreme negative and +1 represents extreme positive.

3.2 Content-Based Feature Extraction

This process generates a set of review content-related features which are used to identify the fake reviews and truthful reviews. Table 1 shows the descriptions about the extracted content-based features. The sentiment analysis related features should be extracted from the previous aspects and opinion extraction process.

3.3 Fake Detection Module

For some of the features, threshold values are defined for making the final decisions. Those features are compared with the threshold values when deciding on the fake or truthfulness. Based on the comparisons over the content-based features, the review can be classified as truthful or spam. The content-related features of the incoming review are calculated and stored within the ontology. Once inferencing, the review is automatically classified into the spam or truthful class according to the feature values and rules. By querying, all the available spam reviews can be displayed (Fig. 3), while the class category of a particular review can also be retrieved (Fig. 4).

4 Experiment and Evaluation

Most of the supervised and semi-supervised fake detection methods used labeled dataset for the model training. It was difficult to find a huge amount of labeled dataset which can guarantee the accuracy. Therefore, this research used unlabeled dataset of Amazon unlocked mobile reviews which is provided by Kaggle for model training. This unlabeled dataset contains 5000 unlabeled reviews with the review content and the rating. The variation of the given rating by the reviewers and the calculated sentiment polarity of the dataset is shown in Fig. 5. Generally, the outliers are deviated from common reviews, and it can be argued that the outliers may be generated through some other mechanism which is not consistent with general reviews. This argument is used to generate labeled spam reviews as outliers. The Mahalanobis distance [30] is used to detect the outliers of the multivariate dataset. The outlier distribution according to the existing opinion words of reviews is shown in Fig. 6.

Table 1 Content-related features

Dimension	Content—based features	Description
Linguistic features	Total word count (F1)	Total number of words in the review
	Average word count (F2)	Average number of words per sentence
	Ratio of numeral word count (F3)	Total number of words containing numerical values/Total word count
	Ratio of exclusive words (F4)	Total number of exclusive words/Total word count
	Ratio of negation words (F5)	Total number of negation words/Total word count
	Ratio of causation words (F6)	Total number of causation words/Total word count
	Ratio of capital letters (F7)	Total number of words containing capital letters/Total word count
	Ratio of all caps word (F8)	Total number of all caps words/Total word count
	Content similarity (CS) (F9)	The similarity percentage of review text to other existing review contents
	Ratio of exclamation marks (F10)	Total number of words with exclamation marks/Total word count
	Ratio of question marks (F11)	Total number of words with question marks/Total word count
	Ratio of named entities (F12)	Total number of named entities/Total word count
POS features	Ratio of nouns (F13) /adjectives (F14)/prepositions (F15)/determiners (F16)/verbs (F17)/adverbs (F18)/connector words (F19)/first person pronouns (F20)/pronouns (F21)	Total number of POS words/Total word count
Dimension	Content—based features	Description
Sentiment analysis	Ratio of aspect-related words (F22)	Total of number of aspects/Total words
	Ratio of opinion words(F23)	Total number of opinions/Total words
	Ratio of positive (F24) /negative (F25) opinion terms	Number of positive/negative opinion terms/Total opinion count
	Sentiment deviation (SD) (F26)	Difference between the calculated sentiment score and user rating

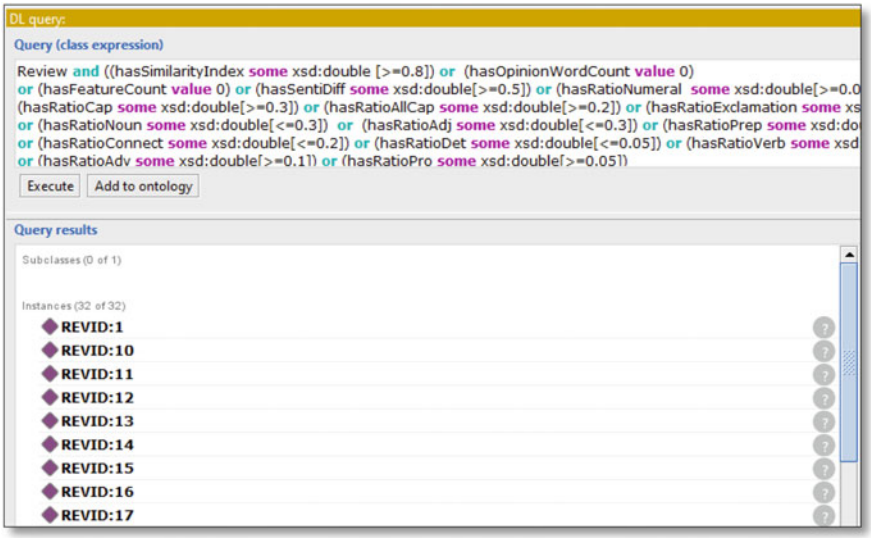

Fig. 3 Results for available spam reviews in ontology

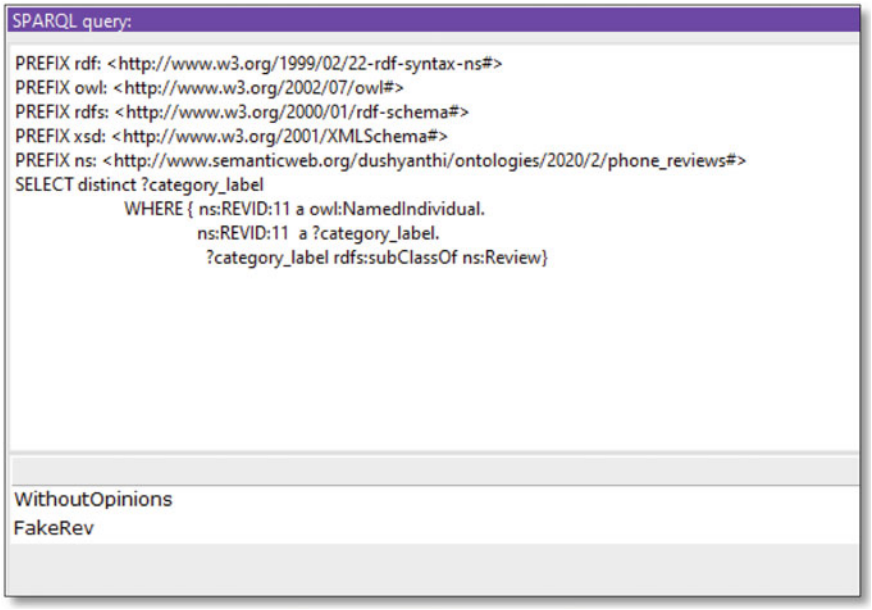

Fig. 4 SPARQL result of the category of review

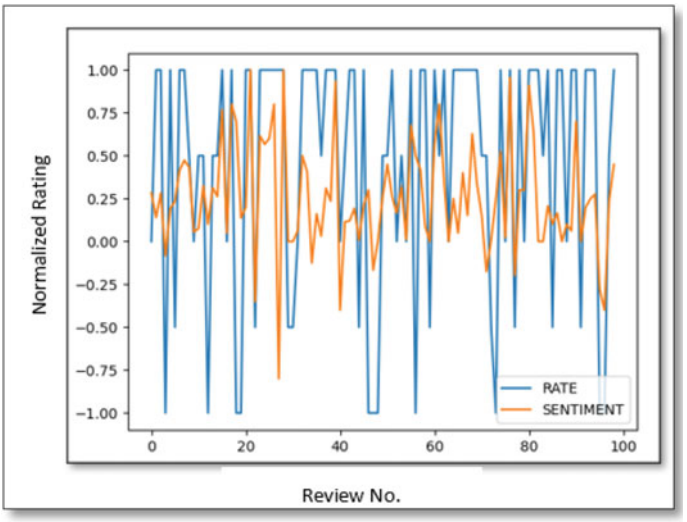

Fig. 5 Variation of given rating and sentiment polarity

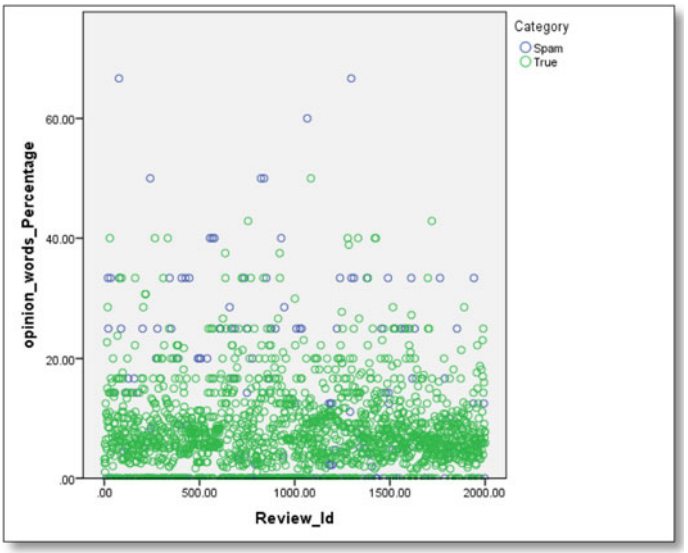

Fig. 6 Outlier distribution over ratio of opinion words

The calculated content-related features are used to cluster the dataset for identifying the spam and truthful labeled data. Then, a labeled dataset was selected with 1500 spam reviews and 1500 truthful reviews, where 70% from the dataset is then

used as training sample, 15% is used for testing, and the other part is used for validation. This training dataset is then used for finding the threshold values of the classifier rules. An iterative approach is taken to fine-tune the threshold values. Finally, the modified rules are included in the rule engine of protégé as SWRL rules. When a new review is arrived, it will be stored in the ontology as a review instance and calculate the content-related feature values. These values are stored as data properties of the ontology. After inferencing, the SPARQL query result will provide the classification result on a review saying whether it is spam or truthful based on rules of the rule engine of the ontology.

In order to evaluate the effect of linguistic features, POS features, and sentiment analysis features, the rule-based classifier is used. As shown in Table 2, different combinations of review content-related features are used to evaluate the performance of the classification. When considering linguistic features only and by combination of linguistic features and POS features, the classifier reached the accuracy of 64.1% and 73.3%, respectively. But when considering linguistic features, POS features and sentiment-related features as a combination, the classifier reached to high values of precision, recall, accuracy, and F1 score.

5 Conclusion and Further Work

The proposed research work has extensively investigated the spam review classification method by incorporating the review content-related features without considering a labeled dataset. The outliers of an unlabeled dataset were considered as spam reviews, and the rest of the reviews were used as truthful reviews for training the model. A rule-based classifier was used for the classification. The content-related features such as linguistic features, POS features, and sentiment analysis features are considered when performing the classification. The sentiment analysis is performed by using the domain-related aspects of the ontology. All the features are calculated for each new review and stored within the ontology. When inferencing, the classification result will be generated according to the SWRL rules of the ontology. The accuracy, recall, precision, and F1 score values of the rule-based classifier are slightly increased by incorporating all the linguistic features, POS features, and sentiment analysis features together without considering them individually. Further, the research directions will be suggested to incorporate the reviewer-related features along with the review content-related features and explore the performance of different classifiers.

Table 2 Performance metrics of classification results

Feature Combination	Precision (%)	Recall (%)	Accuracy (%)	F1 Score (%)
Linguistic	61.11	71.6	64.1	65.9
Linguistic + POS	68	70.2	73.3	69.1
Linguistic + POS + Sentiment	88.69	90.90	88.98	89.79

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Big Data Link Stability-Based Path Observation for Network Security

Nedumaran Arappali, Melaku Tamene Mekonnen, Wondatir Teka Tefera, B. Barani Sundaram, and P. Karthika

Abstract Wireless ad hoc network [WANET] systems are creating multihop communication structure between the mobiles to transfer the data groups. The remarkable qualities of remote frameworks cause the correspondence to interface among the conflicting mobiles. To manage high convey ability and biological blocks, most physical directing shows will not believe the stable associations during pack communication, which prompts the elevated delay and bundle reducing in the master-mind. The proposed research work recommends a way perception support physical steering convention that specifies POPR for WANET. The anticipated guiding show merges the relative partition, course and mid-expand forwarder center point with transfer thickness to propel data toward the objective in order to recover physical sending among the connection point. Multiplication results illustrate the projected directing convention, which performs superior to the existing arrangements.

Keywords Physical routing protocol · Direction · Traffic density · Link stability · Network security

1 Introduction

Transformation past specialists think about wireless ad hoc networks (WANETs) that empower unavoidable accessibility among mobiles and do not rely upon expensive framework system [1]. Correspondence among mobiles and earlier establishment release a lot of different sorts of talented applications for explorers with drivers. The applications are ought to give security with reassurance and help drivers to

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mastermind and talk with one another so as to keep away from any mishap, road turned parking lot, inconspicuous impediments, speed infringement, climate data, sight and sound administrations, and so on [2]. Despite the fact that being a subclass of portable specially appointed systems, a remote system has a few properties that recognize it from other impromptu systems. The most imperative differentiations are high compactness plan; fast varying and dynamic topology which direct to high framework fragment and the disconnectivity in sort out [3].

2 Literature Survey

Wide range of networking applications is depending on productive bundle directing to upgrade the security and becomes open to driving condition [4]. A wide scope of steering conventions has been proposed to adapt to meager and profoundly versatile remote systems that are extensively gathered into various sorts. Physical directing conventions will build up resuscitated enthusiasm for versatile and remote systems [5]. In physical steering, the bundle sending choices depend on location of through the neighbors with objective center point. These shows were roughly arranged in group radio frameworks or for adaptable frameworks, and cannot map truly to remote frameworks. One of the basic purposes for these wonders was the improvement of the mobiles held in ways and ways are allowable by the circumstance [6]. In light of the vehicle thickness of the ways, the steering conventions must use limit data to accomplish the versatility prerequisites in the system [7]. Therefore, the vehicle hubs forward the parcels with the assistance of neighborhood data that are provided closer by direct neighbors. This procedure prompts fewer control transparency in light camouflage of the vehicle center point information of various bits of framework [8]. The GPSR show was projected in 2000 for remote data compose. It operates the circumstance of the mobiles and objective center point during method of group sending [9, 10].

3 Problem Identification

These mobiles be outfitted and satellite-based global positioning system (GPS) so as to choose vehicle territory and support multihop correspondence in arrange.

- Each automobile in arrange chooses the circumstance of its nearby convergences by preloaded electronic street level maps.
- Every automobile is in like manner responsive of remote traffic during a fundamental movement framework for way traffic judgment and transfer sensors introduced next to the intersections.
- The reference point messages be traded to recognize the nearby nearness, position with bearing in organize.

- The Dedicated short-range communication (DSRC) average is utilized for correspondence.
- Greatest sending separation is unchanging.

4 Implementation

4.1 Routing Protocol

A hub has a lot of a jump nearby hubs within transmission extend that checks the ideal sending hub with various techniques. This vehicle hub is moving arbitrarily and habitually changes their location. Every vehicle hub intermittently communicates the guide messages to identify the portability attributes and get the data of one another. Along these lines, the guide messages contain the sequence of current location, time, bearing, and velocity obtained starting GPS.

4.2 Projected Routing Convention Sending Model

Since prior to delineating the proposed coordinating show, the key idea and methods of reasoning are rapidly depicted. The procedure additionally checks the facilitator hub, and if the organizer hub is accessible the convention begins the crossing point-based need activity. In the event that there is no facilitator hub accessible, at that point its determination checks partition, heading and middle region center to propel the pack. Figure 1 shows sending model, anywhere the source center needs to throw the package toward objective.

4.3 Routing Measurements Between Crossing Point

4.3.1 Distance and Path

The division and course are considered as noteworthy parameters. Since in transmission extent of vehicle center point, there is a probability that two centers are close to each other or of course they are confined through a partition of most outrageous radio range. The shorter partitions of vehicle center points prompt high number of bounces and nearest centers can deliver higher interface in organize. The likelihood of connection disappointment builds due to high flag lessening of problematic remote channels.

Fringe decision and ludicrous transmission go center completion may have a higher likelihood of leaving the radio range and dropping the bundles.

Fig. 1 (POPR) operation between intersections and at intersection

4.3.2 Result Midexpanse Node for Next Hop Node

The sender vehicle center point picks the sending skip, in which heading is neighboring to the source and objective directly lines which progresses a similar way to stable parcel sending.

$$\text{Distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \tag{1}$$

The vehicle center point's course is obliged by ways and, in directly interstate circumstances, mobiles are touching in the identical or then again backward bearing. In Fig. 2, when the source center point intends to course the data package toward the objective, it sends the group from its directional neighbor center toward the objective center point. The source hub figures the mid-separation next bounce as pursues. The hid mid-zone is generally called affiliation zone with various neighbors inside the Radius1 and other with the Radius_2. The hidden zone M_S can be resolute as.

$$M_s = M_1 + M_2 \tag{2}$$

where

$$M_1 = \text{Radius}_1^2 \cdot a_2 - \frac{\text{Radius}_1^2 \cdot \sin(2a_1)}{2} \tag{3}$$

$$B_2 = \text{Radius}_1^2 \cdot \alpha_2 - \frac{\text{Radius}_1^2 \cdot \sin(2\alpha_1)}{2} \tag{4}$$

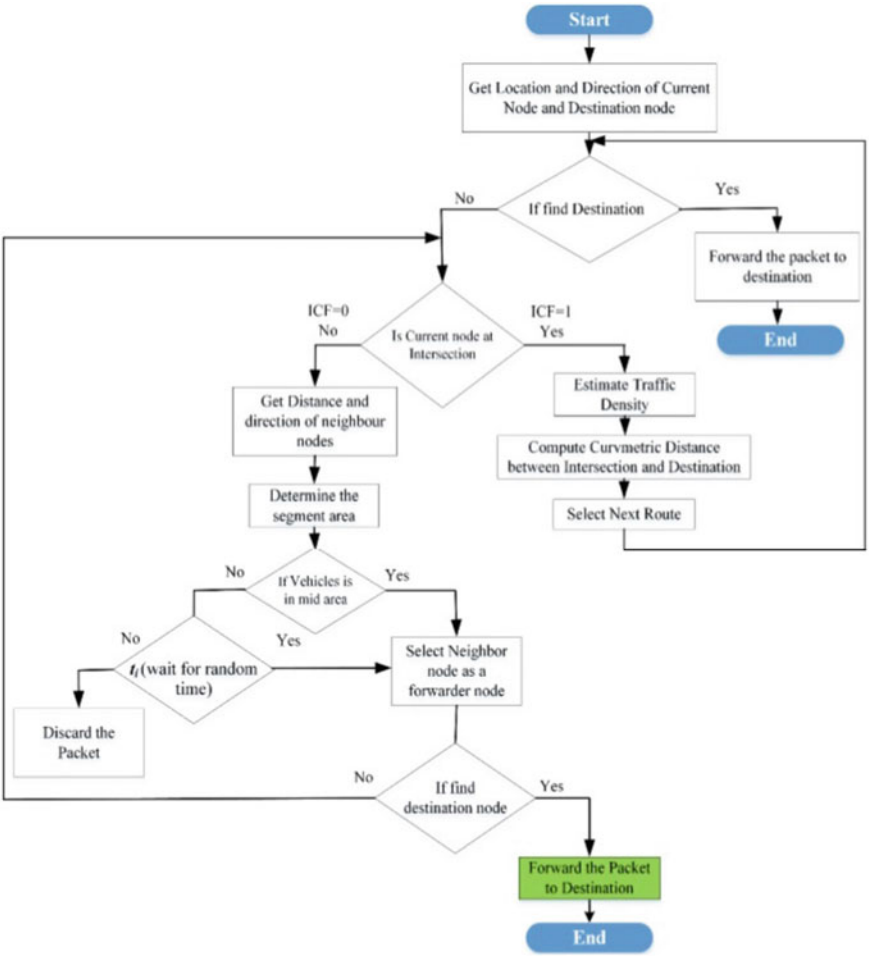


Fig. 2 Architecture of POPR

The line among source center point and objective center point $90° = (\alpha_1 = 45°)$ is bisector of point; in this method, mid-region is M_S

$$A = \text{Radius}_1^2\left[\frac{\pi - 2}{4}\right] + \text{Radius}_2^2 \cdot \left[\alpha_2 - \frac{\sin(2\alpha_1)}{2}\right] \tag{5}$$

The mid-zone is a combine of two circular fragments Radius_1 and Radius_2 the inference of α_2 rely upon the communication scope of source hub and the disconnection between source and goal hub. It ascertains the traffic thickness and heading

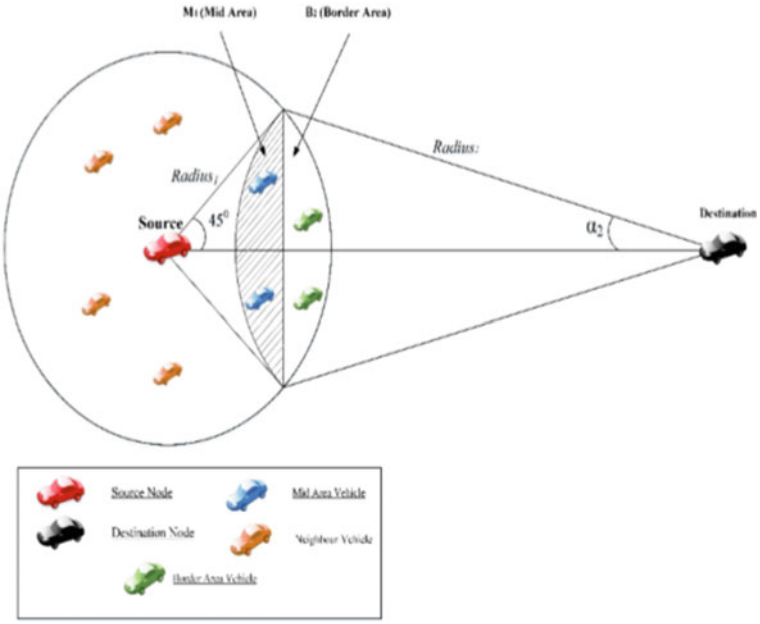


Fig. 3 Mid-area with shaded line $M_s = (M_1 + B_2)$

toward the goal so as to choose next forwarder hub and course in Fig. 3. The greatness of path decision as the vehicle great ways from the transport center point to objective is as per the following

$$\mathrm{Dis}_{wv} = \max\left[\log\left[\frac{CD_{s,d}}{CD_{j,d}}\right], 0.1\right] \tag{6}$$

In condition (6), the Dis_{wv} shows the separation with weight worth and $CD_{s,d}$ shows the bend metric good ways from source hub to goal and $CD_{j,d}$ presents the curve metric good ways from current intersection to objective. In condition (7), the Dir_{wv}(heading weight regard) with interface quality (LQ) factor is resolved between course of development vehicle and package transmission.

$$\mathrm{Dir}_{wv} = \left[\mathrm{LQ}\left(\overrightarrow{D}_n, \overrightarrow{D_{pt}}\right)\right] \tag{7}$$

When the vehicle gets a bundle, it discovers the weight score of each neighboring convergence dynamically traffic thickness (TD_{wv}) with typical number of mobiles (N_{avg}) and reliable degree of system (N_{con}) inside a telephone, as showed in condition (8).

$$TD_{wv} = [1 - D_c] + \left[\min\left[\frac{N_{\mathrm{avg}}}{N_{\mathrm{con}}}, 1\right]\right] \tag{8}$$

β, γ and δ are utilized for weighting factors for separation, course, and traffic thickness, individually with $\beta+\gamma+\delta = 1$. Consequently, in view of the above examination, condition (9) characterizes the weighting score of the following convergence (Score (NI)).

$$\text{Score}(Nl) - \beta \times \max\left[\log\left[\frac{CD_{s,d}}{CD_{j,d}}, 0.1\right]\right] + \gamma \times \left[LQ\left[\overrightarrow{D_n}, \overrightarrow{D_{pt}}\right]\right] + \delta \times [1 - D_c] + \left[\min\left[\frac{N_{\text{avg}}}{N_{\text{con}}}, 1\right]\right] \tag{9}$$

The principle factor Dis_{wv} is to check the partition to the objective in way length. The shorter detachment is favored toward the objective. The second factor Dir_{wv} measures the vehicle heading with interface quality factor between developments vehicle and pack transmission. The last factor is the traffic thickness TD_{wv} between the present and potential intersection point. In this tests, the vehicle transfer changes from 100 to 350 center points.

The Dijkstra calculation is utilized to locate the briefest ideal way with least weight. The DSR convention execution is not superior to CMGR and Geo SVR, in view of its way term expectation metric in Fig. 4.

The pattern in chart is enhanced for PDR contrasted and 150 hubs, since extra vehicle hubs in organize spread huge segments of the guide and broadcast extend. The POPR directing convention execution is enhanced within Fig. 5 for 250 hubs and a lot higher contrasted with meager system with 150 hubs.

At the point when the hub thickness expands, the briefest way along the ways turns out to be bound to have enough hubs and the PDR naturally increments.

The SDR execution is not superior to CMGR toward the beginning yet when the system will balance out, it is nearer to CMGR. In the preceding diagram, vehicle hubs are position to 350 shown in Fig. 6 and POPR execution is enhanced contrasted with

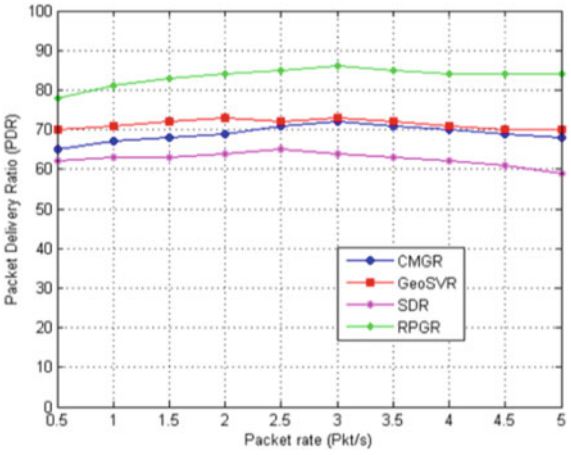


Fig. 4 Average delivery ratio with 150 vehicle nodes

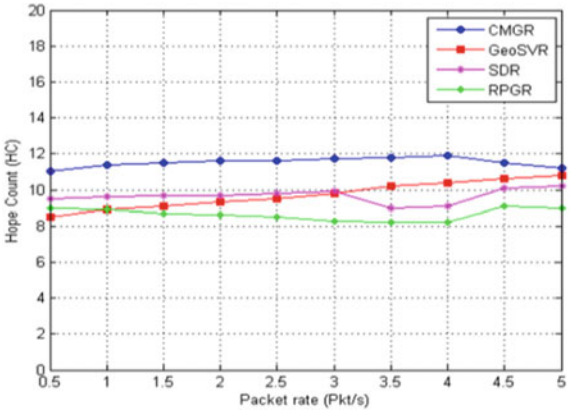


Fig. 5 Average hop count with 250 vehicle nodes

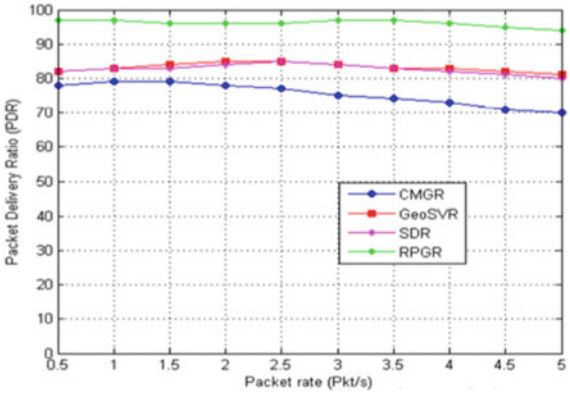


Fig. 6 Average delivery ratio with 350 vehicle nodes

fewer thicknesses in organize. The POPR execution is better a result of its course and continuous traffic thickness measurements.

5 Result and Discussion

This corruption alludes to the bigger bundle size that prompts the higher data transfer capacity utilization and high immersion in remote channel. As appeared in Fig. 7, the PDR for all conventions diminishes attributable to colossal traffic load with enormous bundle size which at long last prompts high parcel misfortune.

The subsequent test in Fig. 8 plots the normal deferral of proposed POPR convention with other best in class directing conventions and dependent on the outcomes within the sight of various bundle measures, the POPR delay is not exactly the other. Then again, the SDR convention delay is superior to CMGR and Geo SVR.

Fig. 7 Packet delivery ratio

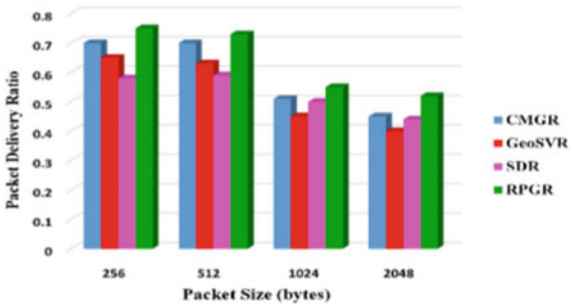
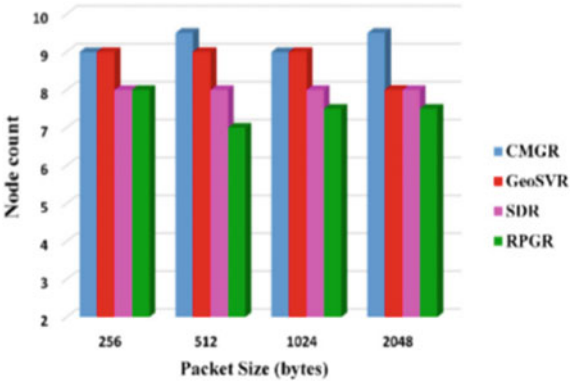


Fig. 8 Node count



The CMGR convention bundle delay is high contrasted with different conventions attributable to the loss of some high idleness in information parcels.

The convention decides the mid-territory hub by checking the separation of neighbor hubs and heading toward the goal. This mid-territory determination offers bit of leeway to deal with high versatility and as often as possible changing topologies in remote systems.

6 Conclusion

This paper displays the POPR convention for bundle sending in WANET for urban-based condition. The POPR thinks about separation, course, and mid-locale hub to responsively choose the following crossing point. At whatever point the forwarder hub is at the crossing point, bend metric bearing and high traffic thickness are rechecked and forward the information toward goal in the system. The exhibition of the proposed steering convention has been dissected in reproduction with three existing CMGR, Geo SVR, and SDR directing conventions. The outcomes show

better execution of POPR as far as PDR, normal parcel defer and normal way length with various vehicle thickness and bundle size.

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Challenging Data Models and Data Confidentiality Through "Pay-As-You-Go" Approach Entity Resolution

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Abstract **Problem importance**: Predictive analytics seems to be an exceptionally complex and vital concern in domains like computer science, biology, agriculture, business, and national security. When big data applications were indeed accessible, highly efficient cooperation processes are often meaningful. Simultaneously time, new subjective norms originate when the high quantities of data will conveniently assert confidential data. This paper has reviewed two complementary huge issues: data integration and privacy, the ER "pay-as-you-go" approach (Whang et al. in IEEE Trans Knowl Data Eng 25(5):1111–1124 (2012) [1]) in which it explores how the developments of ER is maximized to short-term work. Stepwise ER problem (Whang and Molina in PVLDB 3(1):1326–1337 (2010) [2]) is not even a unique process; it is done concurrently by the better usage of information, schemes, and applications. Joint ER problem with multiple independent datasets are fixed in collaboration (Whang and Molina in ICDE (2012) [3]) and the problem of ER with inconsistencies (Whang et al. in VLDB J 18(6):1261–1277 (2009) [4]). To overcome the research gap in the existing system, the proposed research work addresses an entity resolution (ER) problem that tends to address the records in databases referring to a certain complex real-time entity.

Keywords Data analytics · Data availability · Privacy · Entity resolution

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1 Introduction

Application data integration priorities for real world suggest methods efficiently and produce records for optimized ER outputs while reducing data size and to research how ER implementations can use generated hints. Maintaining revised ER outcomes as the ER framework used in record analysis changes frequently.

A functional framework of modular resolution in which developed ER algorithms, built over a certain record form can be embedded into and used with many ER algorithms. Prohibit ER solution irrationality using ER negative laws

Data privacy policy seeks to establish an information security model that considers the loss of personal privacy issues on an ongoing scale ranging from zero to one, provides effective computational leakage algorithms, assesses the efficiency of the information and its scalability to control information leakage, and suggests deception methods for agency resolution.

Flexible ER techniques and different ER features are also introduced. ER is often considered as a black-box process and includes basic techniques for operations. The issues of handling data corruption are initiated, in which sensitive information bits should be shielded by ER in order to prevent unnecessary loss. When a number of retailers, healthcare professionals, staff, networking media and so forth are more open to our personal data, there is an average increase that an attacker will link the dots and put our metadata together, resulting in much more privacy loss. This paper suggests a method to estimate the leakage of information and use "disinformation" to prevent leakage of information.

To fill the gap of existing system in this paper, an entity resolution (ER) problem that addresses records in databases referring to a certain complex real-world entity. Related to the recent digital revolution, ER seems to have become a challenge in a variety of technologies. We also suggested the use of modular ER methods and tools for huge datasets. We apply terms of strategy since they anticipate either its complete ER phase as a black-box deployment and can therefore be included in a large number of ER applications, or perhaps the refer fusion mechanisms. We have suggested a paid-by-go method for ER, in which we focus on making optimum progression despite the limitations in basics (e.g., function and runtime).

2 Literature Status

Andrew K. McCallum (2000), Rohan Baxter (2003): The blocking strategies aim to increase the optimal ER operating time in which documents can be separated into inconsistent blocks and indeed the blocks are set one by one [5, 6].

Omar Benjelloun (2009), Christopher D. Manning (2008): Contrasting documents and deciding whether they are related from the same entity is part of the precision of the entity. Much of the job is part of one of the ERs that match-based clustering is

taken into account [7]. The ER work involves elaborating ER's precision or latency efficiency, but typically assumes a predetermined logic for records resolution. As far as we recognize, our task will be the one to take into account the ER problem until the alternative logic modifications itself [8, 9].

Steven E. Whang (2011): ER-based actions to estimate the quantity of confidential information published to the public [10]

Steven Euijong Whang (2012): This paper examines how to significantly increase innovations of ER utilizing "hinting" in a constricted volume of work to apprise everyone about records probably belong to the same real-world organization everywhere. A hint is worthy of consideration with different configurations (for example, an aggregation of records relying on certain chances of overlapping), and ER would use the data as a recommendation to evaluate records first. A class of procedures are implemented for the powerful construction of hints and strategies for the maximization of compatible records with a minimal workload. The proposed significant value as a pay-as-you-go approach is correlated and displayed to implement ER without the use of hints with virtual datasets [3].

Steven Euijong Whang, Hector Garcia-Molina (2013): Their methods can be combined with the disinformation issue. It has been supposed that while an "agent" seems to have certain sensitive information to obtain from the "adversary." For instance, a cameras corporation might secretly design a latest camera prototype and a customer (the opponent) might also want to understand the full specifications in ahead of time. The purpose of this agent will be "dilute" what the opponent knows by disseminating false information. The opponent is structured as an entity resolution (ER) mechanism, which compiles resources displayed. They ratify the question of determining the most beneficial disinformation with a small budget for disinformation and performance. They officialise the challenge of disinformation with a restricted resource and recommend optimization techniques to address the situation with the utmost importance. After this, they scrutinize the rigidity of emerging ER algorithms with our methodologies for disinformation scheduling on ultimate and synthetic information. The disinformation methods may usually be enough to assess ER durability [11].

Gagan Aggarwal (2004): The P4P policy is designed to cover the unauthorized use of private information that is now being revealed to an opponent. For relevant information, mechanisms of multipurpose are formulated to maintain data control system [12].

Rui Xu (2005): Clustering strategies streamlined toward noise were thoroughly examined in the past. With in face of excessive noise, this kind of work suggests learning algorithms that obtain the exact clusters. Conversely, the aim is to deliberately distract the ER technique even more than necessary for the target entity [13].

Arvind Arasu (2006): Some activities suggest efficient combinations of similarity. Our pay-as-you-go methods strengthen blocking through just using the ordering of record pairs to obtain the maximum intermediate ER performance. [14].

E. Laxmi Lydia et al. (2016): K-means is one of the most basic and unsupervised learning techniques that resolve any well-known clustering problem. Suggest a cluster K number for the quick and fast classification of grid processor. Since K-means clustering is centered on cluster centroids, there is no guarantee of an excellent solution. The framework then uses the clustering of K-centroids [15].

E. Laxmi Lydia et al. (2016): With author's ongoing research on the disparateness of cluster system, resource type, processing speed, and memory features are developed. The device must form a cluster with the K-centroid clustering to prevent a scheduled interruption. The node transfers to the cluster [16] are based on higher key objectives.

3 Detailed Methodologies of the Research

Existing System: This paper has investigated two distinctive complicated issues: data integration and data confidentiality, the ER "pay-as-you-go" approach [1] in which it examines where to achieve maximum growth of ER with a small workload. Sequential ER problem [2] ER is not really a unique process, and it is carefully examined by the proper understanding of data, schemes, and applications. Joint ER problem for which multiple individual datasets are handled in combination [3] and the incoherence phenomenon of ER [4].

New Area to Fill the Gap of Existing System: This project will instead address the issue of entity resolution (ER), where database records are identified that further correspond to almost the same real-world entity. Due to the recent data explosion, ER has become a challenge in a multitude of scenarios. Further, it also suggests the use of modular ER techniques for complex data. The overall strategies are applied since they recognize whether another entire ER process as either a black-box operation and therefore can be used in a vast array of ER application domains, or the contest and fusion functions. A pay-as-you-go method is suggested for ER to make optimum advancement considering the problems in resources (e.g., function, runtime).

The extensible ER methodologies and new ER features, which were not previously practiced are utilized here. ER is often interpreted as black-box process and has simple basic applications that will be used. Besides that we address the issue of information leakage management, where you have to work to prove that sensitive info bits are not played with by ER and defend toward data privacy losses. When our personal details become more accessible to a number of vendors, distributors of healthcare, workers, Web media, and perhaps more, an attacker seems to be more likely to "connect the dots" to our information and to bring it together, contributing to an

increased risk of confidentiality. A quantitative measure is asserted for leakage and to use "disinformation" as a device to incorporate disclosure of sensitive information.

3.1 The Following Portrays the Proposed Model in Detail

Also because of very massive datasets and complex record comparative analysis, an ER approach is generally cost-effective. The processing of platforms such as social media, for illustration, will generate thousands or even millions of data which has to be remedied. It can be expensive to check each pair of documents in order to progress their "similarity," as distinct fields are contrasted, invoking substantive application logic. Around the same time, running ER in a quite short time can be very critical. The "pay-as-you-go" model has been utilized to perform entity precision, which slowly yields extracted features by resolving them. As observed, all documents belonging to the same real-world individuals cannot be classified by preliminary results. Our ultimate objective seems to be to gather even more of the eventual outcome as possible, as quickly as necessary. It is significant to mention which our current job is qualitative by existence. Suggested hints are identified as heuristics. Further, our overall objective is to attain a collaborative platform for hints and to assessing the potential improvements.

The following Fig. 1 demonstrating the flowchart of methodology steps in brief.

3.2 The Methodology Adapted

- Pay-as-you-go ER is formally accepted model attempt to optimize the temporary ER consequence. Our blocking techniques depend on the regular ER control flow.
- Various levels of hints are suggested:
  - The most detailed (and yet compact) form of hint: the sorted list of record pairs.
  - A hint that is relatively informative and portable: A hierarchy of partitions
  - The most compressed form of hint (and yet least informative): Sorted records
- The techniques are proposed with successful hints generation at each hint form and scrutinize whether ER iterations can optimize ER efficiency whereas limiting record number correlations.
- Our approach has been enlarged to include multiple hints.
- It will quantitavely consider what ER can yield results quickly with the application of tips. We use valid comparison consumer details from Yahoo! Shopping and hotel statistics from Yahoo! Travel. Our findings indicate situations in which suggestions boost the ER filtering such that most corresponding records can be found in a proportion of the overall runtime.

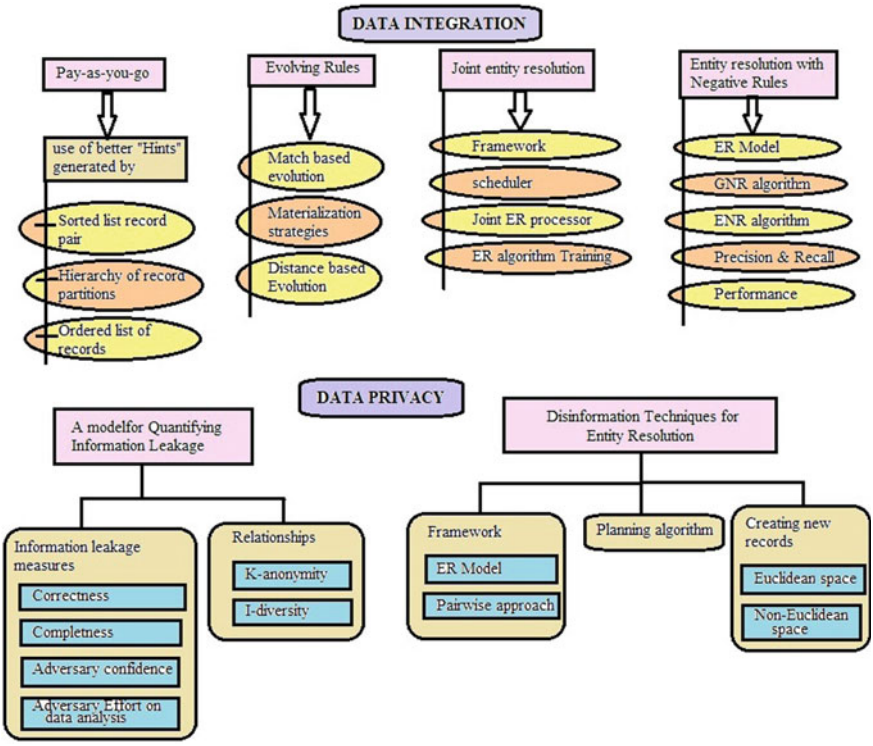

Fig. 1 Flowchart of the methodology

3.2.1 System: Architecture and ER Design

This section describes the proposed pay-as-you-go ER system in this module. Initially, a general business determined model is proposed, followed by an overview of where pay-as-you-go works.

A database collection R, which represents real-world entities, is used as an EE encoder E. The ER performance is an input partition which mostly contains information representing a certain real-world object separately. Case: output $P = \{\{e1, e3\}, \{e2\}, \{e4, e5, e6\}\}$ means that e1 and e3 of records are an individual entity, and e2 is an individual entity, etc. Since it sometimes requires to run ER on the results of a previous resolution, developers have defined this as a fraction. That record in its own folder directly, e.g., {{e1}, {e2},} e4, {e5}, {e6}}. This sense that report is a single partition. The ER product of R at time t is revealed that $E(R)[t]$.

3.2.2 Description for Pay-As-You-Go Model

The pairs of candidates are concretely organized with pay-as-you-go template by the probability of a matchup. So, the ER approach identifies the record with the more probable pairs instead. The objective is obviously, since the requirement is unpredictable to evaluate the couple sequence very effectively.

To display this, six records have been put in two blocks: one block holds the records e1, e2, and e3, and the second block holds the records e4, e5, and e6. The candidate pairs are indicated by {e1–e2, e1–e3, e2–e3, e4–e5 ….}. A conventional ER algorithm will indeed analyze between pairs, perhaps in some random order regarding most of these pairs during the first block as well as the second block pair. However, the most feasible pair is equated and assumes as d5-r6, with pay-as-you-go. Then, it probably correlates the very next, say e2-e3. Fortunately, every block is authorized autonomously if only yet another block at such a time fits into the memory. Specifically, first of all the first block pairs are equated by the chance of a downward match, and then the second block seems to be the same. In any case, the solution is to determine compatible pairs more quickly than from randomly analyzing the candidate pairs. The ER automated system could then build an output portion which approaches the overall product more rapidly. (To measure performance continuously and to treat candidate pairs as a consequence of increasing probability, it is not like all ER methods can, as stated previously.)

The first prerequisite is our key objective of providing early ER outcomes of higher quality. The second prerequisite assures that the pay-as-you-go defines the findings preceding the ER of almost the same accuracy as the outcome without any hint. Blocking techniques will in response give an estimated ER result for which output has slipped. The auxiliary data format suggestions are used to effectively produce candidate pairs in (equivalent) sequence of probability. They address three kinds of clues, as shown in Fig. 2.

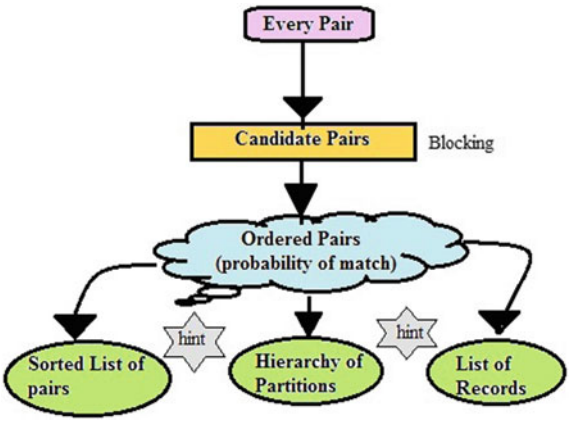

Fig. 2 Implemented framework for pay-as-you-go model

3.3 Implementation of Pay-AS-You-Go Model Through Ordered Pairs with Sorted List

This section discusses a hint that provides a list of record pairs that mostly fit pairs. It has been claimed that both the distance and match function would be used for the ER algorithm. The distance function $d(r, s)$ has been used to quantify the difference among both r and s records: as the distance is shorter, r and s display the same truth. A match function $m(r, s)$ is evaluated as valid if r and s are assumed to be another object in the real life. It must be noted that may be a match feature may use a remote. This might be the form of "if $d(r, s) < T$ and subsequently valid" when T is a threshold, for starters. It can also be assumed that $e(r, s)$ is much affordable than $m(r, s)$ and $d(r, s)$ for calibration. The ER technology requires an equivalent function, the relatively small $e(r, s)$ valuation, the greater the likelihood of the $m(r, s)$ being counted as valid. The sequence of all record pairs, procured by the through value, is another conceptual suggestion. The collection cannot in action be produced completely and precisely. For comparative purposes, beyond a certain series of pairs and even after the predictions reach a certain threshold the category may be distorted. As you can see, the pair seems to be another substitute: The ER algorithm will query the next pair upon this list, as well as the pair is determined at that juncture. Then, an $O(N_2)$ complexity can be avoided when the hint is generated. The proposed research work will converse over how to produce a pair list indication and using a pair list more with ER algorithm.

3.4 Generation

Many ways are suggested to develop a portion hierarchy adequately. Within the next segment, the hints are created with which the application predictions are more focused on the sorted records. Then, this section will explain how memory hierarchies can sometimes be produced with hash (also implementation estimates, but not evaluation predictions) and affordable distance functions.

3.4.1 Using Assumptions of Applications

For certain instances, an application-specific prediction function may be built which is inexpensive to measure. For comparison purposes, if indeed the remote function calculates a gap among records, then zip code is used to calculate the distance: if two records use the same zipper code, then it will be conveyed that they are close; otherwise, we will say individuals are far. The approximation can hardly recognize one or two attributes, yet the most impressive, unless the distance function calculates and merges the similarity among most of those of the record's features.

In order to develop the hint, $e(r, s)$ are calculated including all record couples but every pair can be inserted and estimated in a heap data structure. Once all pairs have been added, where it might delete all couples by increasing estimates, because it is highly required to complete the list. However, developers could even delete entries until we hit a threshold distance just a couple of pairs just before ER algorithm begins to demand challenging pairs.

For many other situations, the projections project over a single dimension to distances, though in that case a large reduction throughout the data amount in the heap will take place. For instance, $e(r, s)$ has been the difference in quality of records. In this case, the records could be sorted by value. (Notify them a certain records near as possible in price seem to be likely to accept) Then, on the cost dimensions (and consequent cost difference), we insert into the heap with each record, its nearest neighbor. The record r is obtained from the heap with the closest neighbor to get the smallest estimate set. R's next nearby neighbor is subsequently searched (in the sorted list), and the new assessment is used to integrate r into the heap. Throughout this case, the maximum capacity is analogous to, the record number. From the other hand, the maximum capacity order whenever all pairs of records will remain on a heap as $O(|R|_2)$.

3.4.2 Implementation of Pay-As-You-Go Model Through Hierarchy of Record Partitions

We suggest the hierarchy of partitions as a potential structure for hints in this statement. A result hierarchy provides details on possibly complete analysis in the context of scoreboards with various granularity rates where each score reflects a "potential world" of an ER outcome. The lower-level portion is the finest clustering of the raw data. Less rough grain with bigger clusters is greater collections in the Hierarchy. Namely folders in order of granularity, during which grosser cuts are extremely high up in the hierarchy, without ever storage of arbitrarily defined partitions.

Algorithm 1 Developing a hierarchy of partitions from sorted records.

Input: Two lists such assorted records and Thresholds were considered Sorted = [r1, r2,….] and T = [T1,…..TL]

Output: Aim is to achieve a hint H = {S1,…, SL}

Process:

3: Start with S1,…., SL partitions

4: Perform for r ∈ Sorted

5: Perform for Tj ∈ sorted

6: check for the condition if r.prev.exists() ˆ KeyDistance(r.key, r.prev.key) ≤ Tj then

7: Extend r to Cluster Sj

8: else

9: Build a new Sj cluster with r

10: return {S1, …., SL}

The Algorithm 1 demonstrates when to create a hint H partition hierarchy employing various T1 and TL thresholds, regarding the key value length of partitioning information. For example, suppose a 3-record list of records [joy, joyful, joyous] (the records are listed and sorted by names) is included. (The thresholds are predefined focused on level L count in H) Believe that set 2 thresholds T1 = 1 and T2 = 2, and use the editing interval. For the purpose of highlighting the differences between the records, thus eliminating the right to shift the series to the next. Second, joy reads the algorithm 1 and applies it to the existing S1 and S2 cluster (Step 9). The word joyful will be added in the first cluster in S2 (Step 7), because the edit distance does not exceed T2. The last record of joyous is 4, which satisfies all thresholds. Change difference only with previous estimate joyful is 4. A conjugating for both S1 and S2 is therefore established with joyous. Thus, there are two partitions in the subsequent hint:

S1 = ffjoyg, fjoyfulg, fjoyousgg and S2 = {{joy, joyful},{joyous}.

The results below display first algorithm consistency.

Proposition 2.3.1 A relevant hint is given by the first algorithm.

Proof A partition S of higher rates is often grosser than even a partition S0, whereas an increased threshold has been used in the sorted list to break data. S0_S, therefore, since partitions of the highest level is often more delicate than partitions of the lower level, H is the description hint. Since the sorted input has now been sorted, Algorithm 1 is used to iterate all records in sorted in O(L) time and iterates across all threshing levels within each record.

4 Requirements for Experimental Analysis

This paper will experiment with a retail comparison dataset from Yahoo! that maintains (shopping and hotel) data. This will test the SN, HCB, HCBR, ME, HCDS, and HCDC algorithms for ERs. Algorithms were performed testing using the 2.4 GHz Intel (R) Core 2, 4 GB RAM processor in Java.

The detailed software information's are as following:

Language	Java programming
Used system	checked only in GNU/Linux
IDE supporter	NetBeans IDE 6.0.1
UML software documentation	Umbrello UML Modeler 2.0.3

As Hadoop and Mahout function locally with Java, accessibility between components generated by Java would be easy. Considering this reality, Java was picked as the programming language. Umbrello UML Modeler has a basic yet effective arrangement of demonstrating instruments, because of which it was utilized for UML documentation. NetBeans IDE was picked as formative IDE accounting to its rich arrangement of elements and simple GUI Builder tool.

4.1 Real Data

Yahoo! Shopping issued the comparative assessment shopping dataset that has been used here and includes millions of records that turn up consistently from divergent online stores and have to be addressed before customer queries are replied. Almost every database includes different attributes, except the title, price, and object type. The plan checked a small portion of 3000 shopping documents with the string "iPod," and a random subsystem of 1 million purchasing files. This was also checked with a hotel dataset given by Yahoo! Where decades of thousands of customers accumulate and must be processed prior to users travel from various sources (e.g., Orbitz.com) being seen. The 3000 accommodation information will be checked in the USA, which is a randomized subset. The 3 K shopping and hotel statistics are memory capable, but the 1 million shopping datasets are memory capable and have to be reserved from the server.

4.2 Guidelines of Match

The match guidelines in our experimental work are summarized in Table 1. The sort attribute specifies yet if the match requirements are Boolean or RM rules. The details of the field indicate the source of data: shopping or hotel information. The column for the match requirements shows the match regulations apply. Boolean rules on shopping and hotel datasets are specified throughout the first two rows. B_1^S relates two retail documents "names and ranges, while B_2^S relates the retail records" titles and costs. B_1^H relates the state, city, zip codes, and names of the hotel documentation for the information on the data analysis of the hotel. The B_2^H rule contrasts two hotel files with states, towns, postal code, and home locations. Later, D_1^M measures the

Jaro distance between adjacent shopping item titles while D_2^D random modifications distance from D_1^S to fulfill the demands of 5 percent. The Jaro distance is given to the [0, 1] quantity of the shopping record and appears to give larger levels to close databases. The Jaro value is calculated to a maximum ratio of 5 percent with each of the two rows. Again D_1^H accumulates the gap from Jaro for hotel data from the descriptions of two records and indeed the equality including its two applications weighted at 0.05 from the regions. Nowadays, the equality distance increases to bring back one if two values are identical and 0 and if they are not identical. The D_2^H rule perfectly illustrates the Jaro distance between certain names of the zip codes weighed by 0.05 with the appropriate intervals between them. As a matter of fact, at majority the 0.05 ER and rule evolution methodology that affects the altitude from D_1^H. This paper is experimental with the development of SN, HCB, HCBR, ME, HCDS and HCDC. Following Table 2 shows each ER implementation and the rule evolution mechanism which has been used. (This does not undergo rule progression rather than using the join ER model, however, emphasizes upon on clustering ER model) The remote advanced analytics HCDS and HCDC end with a fixed distance of around the threshold of 0.95 among both clusters (remember relatively close accounts have relatively high Jaro + Distance inclusiveness). Whereas ME and HCDC models do not comply with RM, Algorithm 7 can indeed be implemented to develop quality and limited loss of consistency new ER outcomes. Confirm that, while ME is GI, Algorithm 3 is not reliable, as ME derives and resorts all documents in the current

Table 1 Match rules

Type	Data	Match rules
Boolean	Shopping	$B_1^S : p_{ti} \wedge p_{ca}$ $B_2^S : p_{ti} \wedge p_{pr}$
Boolean	Hotel	$B_1^H : p_{st} \wedge p_{ci} \wedge p_{zi} \wedge p_{na}$ $B_2^H : p_{st} \wedge p_{ci} \wedge p_{zi} \wedge p_{sa}$
Distance	Shopping	D_1^S : Jaro$_{ti}$ D_1^S : Jaro$_{ti}$ with random shifts in less than 5%
Distance	Hotel	D_1^H : Jaro$_{na} + 0.05 \times$ Equals$_{ci}$ D_2^H : Jaro$_{na} + 0.05 \times$ Equals$_{zi}$

Table 2 Referenced implementations for ER and rule evolution

ER algorithm	Algorithm for rule evolution
SN	Algorithm for SN
HC_B	Algorithm 3
HC_{BR}	Algorithm 7
ME	Algorithm 7
HC_{DS}	Algorithm 7
HC_{DC}	Algorithm 7

partition Pi (not through any of the Pi clusters). Algorithm 7 will be used for the distance-based clustering pattern, including both HCDS also HCDC computational methods.

5 Conclusion

The paper reports primarily concerns about data processing to tackle the issues of computer science, and perhaps other relevant fields besides the finance and medicine. Then, the proposed research addressed the entity resolution question (ER), which mostly recognizes database records belonging to a certain real-world object, in the paper implemented. The pay-as-you-go method is suggested for ER, in which attempts to achieve and produce the majority and given a constraints (e.g., job, runtime). In order to stop sensitive pieces of documents that are being resolved by ER, the issue of handling the leakage of information is incorporated to protect toward loss of privacy. For more of our personal details disclosed to a number of vendors, care professionals, supervisors, and other networking media, there is a greater risk which an offender will "mark the dots." The estimation has been formulated to evaluate the leakages while using "disinformation" as a platform to constitute leakage.

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Preserving and Scrambling of Health Records with Multiple Owner Access Using Enhanced Break-Glass Algorithm

Kshitij U. Pimple and Nilima M. Dongre

Abstract Cloud computing servers gives a stage for the clients to remotely store information and offer the information to everyone. Healthcare record management system (HRMS) has been developed as a tolerant-driven model for health-related data exchange. Classification of the common information, i.e., visit details, report details, etc., remains as a serious issue when patients utilize public cloud servers since it might be viewed by everyone. To guarantee the patient's control over admittance to their own uncommon well-being records, it is a promising technique to encode the reports before redistributing and pick up the gain power to that data. Security introduction, adaptability in key association, and flexible access experience have remained the most essential difficulties toward accomplishing fine-grained, cryptographically endorsed data get the opportunity to control. This research work proposes an arrangement of systems for information get to control to healthcare record management system (HRMS) put away in outsider servers with classification of data into public and private data. In HRMS for accomplishing smooth and adaptable information get the chance to control, attribute-based encryption (ABE) methodologies are utilized to encode each patient's HRMS record for getting to. While providing secure data outsourcing, the main concentration is the multiple owners of data. On account of this framework significantly diminishes the key administration unpredictability for information owners and clients, HRMS ensured a high level of patient security. With respect to emergency situations, a break-glass extraction method is introduced here to access the data in emergency situations with authorized keys.

Keywords Cloud computing · Cryptography · Attribute-based encryption

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1 Introduction

The Internet has become very vastly as of late, and it offers different abilities that could bolster physicians to perform their responsibilities from multiple points of view. Cloud computing (Fig. 1) is the conveyance of processing administrations including servers, stockpiling, databases, organizing, programming, investigation, and insight—over the Internet ("the cloud") to offer quicker development, adaptable assets, and economies of scale.

With the advancement of data and restorative innovation, medical information has been changed from manual written records into e-records into electronic therapeutic records which are extensively used. Nowadays, programming structures have created from the individual customer's neighborhood equipment to a focal server that works from a remote region. A health record is nothing but record of a person user's health data put away in PC and can oversee, track, and take an interest in possess medicinal services. The benefits of data-driven healthcare systems, in any case, accompany a value, an exceptional exertion and effort to secure patients' protection without trading off the utility of the information and related human services administrations. Like in training and interpersonal interaction, securing privacy in medicinal services frameworks is critical and testing as a result of the affectability of the related information and the multifaceted introduction of the healthcare systems.

Unapproved presentation of the touchy medicinal services information can have profound established social, financial, and well-being related outcomes to the patients. Masters, orderlies, lab experts, emergency responders, and cure handlers comprise the healthcare systems and approach patients' data. Additionally, specialists and other model shoppers require patients' information and the created models for their logical investigations and business purposes, including some possibly against patients' best preferences. Furthermore, the sheer measure of information and related multifaceted nature of investigation require human services frameworks to utilize outsider cloud foundation suppliers for enormous scale parallel taking care of and

Fig. 1 Cloud computing [23]

data stockpiling. These exposures cannot be discarded because of the basic jobs the taking an interest substances play. Ensuring security requires guaranteeing that individuals keep up the legitimately to control what information is accumulated about them, who takes care of it, who uses it, how it is used, and what reason it is used for.

1.1 Data Privacy and Security

Data privacy can be defined as:

(1) Untraceability: Making it problematic for an adversary to recognize that a comparable subject played out a given course of action of exercises.
(2) Unlinkability: Concealing information about the association between any things, for instance, subjects, messages, activities, and so forth.
(3) Unobservability: Concealing how a message was sent (rather than covering the identity of the sender of message)
(4) Anonymity: Concealing information who played out a given action or who is delineated by a given dataset.
(5) Pseudonymity: Using pen names of utilizing genuine identifiers.

Giving security requires counteracting access to information or unique articles by unapproved customers [4, 5], similarly as guaranteeing against unapproved changes or pummeling of customers' information.

The commendable significance of security levels with it, with characterization, decency, and openness, called (by its contraction) the CIA gathering of three. The ISO 7498-24 standard stretches out the security definition to the going with necessities that can use the gathering CIA-AANN:

(1) Confidentiality: Data is not made open or uncovered to unapproved individuals, substances, or techniques.
(2) Integrity: Information has not been changed or obliterated in an unapproved way.
(3) Availability: A system is operational and handy at a given moment (it isn't down).
(4) Access control: Clients get to simply those advantages and organizations that they are equipped for access, and qualified customers are not denied access to organizations that they sincerely plan to get.
(5) Authentication: The confirmation that a component is the one declared, and the wellspring of got data is as ensured.
(6) Nonrepudiation: The senders/recipients of messages cannot deny that they actually sent/got the messages.
(7) Notarization: The enrolment of data with a trusted in outcast that ensures the precision of data traits, for instance, substance, origination, and creation time. Protection and security are specific. Regardless, in human administrations Fifield, the association between those two thoughts is data affirmation. The

basic association exhibits among security and protection in the beneath figure; that is, confidentiality is situated in the convergence of protection and security.

1.2 Data Security in Health Care

Healthcare record management system (HRMS) has created as a tolerant driven model of well-being data trade. Commonly displaying HRMS organizations for each individual, there are various security and safety risks that may block its huge selection. The focal concern is about whether or not the patients could truly control the sharing of their fragile prosperity realities, particularly when they are made sure about on a public worker which people may not completely trust. From one perspective, regardless of the way that there exist human administrations rules, for instance, HIPAA which is starting late changed to join colleagues cloud suppliers are commonly not verified substances. Obviously, because of the high assessment of the delicate individual health information, the untouchable storing workers are regularly the objectives of different poisonous practices which may impel introduction of individual health information. As a lofty occasion, a Department of Veterans Affairs information base containing fragile individual prosperity information of 26.5 million military veterans, including their administration oversaw investment funds nos. also, clinical issues was burglarized by an agent who took the data outside without endorsement. To guarantee lenient-driven security control over their own HRMS, it is essential to have fine-grained information get the chance to control parts that work with semi-trusted in workers. Therefore, another framework is recommended that guarantees the security of HRMS that ought to be finished utilizing ABE algorithm. HRMS association enables a patient to administer and control her own extraordinary thriving data in a lone spot through the web, which has made the cutoff, recuperation, and sharing of the remedial information continuously possible. The principle objective is to verify individual health records utilizing multi-expert ABE. That is various experts can get to the HRMS without influencing the security highlights. For taking care of crisis circumstances, crisis office is executed with outer security. Healthcare record management system (HRMS) has created as a tolerant-driven model of well-being data trade. Commonly displaying HRMS organizations for each individual, there are various security and safety risks that may block its huge selection. The focal concern is about whether or not the patients could really control the sharing of their sensitive prosperity realities, particularly when they are made sure about on a public worker which people may not altogether trust. From one perspective, regardless of the way that there exist human administrations rules, for instance, HIPAA which is starting late changed to join colleagues cloud suppliers are commonly not verified substances. Obviously, because of the high assessment of the tricky individual health information, the outcast amassing workers are regularly the objectives of different toxic practices which may impel introduction of individual health information. As an esteemed occasion, a Department of Veterans Affairs information base containing sensitive individual prosperity information of 26.5 million

military veterans, including their administration oversaw investment funds nos. what is more, clinical issues was looted by an agent who took the data outside without endorsement. To guarantee lenient-driven security control over their own HRMS, it is essential to have fine-grained information get the chance to control parts that work with semi-trusted in workers. Therefore, another framework is recommended that guarantees the security of HRMS. That should be done using ABE algorithm. HRMS organization empowers a patient to oversee and control her own one of a kind thriving information in a solitary spot through the web, which has made the breaking point, recovery, and sharing of the remedial data progressively suitable. The principle objective is to verify individual health records utilizing multi expert ABE. That is various experts can get to the HRMS without influencing the security highlights. For taking care of crisis circumstances, crisis office is executed with outer security.

2 Literature Survey

2.1 Attribute-Based Key Generation Scheme

- Green et al. prescribed to re-appropriate the decoding load, so the customer can recover the message with lightweight computation. To support the exactness of the changed code text, the evident redistributed decoding issue is inspected in [11] to give a ground-breaking course to the rightness affirmation. To expand the ABE security for video content, a period area trait-based admittance control (ABAC) plan is proposed by Yang et al. [18] to guarantee the cloud-based video substance sharing, which introduces the time into the code text and keys to recognize time control. To decrease the trust of a single position, the multi-pro ABE plan is investigated in [6–8, 10, 13, 16]. Attribute-based encryption (ABE) is another philosophy that reuses the open key cryptography thoughts. Out in the open key cryptanalysis, a message is encoded using the open key shared by recipient. New character-based cryptography changes the standard thought of open key cryptography. It empowers the open key to be a self-assertive string, e.g., the email address or phone no. of the collector.
- ABE goes well beyond and describes the lifestyle as set of attributes not confined to single nuclear key. There are various forms of ABE as multi-authority ABE (MA-ABE), key-policy ABE (KP-ABE), and cipher-text effective access control (CP-ABE), and the public-key encryption (PKE) can be utilized. Be that as it may, there is high overhead of key administration and requires to encrypt numerous duplicates of a document utilizing various clients keys. To give the secured and flexible game plans, one-to-various encryption strategies like ABE can be used. In [12, 17], information is scrambled utilizing credits set with the objective that various customers can decode it. This makes encryption and key administration more effective. In 2016, a secret phrase-based break-glass access plot is proposed,

which is based on two-factor encryption: mystery secret phrase-based encryption and master secret key-based encryption.

2.2 Access Control Mechanism

- The feature-based encryption for data privacy and access control framework proposed in [15] is considered to give data openness in emergency conditions and talks about circulating made sure about information among different client, proprietor, and various position situations. Access control and security of the well-being data in the constant application are given through attribute-based encryption. In [19], maker gives a merged procedure of fine-grained get the chance to order over cloud-based multi-worker data close by a provably secure compact customer affirmation segment which can be endorsed comprehensively in different heterogeneous condition. In [20], author supports facilitated exertion and gathering-based thought movement and ability to utilize applications subject to strategy essentials and an average plan of clinical information. It grants fuse of new organizations reliant on a total and longitudinal point of view on patients paying little mind to where or by whom the thought was passed on.
- Qihua Wang et al. proposed the distributed access control with outsourced computation in fog computing model which relies upon attribute-based encryption (ABE) which can viably accomplish the fine-grained admittance control. In any case, the computational intricacy of the encryption and decoding is developing straightly with the expansion of the quantity of traits [2]. To lessen the computational expense and assurance the secrecy of information, appropriated admittance control without sourced calculation in haze figuring. The standard thought of their methodology is to give fine-grained getting the opportunity to control [14] over sensor information, and it is versatile against ambushes, for example, client enamoring and center settling. Nevertheless, their model relies upon united methodology because solitary the [9, 21] framework regulator can perform key the board.

3 Motivation

Patients information is the opportunity not to be watched. It is viewed as a fundamental right that is critical to well-being, security, and personal satisfaction. Maintaining its security and privacy with access control policies for different users is a basic necessity w.r.t to existing applications [1, 3, 18]. However, in current scenario, there is a lack of access control policies as the data can be accessible to only doctors or in other cases the data is made public. In both cases, there are issues of security, privacy, and accessibility gaining all at once. A patient with obscure manifestations could be analyzed and treated with various restorative records in a few emergency clinics in the current medicinal framework. Therefore, recognizing cross-area secure

information sharing framework is important to encourage the treatment of the patient between different medical clinics. For example, medical clinic A's examination report can be obtained by the emergency clinic B specialists. The encrypted therapeutic papers produced by different emergency clinics are sent for capacity and inevitable information to the open mists. Crisis circumstances can occur in restorative frameworks, such as an auto-collision or a sudden swoon to the patient. In these crisis situations, the license's electronic medicinal records are urged to spare their lives. In any case, the rescue vehicle regularly works on the scene with no consent to the encrypted therapeutic documents. In this circumstance, the information protection security tool may prevent the crisis from saving the life of the patient. It is therefore essential for the rescue vehicle faculty to structure a break-glass access method to access the electronic medicinal documents despite the fact that they do not have the associated characteristic mystery key. Meanwhile, to avoid malignant information access by the aggressor, the break-glass access method should be sensible and responsible.

4 Proposed System

4.1 System Framework

The proposed model offers a privacy-friendly framework as shown in Fig. 2 data storage and self-adaptive access control system with smart deduplication:

1. **Smart cross-domain data sharing**: Patients may have a spot with various clinical establishments, (for example, one of a kind medical clinics and centers) in certified application. The framework is divided into a few medicinal areas as indicated by medical institutes and backups that medical institutes can safely share a patient's encrypted health documents with social insurance surgeons or specialists from medical institutes. Therapeutic records for patients are encoded using key generation-based attributes and AES Rijndael encryption with a cross-domain access policy, so the approved customers tend to have access throughout the framework.
2. **Smart self-adaptive access control**: In this system, the entrance control segment is self-adaptable with common place and crisis circumstances. Patients and medication staff register to their own clinical area and get the mystery keys quality that can be utilized in run of the mill conditions to acquire scrambled archives for patients. In emergency conditions, a break-glass access methodology is arranged with the target that a break-glass key dependent on a mystery expression can recoup every one of the patient's recorded clinical documents.
3. **Smart deduplication**: This system supports astute deduplication over quality-based scrambled information to save the additional room and diminish the expense of trade between the three-phase public cloud and data customers. It can be tested directed off the bat if the substance of the figure is a real one.

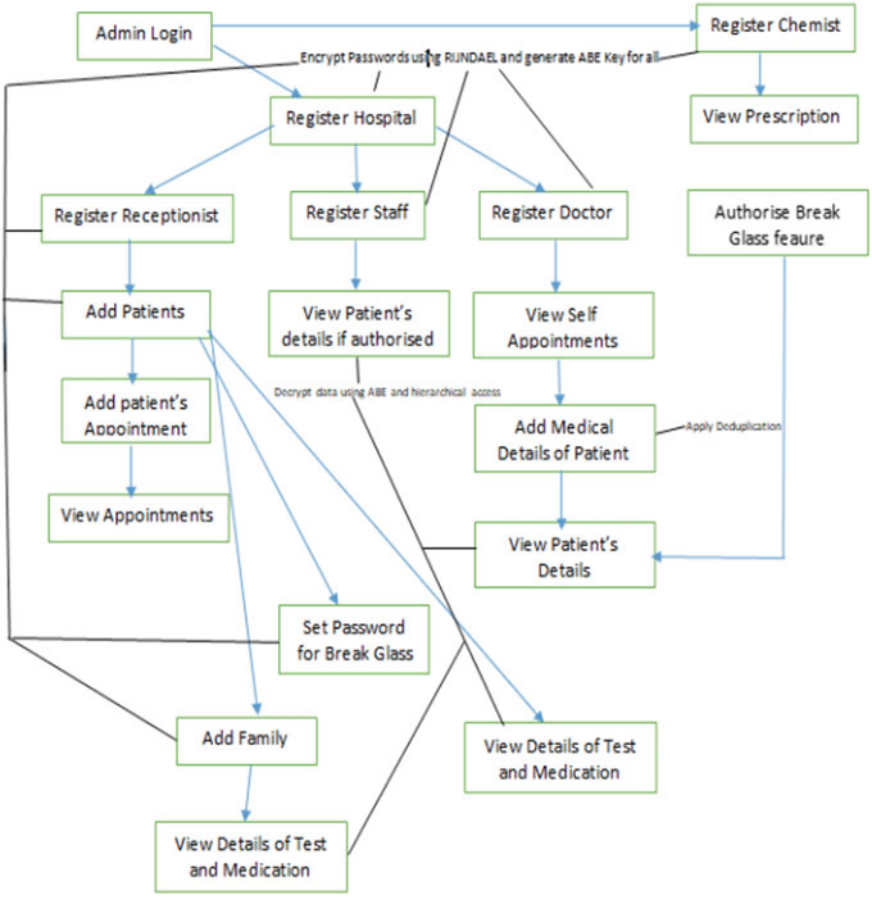

Fig. 2 System flow

Next, it can be tested whether there is an indistinguishable clinical record in the figure works. In conclusion, the figure content is re-encoded using a consolidated access arrangement with the ultimate goal of getting all the first characterized approved customers from the first figure writings to the encrypted data. No plaintext message is spilled into the public clouds during the deduplication procedure.

4.2 System Design

Registration admin has the right to register any hospital and chemist shops to the system. As admin registers the hospitals and chemist, their passwords are encrypted

while storing in cloud, so that the security and integrity of the hospital admin and chemist are maintained. Likewise, hospital admin has the right to register its staff and doctors to HRMS. Their passwords are also encrypted while storing in cloud, so that the security and integrity of the user's password are maintained. Attribute-based key generation is used to generate key of every user for the encrypted data access control. It converts the encrypted document with activation code to the zip file and then sends the activation code to download to the user. For users to access the file, the generated key is important.

Login any user who are registered to the application through their respective hierarchy can login through the login page. Password matching is done to the decryption of password and password match.

Data Upload This module helps the server to upload a file to the cloud, and the document is encrypted using symmetric encryption algorithm, i.e., AES Rijndael and ABE key generation. After getting logged in the cloud, the doctor can upload a file of patient which he wishes to share. While uploading the file, AES works simultaneously. As the file fragments are finished uploading, the file fragments are encrypted through AES and are spared in encoded design in the cloud. The client who has the position to get to the document would require the trait to coordinate the record access and unscrambling, and exactly at that point, the record can be downloaded.

Data Access On the off chance that any client other than the record proprietor, for example persistent, needs to get to the record from the cloud, they have to get to the document with the approved trait key. In the event that the client property key approves the client to get to the document, he can download the record. As the record is spared in the cloud in scrambled arrangement, the document ought to be first brought into its decoded organization to get the record in its unique configuration. As the user downloads the file, the user automatically decrypts the file via the user's attribute key to download the file and the user downloads the file in decrypted format.

Break-Glass Access The essential methodology of a hopeful security framework is to accept that any crisis circumstance mentioning information access is authentic and should be conceded. The information subjects are permitted to abrogate explicit access control consents. For this, it has proposed a solid break-glass solution that is dependent on password-based encryption and master secret key-based encryption. We have introduced this system for emergency access of the patient's data by any unauthorized user. This is a break-glass access system based on a password in which the user sets a password for accessing his emergency file. Whenever any emergency situation occurs, anybody can access the patients file who has the password. If the password matches, then all the medical reports of the patient can be viewed. With an enhancement in this break-glass system with respect to its security, the encryption of the password is incorporated. But as the system has a hierarchy-based access control mechanism, it is required to link that encryption with attributes of the person. When the patient sets the password, this password is encrypted and stored in database using AES RIJNDAEL algorithm [22]. In emergency situation, only the hospital admin has the right to decrypt the password using the patients mobile no. The hospital admin

can then provide the emergency access of patients file to the doctors which requires it, and the attribute key is matched of that particular user and doctor. If the key is authorized to break-glass access of the patients file, the doctor can access his file without any access control hierarchy mechanism.

5 Performance of Our System

IHRM and the current ABE are contrasted and conspired as far as communication and computation overheads. The tests are coordinated on a PC running Windows 10 64-piece working framework. Figures 3 and 4 show that our system is highly efficient in speed, and as it uses a combination of IBE-ABE, the efficiency of the system with privacy and security is comparatively higher with the other proposed systems for break glass.

IHRM is a giant universe improvement since the expert open key size is predictable and has no limitation on the size of the universe property set. The upside of colossal universe progression is that new credits can be balanced after the structure is set up. Another genuineness is that the extra room is little for assets. The IHRM system is uncommonly capable in speed and moreover can be open and available from any place as it is cloud-based application.

Algorithm

AES RIJNDAEL algorithm uses 10–128-bit keys, which are stored in 4 × 4 tables. The plaintext is also 128 bit chunks stored and divided into 4 × 4 tables. This 128-bit

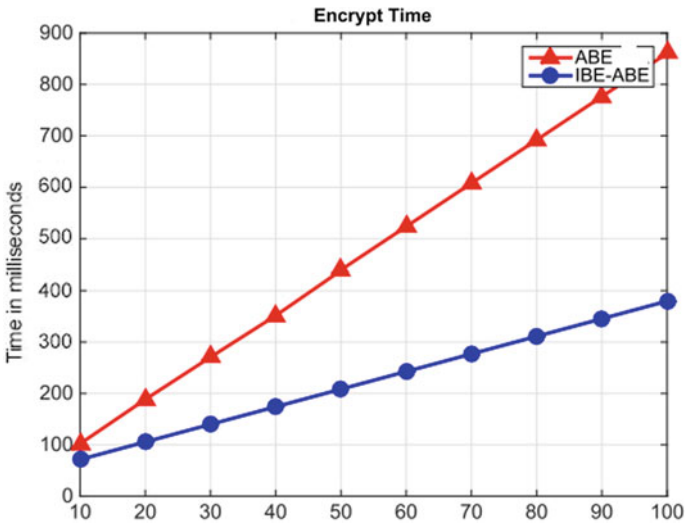

Fig. 3 Comparsion graph-encryption

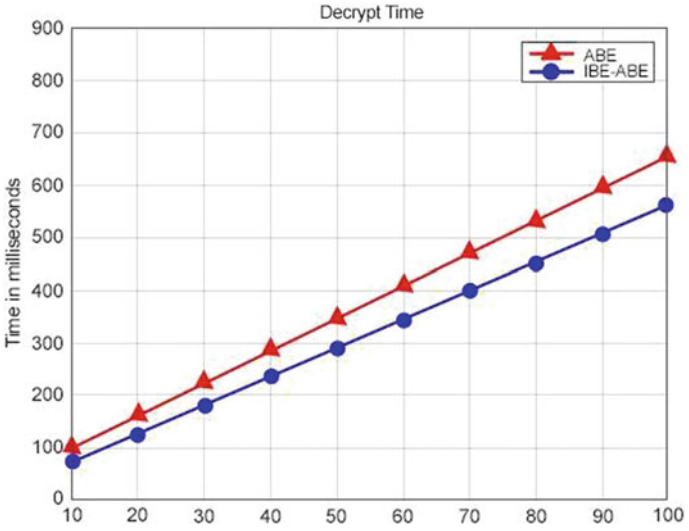

Fig. 4 Comparsion graph-decryption

plaintext chunk is processed each in a 10-round. The processing rounds depends on the size of the chunk, i.e., 10 rounds on 128-bit keys, 12 rounds for 192 bit, and 14 rounds for 256 bit. The code is generated after the tenth round. Each individual byte is substituted in an S-box and replaced by the reciprocal over Galois field (GF) (2 8). Further, a bitwise application of mod2 matrix along with an XOR operation is performed. Thus, the matrix rows are sorted cyclically followed by exchanging of columns via a Galois field (GF) (2 8) using matrix multiplication technique. In each round, an XOR link is applied to the subkey.

ABE-based key generation: In the key generation algorithm of ABE, there are attributes as follows: x1, x2, … xn0,1 r, rx1, rx2, … rxnRZp are chosen randomly to generate the private key SK where

$$SK = \left[g^{(\alpha+r)/\beta}, g^r \cdot H(x_1)^{r_{x_1}}, g^{r_{x_1}}, \ldots, g^r \cdot H(x_n)^{r_{xn}}, g^{r_{x_n}}\right]$$

Those random rs randomly chosen by the key authority is generated once for all users, and each user will be given the private key based on their attributes. To be more clear, assume user A claims attributes x1, x2 while user B claims x1, x3. They both at different times request a private key containing a component for attribute x1. So, rX1 is the same for both requests as grH(x1)rx1, and grx1 will be affected if they are different.

6 Conclusion

The proposed research work has a dispersed stockpiling structure for cross-area remedial archive with break-glass access control and secure deduplication to help the board's data in the medical care framework. Our work focus is on secure deduplication empowering the public cloud to recognize the cipher-texts with a similar therapeutic message; what's more, the restorative foundation's private fog to re-encode the cipher-text with a merged admittance strategy, so all previously approved information clients can get to the new code text. Moreover, this structure is the first to give the clinical applications two suits of access control systems: cross-territory trait-based access in commonplace conditions and break-glass access in crisis circumstances dependent on mystery phrases. These two instruments not only guarantee the safety of scrambled therapeutic documents of patients, but they also provide prompt access to emergency data to the lives of patients.

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Malignant Web Sites Recognition Utilizing Distinctive Machine Learning Techniques

Laki Sahu, Sanjukta Mohanty, Sunil K. Mohapatra, and Arup A. Acharya

Abstract With the development of Web technology, the Internet has become a stage for wide scope of criminal scheme including spam promotion, budgetary fraud, Web page defacement, etc. Because of the fast development of the Internet, Web sites have become the interloper's fundamental objective. As the quantity of Web pages expands, the malicious Web pages are moreover extending and the attack is dynamically gotten progressed. The existing approaches like blacking listing and dynamic analysis approaches are time and resources intensive, hence these methodologies are not adequate to classify the Web sites as malignant or benign. The proposed research work develops a lightweight classification framework to recognize malicious Web pages effectively using distinctive supervised machine learning classifiers like Naïve Bayes, K-nearest neighbors, random forest, AdaBoost, and some distinct relevant URL features. So here, some URL-based features are extracted for the detection of malicious and benign Web sites. We have experimented the test results using Python environment and found the random forest achieves highest classification accuracy of 98.7%.

Keywords URL · Classification · Malignant · Benign Web pages · Machine learning classifiers

1 Introduction

There are several Web sites that scan any URL for free. Recognition of malicious Web site is one of the most interesting research issues in the field of security. Nowadays, Internet has become a necessary aspect of one's life. The function of Web page's vital

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framework in different area, for instance, ease correspondence, safe fund transfer, proper trade management, and smooth E-administration make education to reach all [1]. One approach to robotization is for Web designers to make sure about and enhance their Web pages. Previous research studies have a few resemblance to this paper and uses different parts of URL features [2]. Blacklisting administration was installed in the programs to confront the difficulties however it has a few detriments like mistaken posting [3]. Malicious URLs are traded-off URLs that are utilized for cyberattacks. To ignore data waste, the URL identification proof is the best arrangement. So the recognition of malicious URL is externally a hot sector of data security because it lunches different types of attacks including drive-by download, social engineering, and spam. By utilizing susceptibilities in modules or include malicious code through JavaScript, drive-by download criticize is typically completed [4]. This paper has presented a lightweight method where the Web pages are dependent on a limited number of features. The proposed research has used four different machine learning (ML) techniques and some relevant features in detecting malevolent Web sites.

The rest of the paper is arranged as: Sect. 2 presents the related work, Sect. 3 describes methodology, Sect. 4 presents experiment and results, and conclusion and future aspects of is described in Sect. 5.

2 Related Work

Some correlated machine learning approaches are surveyed for binary classification of malicious Web sites. Tao et al. [5] presented a novel methodology for identifying Web pages as malignant or safe Web pages using classification algorithm (NB, decision tree, and SVM) utilizing HTTP period data (HTTP periods headers, areas of solicitation and reactions) with 50,000 benevolent Web pages and 500 malevolent Web pages. The accuracy of classification algorithms along with trained dataset was 92.2% and with a very low false positive rate was 0.1%. Yoo et al. [6] proposed a two-stage of detection method, in first stage, the discovery model used the decision tree algorithm, for identifying malignant Web pages, in second phase, the recognition model with one class SVM is utilized to identify new kinds of malignant Web pages. The detection rate of the malignant Web pages is 98.9% but the FPR was 30.5%. Dharmaraj et al. [7] presented a features selection and data preparation method in detecting malignant Web pages, detected malicious Web pages statically using URL strings. They used various supervised machine learning algorithms for evaluating the dataset and found the accuracy was between 95 and 99% and very low FPR and FNR for all the models of classification process. Aldwairi et al. [8] designed a lightweight framework considering URL lexical feature, host-based feature, and some special features to recognize malignant Web pages-based. MALURLS framework decreases the training time utilizing genetic algorithm (GA) to extend the training set and get to learn the NB classifiers. TF–IDF improved exactness by up to 10%, JS–Enable–Disable improvement was about 6% while 3–4–5 gm enhancement was restricted to 3%. Wang et al. [9] presented an approach which combines

both static and dynamic analysis for recognizing the malignant Web pages. In static analysis, the static features of pages are identified and the estimators are made to forecast whether the Web page is malignant or safe. But in dynamic analysis context, the Web pages run dynamically in the programming environment and the behavior of the Web pages was analyzed. Kazemian et al. [2] proposed three supervised learning and two unsupervised learning algorithms. They have used all these machine learning techniques to make predictive models for examining more number of malicious and non-malicious Web pages. These Web pages are parsed and different features similarly content, URL, and screenshot of Web pages are machine learning models. A replica of results on supervised learning has built an accuracy of up to 98% and 0.96 for the unsupervised learning technique. Vanhoenshoven et al. [10] presented a malicious URLs detection technique with some machine learning classifiers, such as NB, SVM, multilayer—perceptron, decision trees, random forest, and KNN. They implemented a dataset of 2.4 M URLs and 3.2 M features. The results are obtained using random forest and multilayer perceptron achieves higher accuracy. Sirageldin et al. [11] designed a shell for malevolent pages identification using an artificial neural network learning algorithms. They have considered two features of algorithms such as URL lexical features and page content features. The observation results is a high false positive rate (FPR) which delivered by machine learning approaches is decreased. Abbasi et al. [12] proposed a method where health-related data and guidance accessible on the Web are used for feature vector. They prefer adaptive learning algorithm known as recursive trust lsabeling (RTL). It utilizes substance and chart-based classifiers for increasing recognition of fake clinical sites. The experimental results have shown better accuracy of 94%. The results were obtained for confidence, security, and public safety. Kim et al. [13] build up a Web-Mon instrument which runs quicker than the conventional tools. They have used the techniques RFC, NB, LR, Bayes Net, J48, and SVM algorithms. For a malevolent pages identification method, an active representation was initiated which comprises of WebKit-2, ML, and YARA-based structure.

While there are a few methodologies have been proposed for identifying threatening destinations, the drawback of these approaches is to accomplish their results they used tens and hundreds and thousands of examples, used no process to identify vindictive URL redirection which going up against the difficulties in social event a wide scope of tests. The summary of the literature reviews is represented in Table 1.

3 Methodology

This section presents a lightweight binary classification method to recognize the malignant Web pages. The proposed research work has developed a framework of considering different binary classification algorithms including URL-based and host-based features to recognize the malignant Web pages represented in Fig. 1. The dataset is gathered from Web sources for the detection of malicious Web sites. Then, the data is cleaned by eliminating the noisy and messy data. Out of 21 features, only 9 relevant

Table 1 Summary of literature review

S. no.	Articles	Techniques used	Feature selection	Results
1	Tao et al. [5]	Naive Bayes (NB), decision trees, SVM	HTTP session information, domain-based and session header	Detection rate: 92.2% FPR: 0.1%
2	Yoo et al. [6]	Static analysis	HTML document, JavaScript feature	Detection rate: 98.9% FPR: 30.5%
3	Patil et al. [7]	SVM, AdaBoost, J48, random forest, random tree, NB, LR, SGD, and Bayes Net	Static features	Detection rate: 95–99%
4	Aldwairi et al. [8]	Genetic algorithm (GA), NB	Lexical, host-based and special features	Avg. system detection rate: 87%
5	Woiig et al. [9]	Static analysis, dynamic analysis, hybrid analysis	URL. HTML document JavaScript features	Precision:0_95 Recall: 0.82 F1 score: 0.91
6	Kazemian et al. [2]	NB, KNN, SVM, K-means, affinity propagation	Content, URL, javascript features	Accuracy of supervised; 98% unsupervised: 0.96
7	Vanhoensho et al. [10]	NB. SVM. Multilayer perceptron. Decision tree. Random forest. KNN.	URL-based features.	Highest accuracy: RFC And Multilayer Perceptron
8	Sirageldn et al. [11]	Artificial neural network	URL lexical, page content	High false positive rate
9	Abbasi et al. [12]	Recursive trust labeling (RTL)	Content-based, graph-based features	Accuracy: 94%
10	Kim et al. [13]	Random forest, logistic regression, Bayes Net, J48, SVM	HTML document, JavaScript and URL features	Detection rate: 98%

features and 830 records are extracted. Then the dataset is divided into two groups: training dataset consisting of 664 data and testing dataset comprises of 166 data. In step 4: data have been implemented on different machine learning classifiers with the solution of training set. In last step, the machine learning classifiers are utilized to predict the accuracy.

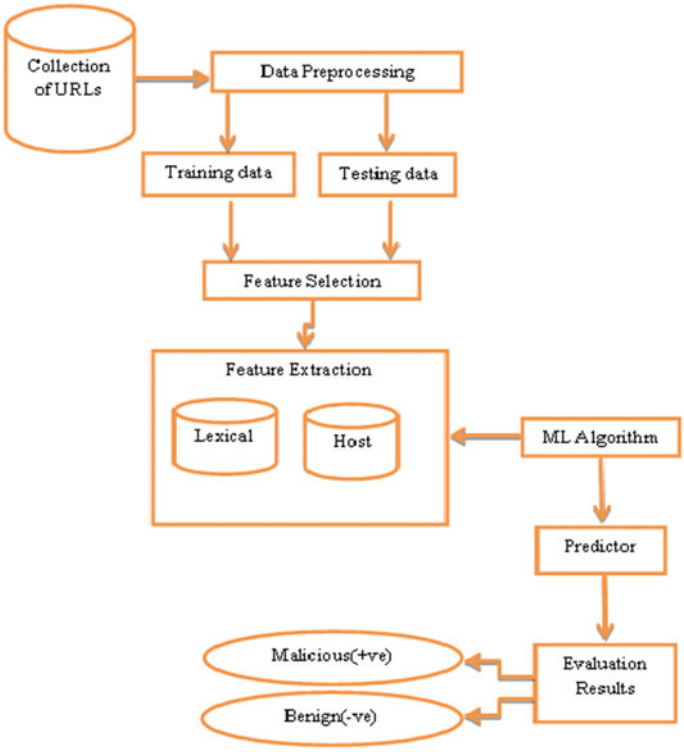


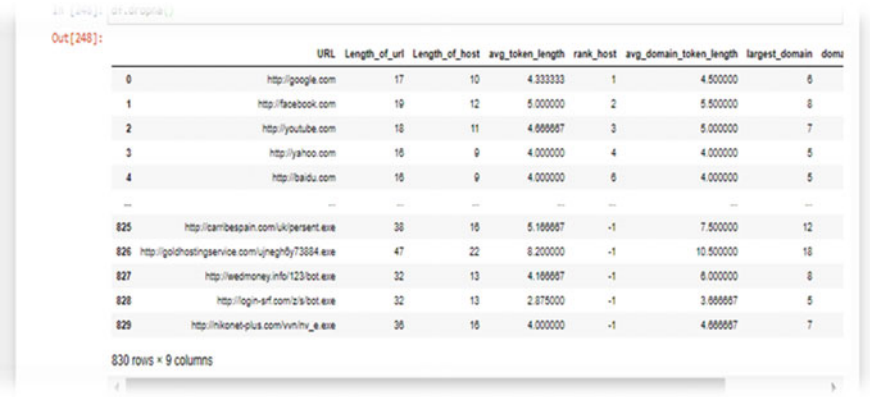
Fig. 1 Classification framework for malicious Web sites detection

3.1 Dataset

The downloaded Web pages are partitioned into one set yet it contains both malicious and benign [2]. The source for the URL-based dataset accumulated from finding malicious URL through URL features [14]. This dataset has 830 data and 21 features. Out of 830 data, for training set, 664 data are utilized and another testing set 166 data are used. Portrait of our data file is given in Fig. 2.

3.2 Selection of Features

The URL features are selected manually. Out of 21 features, we have selected nine essential relevant features which are required for our research purposes. In the feature selection process, the raw and noisy data are eliminated. These features' description is presented in Table 2. Features are categorized into two groups, i.e., lexical-based feature and host-based feature. Lexical-based feature involves URL, domain token



Out[248]:

	URL	Length_of_url	Length_of_host	avg_token_length	rank_host	avg_domain_token_length	largest_domain	domu
0	http://google.com	17	10	4.333333	1	4.500000	6	
1	http://facebook.com	19	12	5.000000	2	5.500000	8	
2	http://youtube.com	18	11	4.666667	3	5.000000	7	
3	http://yahoo.com	16	9	4.000000	4	4.000000	5	
4	http://baidu.com	16	9	4.000000	6	4.000000	5	
...	...	...	...	...	...	...	...	
825	http://carribespain.com/uk/persent.exe	38	16	5.166667	-1	7.500000	12	
826	http://goldhostingservice.com/ujneghfy73884.exe	47	22	8.200000	-1	10.500000	18	
827	http://wedmoney.info/123/bot.exe	32	13	4.166667	-1	6.000000	8	
828	http://login-srf.com/zls/bot.exe	32	13	2.875000	-1	3.666667	5	
829	http://nikonet-plus.com/vvn/nv_e.exe	36	16	4.000000	-1	4.666667	7	

830 rows × 9 columns

Fig. 2 URL dataset

Table 2 Lexical- and host-based features

S. no.	Features	Descriptions
1	URL	It is tile anonymous distinguishing proof of tile URL brake down ill tile investigation
2	LENGTTH-OF-URL	It is a quantity of characters in the URL
3	Length of host	It needs to be specified as variable in the send
4	Avg. token length	Number of characters in tile token. The average token length of each approach, the data are taken from the training data
5	Rank host	It offers services like Web hosting, domain registration, and Web design, Web site development, software development, Web site maintenance on Linux and windows server
6	Avg. domain token length	Represent the maximum no. of characters you can have in a Web sites address left of "." is 63 characters
7	Largest domain	That means consider only values of "real numbers" which make tile function defined
8	Domain token count	It is a simple module to provide alternative domain associated tokens for administers to send e-mails to users
9	Malicious	It represents target value

length, largest domain, domain token count, and the rest of the features involved host-based features [14].

3.3 Classification Algorithms

The binary classification algorithms of machine learning are used in our experiments to predict the classification accuracy of malicious Web pages. These are K-nearest neighbor (KNN), Naïve Bayes (NB), random forest (RFC), and AdaBoost classifier.

KNN: KNN is a nonparametric method. It manages marked focuses to prepare name other focuses. It marks the new point by choosing the focuses that are near that point. K is the quantity of nearest neighbors used for accuracy expectation.

Naive Bayes: NB is a binary classification techniques based on Bayes' theorem. A Naive Bayes classifier assumes that the presence of a particular feature in a class is not related to the presence of any other feature.

Random Forest: It commands overfitting utilizing bootstrap aggregator or bagging. The objective of random forest classifiers is to combine various decision trees to get the final result.

AdaBoost: AdaBoost classifier is an ensemble machine learning method used to boost the performance of decision trees on binary classification problems. AdaBoost can be used in conjunction with many types of learning algorithms to improve performance.

4 Experiment and Result

The machine learning algorithms such as Naïve Bayes, KNN, random forest, and AdaBoost classifiers are implemented on Jupyter NoteBook [15] and belong to an interactive Python environment. With its integrated support for Pandas, Scikit-learn, Matplotlib and plots a much more understandable presentation of the flow of the code can be designed. Four algorithms are compared to recognize malignant Web pages. But as compared to other algorithms random forest classifier achieves highest accuracy to detect the malicious Web pages.

The different machine learning performance metrics like accuracy, precision, recall, F1 score, and AUC score are used for the detection of malicious Web pages, which is represented in Table 3.

Table 3 Comparison table of machine learning classifiers

Machine learning classifiers	Accuracy (%)	AUC score	Precision	Recall	F1 measure
NB	96.3	0.971	0.92	1.00	0.86
KNN	93.3	0.937	0.82	0.95	0.88
RFC	98.7	0.977	1.00	0.82	0.92
AdaBoost	96.0	0.967	0.88	1.00	0.94

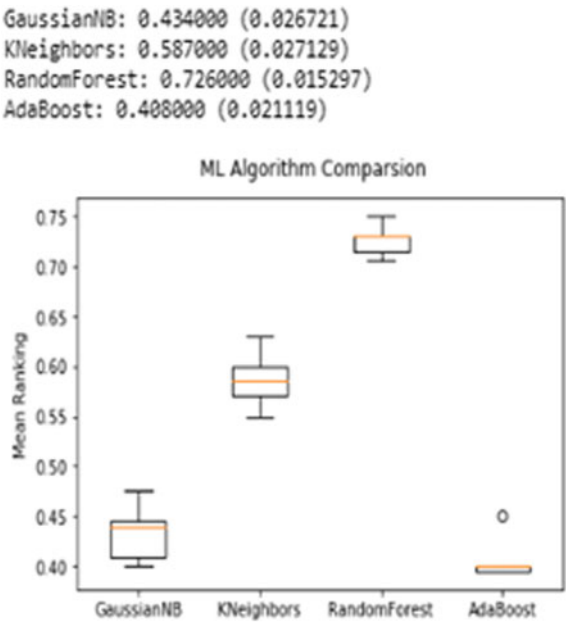


Fig. 3 Mean and standard deviation accuracy of ML classifier

The mean accuracy and the standard deviation accuracy of different classifiers are depicted in Fig. 3.

The graph in Fig. 4 represents that random forest has the highest accuracy score and gives exact outcome when compared with the other algorithms. It is clearly represented that the RFC classifier achieves highest accuracy of 98.7% and KNN achieves lowest accuracy of 93.3%.

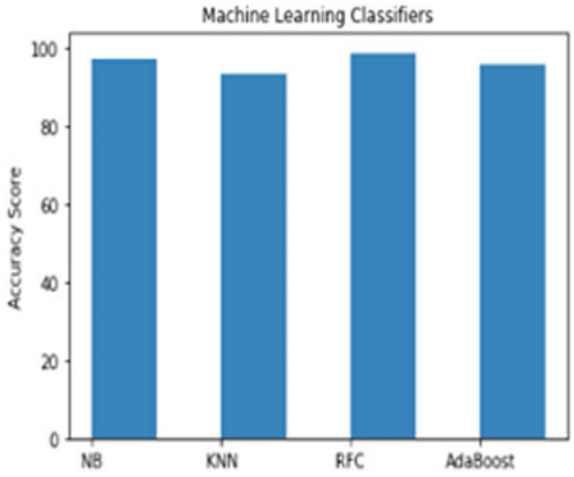


Fig. 4 Accuracy comparison of ML algorithms

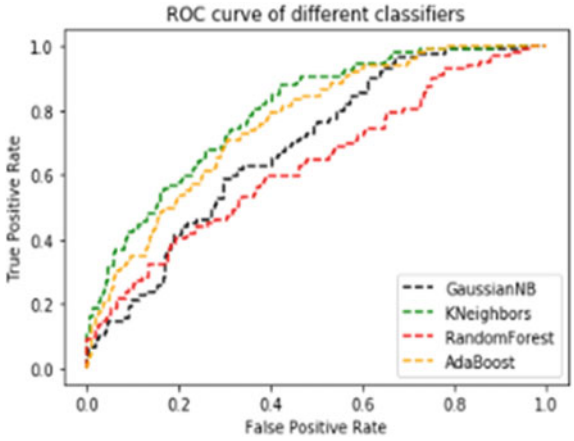


Fig. 5 ROC curve of different classifier

Receiver operating characteristic (ROC) curve in Fig. 5 is utilized to examine the efficiencies and performance of these four algorithms.

5 Conclusion and Future Aspects

The multitude of cyberthreats out there, malicious Web sites play a critical role in today's attacks and scams. Web services are the foundation of connection and communication between applications over the Internet. Recognition of malicious URL is most interesting topic in cybersecurity. Though a few examination contemplates have been performed identifying with the issues of malignant Web pages identification, yet these are expensive as they devor additional time and assets. This paper has utilized new Web site characterization framework dependent on URL-based feature to predict the Web page as malignant or safe utilizing machine learning algorithms. The proposed approach has been implemented and the experimental result shows that random forest classifier (RFC) has the highest classification accuracy of 98.7% of detecting malicious Web pages in comparing various machine learning techniques. In future, it can be planned to use a selection technique for different data sources to improve the performance results of the classifiers.

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Speech Parameter and Deep Learning Based Approach for the Detection of Parkinson's Disease

Akhila Krishna, Satya prakash Sahu, Rekh Ram Janghel, and Bikesh Kumar Singh

Abstract Parkinson's disease is one of the common chronic and progressive neurodegenerative diseases across the globe. Speech parameters are the most important indicators that can be used to detect the disease at its early stage. In this article, an efficient approach using Convolutional Neural Network (CNN) is used to predict Parkinson's disease by using speech parameters that are extracted from the voice recordings. CNN is the most emerging technology that is used for many computer vision tasks. The performance of the approach is discussed and evaluated with the dataset available in the UCI machine learning repository. The dataset will contain the attributes of voice recordings from 80 individuals out of which 40 individuals are Parkinson affected. Three recordings of each individual are used and 44 features are extracted from each recording of a subject. The experimental setup of the proposed approach on the benchmark data has achieved the best testing accuracy of 87.76% when compared with the available ground truth of the dataset.

Keywords Computer-aided system · Parkinson's disease · Convolutional neural network · Deep learning

1 Introduction

Researches have been conducted to find appropriate indicators that allow the development of decision support tools that can detect diseases in a very precise and fast manner. Neurodegenerative diseases are caused due to the loss of functionalities of neurons in the brain and peripheral nervous system. Parkinson's disease (PD) is one of the most common neurodegenerative diseases [1]. This disease is characterized by neuron loss in the brain near the motor cortex thus, affecting the movement of a person. As the death of neurons is a very long process, symptoms start to appear at

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the later stages [2, 3]. It makes it difficult to diagnose the disease at the early stages and give the proper medication. The most common symptoms of PD are balance loss, muscle stiffness, tremor, and motor skill damage [4].

According to the world health organization, 10 million people are already affected by the disease, and the Parkinson foundation states that by 2020 at least one million people in the US will be affected by PD. As the motor-related symptoms which are the primary measures to diagnose the disease tend to appear only after 80% of neurons die in the brain, the diagnosis of the disease is very harder through motor-related indicators [5]. Besides motor symptoms, one of the most important non-motor symptoms is speech impairment due to the weakening of voice muscles.

The voice disorders are found in 89% of the PD patients [6] and the formation of the abnormalities in the speech is discussed in the publication of James Parkinson [7]. The main abnormalities in speech are due to impaired mimicry, the deficit of laryngeal function, decreased speech force and reduced lung life capacity. These irregularities cause abnormalities in voice including monotonous speech (modulation will be limited), tone of the voice will be lowered, difficulties with changes in loudness, rough and hoarse tone, voltage reduction of vocal folds, change in speech pace, and improper articulation.

A specific clinical technique is not available for the diagnosis of disease instead neurologists predict using medical history through close examination of physical and neurological signs and symptoms of a patient. Computer-aided systems are taking on a new era of disease detection and diagnosis. These technologies ensure a short time diagnosis which can be more efficient as it detects even the slightest variations which are not even perceptible to the human.

The subtle abnormalities in the voice of PD affected people are not perceptible to the listeners at the early stage but can be identified by doing acoustic analyses on speech signals that are recorded [8–10]. The features extracted from the acoustic analysis phase can be used to identify the disorders or abnormalities in the voice. Even though there is no permanent cure to the disease, symptomatic relief can be achieved which in turn helps to enhance the life of patients.

1.1 Related Work

Many kinds of research have been done to prove acoustic analysis can be one of the best non-invasive techniques for earlier detection of Parkinson's disease. The acoustic analysis along with a proper classification framework leads to the identification of the disease accurately. Some of the classification techniques which are employed in this context are artificial neural networks, Support Vector Machines, Regression, etc. [11–13]. Recently deep learning techniques are also found to be effective. In Yasar et al. [11], an artificial neural network was used with voice features extracted from both PD patients and healthy people. Maximum accuracy of 94.93% was recorded in this article using this technique. Hemmerling et al. [12] discusses nonlinear support vector machine to detect the disease using vowel /a/ phonation in a sustained manner and

Principal component analysis (PCA) is used to extract the features. This technique produced a maximum accuracy of 93.43%. The disease detection discussed in Lin et al. [13] is done using a discriminative model based on logistic regression.

Disorders in speech are identified for proper diagnosis of speech-related diseases. Deep learning is found to be the emerging technologies in finding the disorders associated with the voice or speech. The article [14] compared a Multi-layer perceptron algorithm (MLP) and a convolutional neural network architecture for identifying voice pathology or the voice samples with phonetic and speech disorders. Convolutional neural network outperforms MLP with better results. Similarly, another deep learning technique, the Long short term memory model (LSTM) was discussed in [15] for voice pathology detection. The combination of deep learning techniques CNN and LSTM is also an efficient way of voice pathology detection and it is discussed in [16].

This article investigates the effectiveness of the deep learning approach (convolutional neural network) in detecting Parkinson's disease using the vocal features extracted from the voice recordings. Manual selection of the features is avoided and the convolutional layers themselves are used to select the best features that can distinguish between PD patients and normal individuals. Thus, an automatic and easier way of finding the best features is employed. The article is a foundation for further researches on deep learning (convolutional neural network) being an effective framework along with semi-automated and automated feature selections to diagnose the disease with extracted acoustic features.

2 Methodology

The proposed deep learning framework is shown in Fig. 1. The first phase of the framework is a data collection phase which is described in Sect. 2.1 of methodology. The next phase is a preprocessing stage where the data is normalized between the range [− 1, 1]. A one-dimensional CNN is built and the data is applied for training the network and the network is tested using another set of data.

2.1 Data

The data used in the experiments of this article was collected from the UCI machine learning repository which contained replicated speech parameters. Three recordings of each subject out of 80 subjects were considered of which 40 are healthy and the other 40 are Parkinson's diseased. 44 voice features or attributes were extracted from each recording which makes the dataset size 44 columns and 240 rows. Voice features from five different families, namely spectral envelope measures, noise features, amplitude local perturbation measures, pitch local perturbation measures, and nonlinear measures are used in the study [8, 9]. Cepstral coefficient of Mel

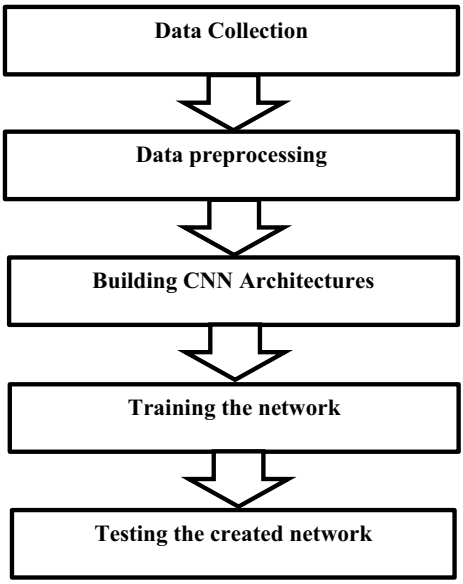

Fig. 1 Flowchart of deep learning framework

frequency from order 0–12 and their derivatives (MFCC and Delta MFCC) is the spectral envelope measures considered in this study which depends on articular position so the slightest misplacement can also be detected [17]. Harmonic-to-noise ratio (HNR) which measures the ratio of noise present in speech are extracted using voice sauce toolbox and HNR measures are calculated using cepstrum-based technique and Glottal-to-noise ratio (GNE) which measures the ratio of vocal fold's voice excitation oscillation to the excitation by the turbulent noise are the noise features used. Absolute jitter, Relative jitter, average relative perturbation, and quotient of pitch perturbation were considered under the local pitch perturbation family of voice features and it is extracted using waveform matching algorithm. The perturbation measures of amplitude used were shimmer in dB, local shimmer, 5-point amplitude perturbation quotient, 3-point amplitude perturbation quotient, and 11-point amplitude perturbation quotient. The last family was nonlinear measures which have been used in many of the previous researches to find the effect of vocal features in the detection of Parkinson's disease using acoustic features. They include Entropy of Detrended fluctuation analysis, Recurrence period density, and Entropy of Pitch period.

2.2 Deep Learning

It is one of the latest technologies which have got attention from industrial and research area in the last decade. This technology is the key to develop and launch smart products in the market. Multiple layers of processing units are designed using

neural network architecture which uses linear and nonlinear transformation on input data. These can be applied to any kind of data: numerical, text, images, audio, or any combination of them [18]. Deep learning is found to be very effective in identifying the voice disorders in the voice as some of these extracted features can discriminate the people with the disease and the normal one. With the help of deep learning techniques, these features are selected and are used for classification using neural networks [11–13].

Convolutional Neural Network

A convolutional neural network or CNN is an important deep learning algorithm that requires comparatively less preprocessing [19]. These are artificial neural networks with alternate convolutional and sampling layers and possess the advantage of self-learning from the given input. The technique is primarily designed for image classification but a variant of CNN called 1D CNN is well suited for one-dimensional data [20]. There are many advantages of 1D CNN over 2D CNN (suited for image classification) which includes low computational complexity due to simple array operations rather than matrix operations, shallow architectures which are easy to design and implement, feasible and relatively fast learning, and is very suitable for low-cost applications [21]. Convolutional Layer, Pooling Layer, and Fully-Connected Layer are the three main important CNN layers.

Convolutional Layer

It is an important layer of CNN that performs the feature extraction so that separate manual feature extraction can be avoided reducing the manual interference in the computer automated systems [22]. The layer performs a convolution operation which is very similar to that of the linear operation in a traditional neural network where the input is getting multiplied by the weights which are constantly being updated according to the error generated. In a forward pass, neuron i in layer l receive input from the previous layer as below:

$$\mathrm{In}_i^1 = \sum_{j=1}^{n} \left(W_{ij}^1 x_j + b_i \right) \tag{1}$$

Here W is the weight, x is the input and b is the weight. Accordingly, the two-dimensional array is multiplied with the input data and the two-dimensional array of weights which are called filter or kernel. In specific, the multiplication performed here is dot product and it is done between the much smaller kernel and the kernel-sized part of the input. The output of this operation for a single time will be a single value as multiplication is done element by element and is summed up. The smaller-sized filter will help in multiplying the same kernel multiples times on different points of input. This is done systematically from left to right and top to bottom on the input.

Pooling Layer

This is the layer present after the convolution layer and more specifically after nonlinearity is applied on the feature map. It gives an ordering of layers and the layer can

be added multiple times in a model [22]. This layer is applied on each feature map which is produced as an output of the convolutional layer and a completely new different set of pooled feature maps are produced but the number of feature maps will be the same as the previous layer. A pooling operation (like a filter) that has a size lesser than that of the feature map is applied which minimizes the feature map size. The two most common pooling operations are average pooling and maximum pooling. The former will calculate the average of each patch of the feature map and the latter will find the maximum value in each patch of the feature maps.

Batch Normalization Layer
The difficulty in taking the right learning rate and initializing network parameters are resolved through this layer. This layer is also used because there is a significant effect by the previous layer parameters on the inputs in each layer which causes a complicated learning problem, covariate shift. Covariate shift is the condition where the inputs of each layer are changing continuously. Feature-wise centering and normalization to mean zero and variance one is the main purpose of the batch normalization layer [23]. Batch normalization has two main stages namely, normalization and scaling. Assuming $f = [f_1, \ldots f_k]$ is the input received, normalization and shift and scale equations are given as

$$\text{Normalization} : f_k' = f_i - \frac{E[f_i]}{\sqrt{\text{Var}[f_i]}} \tag{2}$$

$$\text{Shift and scale} : h_i = \gamma f_k' + \beta_i \tag{3}$$

The new parameters of the network that is used in the training are $\left[\gamma, \beta_i\right]$.

Fully-Connected Layer The above-mentioned layers are for finding the suitable features that are capable of classifying the input appropriately [22]. Now the process of classification is done by a Fully-connected layer from the output of convolution and pooling layers. This layer is very similar to the artificial neural network which is used for classification. Before applying the Fully-connected layer, the output from the previous layers is converted into a single vector of values. The probability of the feature vector to be in each class is evaluated and then compared with each other. The most appropriate weights are identified by using their backpropagation process. The weight received by neurons prioritizes the class to which it belongs.

2.3 Proposed Architecture of CNN

This experiment is performed by generating different architectures of the 1D CNN model to identify the disease in a precise way using extracted speech parameters. These architectures are discussed in Table 1. The architectures are built by varying

Table 1 CNN Architectures used in the experiment

Architecture no	Architecture 1	Architecture 2	Architecture 3	Architecture 4 (adopted)
Layers	Conv1d (8,2) Pooling (2) FC (16) FC (2)	Conv1d (16,2) Conv1d (16,2) Upsampling (3) Pooling (2) FC (16) FC (10) FC (2)	Conv1d (16,2) Conv1d (16,2) Upsampling (3) Pooling (2) Conv1d (16, 2) Conv1d (16,2) Upsampling (3) Pooling (2) FC (16) FC (10) FC (2)	Conv1d (32,3) Conv1d (32, 3) Upsampling (3) Pooling (2) Dropout (0.5) Conv1d (32,3) Conv1d (32,3) Upsampling (3) Pooling (2) Dropout (0.5) FC (16) FC (10) FC (2)
Total Parameters	2762	16,912	25,136	52,498

the number of layers and the trainable parameters. As convolutional neural networks do not require a separate manual feature selection, so features are efficiently selected by the model itself. Thus it reduces the effort of handpicking the best features suitable for classification.

The layers of the best performing CNN architecture among all the experimented architectures are shown in Fig. 2. There are two blocks in the architecture where each block is having two layers of convolution, a batch normalization layer, and a dropout layer. The input is passed into the two blocks and the output of the second block is flattened to a single vector of values. This vector is given to two layers of fully connected layers for classification. Training and testing are performed to validate the model developed. The training phase is carried out by dividing the data into two groups training set and testing set where 20% of the total data is divided and kept for testing the model and the rest is applied to train the network model for increasing the classification accuracy.

3 Experimental Results and Discussion

The proposed convolutional neural network is applied to the voice feature dataset. Python programming language was used to implement with Keras library on a computer with the configuration of Intel core i3 processor with 4 GB random access memory. The performance of the classifiers is evaluated using measures such as classification accuracy, sensitivity, and specificity. The basic reliability of the classifier is determined by accuracy. The sensitivity and specificity measure how well the classifier predicts one of the two categories.

The training and testing accuracy of the architectures referred to in Table 1 is compared in Table 2. It is visible that architecture 4 produces a maximum accuracy

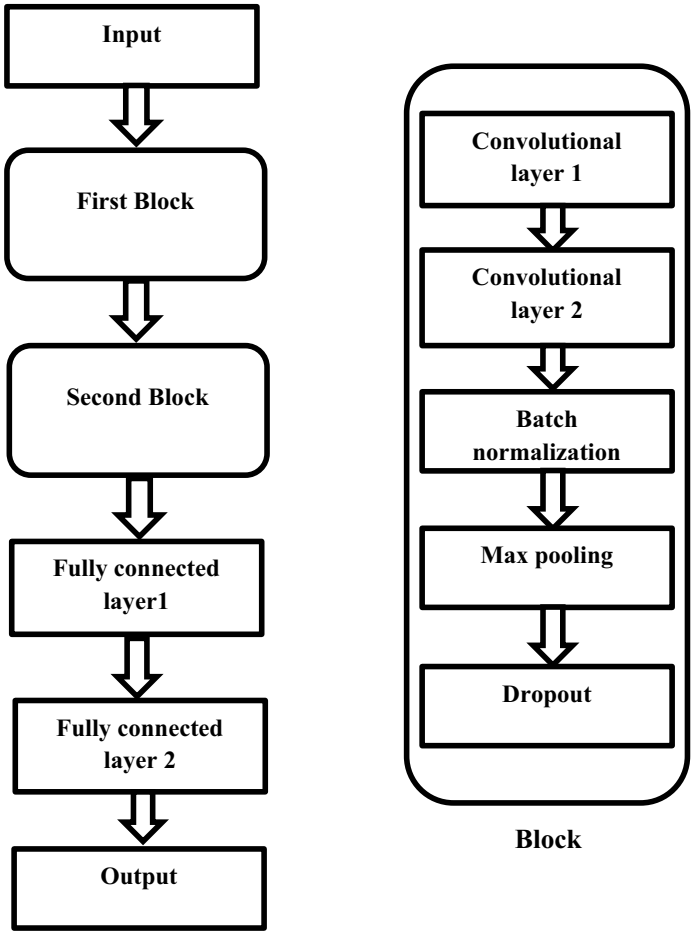

Fig. 2 Adopted architecture of CNN

Table 2 Performance of different architectures

Architecture No	Training accuracy (%)	Testing accuracy (%)
Architecture 1	79.63	77.97
Architecture 2	86.42	82.87
Architecture 3	87.28	85.69
Architecture 4	89.13	87.76

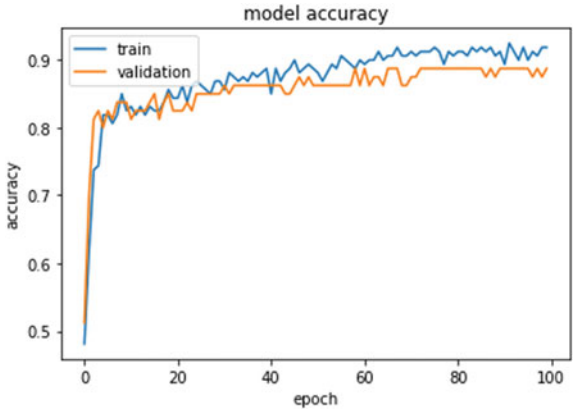

Fig. 3 Training and testing accuracy of architecture 4

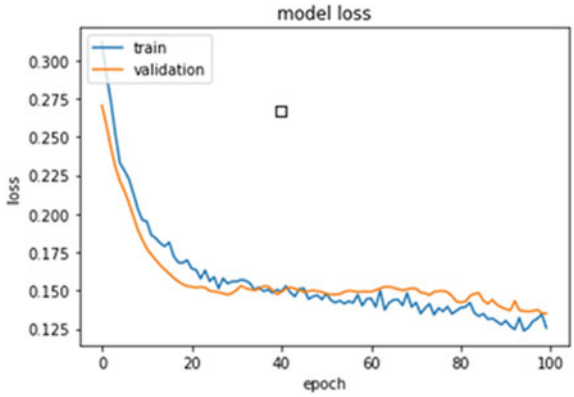

Fig. 4 Training and testing loss of architecture 4

of 87.76%, a sensitivity of 88.7%, and a specificity of 90.5% when architecture 4 is applied with a small dataset of speech parameters. The performance of the model is depicted in Fig. 3 where it is visible that the training accuracy and testing accuracy are almost the same and don't differ too much. Figure 4 shows the loss of the model and this also states that the training loss and testing loss also don't differ much and the value of loss in the last iterations is reaching 0.125.

4 Conclusion

Diagnosis of the disease using a computer-aided system has made revolutions in the medical field. The proposed model is to diagnose Parkinson's disease with a convolutional neural network in diagnosing the disease using speech parameters. Even though the dataset available for the research was having a limited number of entries, a classification accuracy of 87.76%, sensitivity of 88.7% of and specificity of

90.5% is obtained with architecture 4. The results are very promising in comparison to the size of the data used in the research. The proposed architecture is a very simple way of diagnosing the disease with minimal layers of convolution. Compared to any other ways of identifying the disease, voice features enable a low-cost, efficient, and easy-to-use technique and it is very handy as there is no separate feature selection phase. The results are positive to think that on large datasets with more number of subjects, deep learning will outperform the results produced by machine learning algorithms. Hybrid models can be used to enhance the results in the future.

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Study on Data Transmission Using Li-Fi in Vehicle to Vehicle Anti-Collision System

Rosebell Paul, Neenu Sebastian, P. S. Yadukrishnan, and Parvathy Vinod

Abstract This paper examines the relevance of a fast approaching highly secure and fast data transmission technique using Li-Fi. It describes the upcoming technology Li-Fi and its applications as well as the developments made in it so far. It enlightens on the new era that will soon be used in almost all domains like health sector, school, bank and so on. An application framework design has been studied to analyze the role of Li-Fi in the process of communication.

Keywords Li-Fi · Light emitting diode (LED) · Wireless communication · IoT · V2V communication · Data transmission

1 Introduction

Light emitting diodes (LED) bulbs that are used in our household as light source are not only capable of lighting the surroundings but can also be used to transmit data. This idea forms the backbone of the new technology Li-Fi. Li-Fi stands for light fidelity and it uses LEDs intensity variation for transmission of data. It is very difficult or almost impossible for the human eyes to trace this variation as it happens too rapidly. We can say that Li-Fi is a light-based Wi-Fi technology. The Li-Fi revolution can possibly eliminate most of the problems of the existing wireless-fidelity infrastructure (Wi-Fi) in several core areas like medicine and health sector

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since it evokes no electromagnetic reaction. The recent studies made in Li-Fi [1] reveal that it is going to be a part of the framework of 5G. It has been recognized by IEEE since the end of 2017, as an IEEE 802.11 working group has been formed for making the studies on standards for visual light communications. Wi-Fi has to abide to the country's particular regulations as it works with the spectrum allocation but Li-Fi does not.

Professor Harald Haasa German physicist, known as the founder of Li-Fi, introduced the term Li-Fi and he is the co-founder of PureLi-Fi which is a company based on light communication established by him in 2012 to work intensively on this new finding. He successfully illustrated a Li-Fi prototype at the TED Global conference in Edinburgh on 12 July 2011. He used a table lamp with an LED bulb to transmit a video that was then projected onto a screen. [2]. This idea pioneered by him gave a new direction to the researchers to explore more on the light waves [3].

In the next section, the basic principle of Li-Fi is explained followed by a briefing on a few applications of Li-Fi with several examples where it has already been implemented. In the Sect. 4, a comparative study is made with Wi-Fi. Section 5 describes the market growth of Li-Fi along with a study of converging Li-Fi with several emerging technologies. Section 6 is a prototype model framework illustrating the data transmission using Li-Fi in a vehicle to vehicle communication to avoid collision. Sections 7 and 8 show the analog and digital data transmission in our system. The results and inferences obtained from our experimental study are mentioned in Sect. 8. Finally, this paper is a journey through the developments made so far using Li-Fi and the authenticity of using Li-Fi for data transmission in analog and digital format is studied using the prototype model.

2 Principle of Li-Fi

Li-Fi can be termed as light-based Wi-Fi, i.e., instead of radio waves, it uses light to transmit data. In place of Wi-Fi modems, Li-Fi would use transceivers that have LED lamps that could brighten a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is hardly utilized.

LED bulbs or any light source can be used to transmit the data and the photodetector is used to detect the flash light emitted from the transmitter side. The data to be transmitted has to be encoded into a binary format which consists of a sequence of 1's and 0's. This binary stream of data is given as input to the LED light source and it will be transmitted when the LED glows. These flashes are then detected by the photosensors. The photosensors transfer the binary data for amplification, thereby strengthening the signal in order to decode the binary digits. Finally, the decoded data is transferred to the end device [4].

The block diagram of a Li-Fi transmitter and receiver system is depicted below.

Transmitter section consists of the Web server, modem and LED driver (Fig. 1).

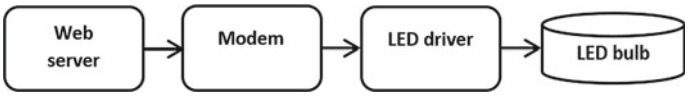

Fig. 1 Basic block diagram of the transmission section

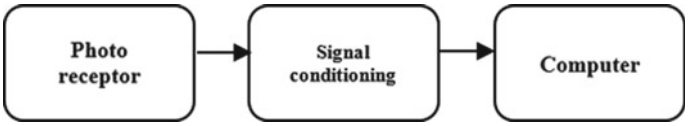

Fig. 2 Basic block diagram of the receiver section

Modem performs the necessary modulation to the incoming data, thereby making the data signals more suitable. As we change the intensity of the current send to the LED bulb, the brightness of the bulb changes which can then be converted into 1 s when illumination is maximum and 0 s when illumination is minimum. In this way the LED bulb is rapidly flickered, millions of time and is not visible to our naked eyes. In order to control this flickering properly, we make use of modulation. The three different types of modulation in Li-Fi are: single carrier modulation (SCK), multiple carrier modulation (MCK) and color modulation [2].

LED driver changes the driving current for this LED bulb according to the incoming streaming data to get the flickering. It plays the role in the conversion of digital signal to photonic signal.

Receiver section consists of the photoreceiver and is then given for signal conditioning before being transferred to the computer (Fig. 2).

Photoreceiver or the photodiode converts the optical signals received into electrical impulses. Signal conditioning mainly performs the necessary amplification and processing of the received signals before sending to the work devices. Thus, we can say that Li-Fi provides a one to one point of communication between any two devices in a highly secure manner. It has a speed much faster than the existing connection technologies. Though the term came into being in 2011, several studies and research are still being done to make it accepted all over the world. Since it makes use of the visible light spectrum, it can be used to pave way for communication at places where Internet access is denied like petrol pumps, operation theater, aircraft, etc. A study on the several applications developed using Li-Fi in several systems reveals that this technology will soon conquer the whole world. Li-Fi can protect the mankind from radio waves as the light spectrum used in Li-Fi does not penetrate through the body and is much safer when compared to the hazards caused by radio waves [5].

3 Applications of Li-Fi

3.1 Li-Fi in Medical Department

The radiation hazards caused to the human body can be drastically reduced if we make use of Li-Fi technology. The minute details of patients can be continuously monitored as long as there is a LED light in the room and the data transmission is done in such fast rate that emergency situation can be handled well. The main challenges in our hospitals are that the rooms require multiple access, and therefore the network becomes dense and heavy and complex cables are needed for the different equipment. The typical network architecture which consist of laying cables, installing routers, switches, etc., becomes difficult in hospitals. Schnell Li-Fi along with Huawei has come with the idea of all optical hospital in which they use Li-Fi and optic fiber as a better choice for hospital infrastructure. They called it green networks as Li-Fi technology uses passive light with no known health hazards. Similarly, Li-Fi is the best option in a room which has confidential information as it cannot be hacked. The photonics network will always be preferred in future for sensitive environment which consist of several medical devices as the Wi-Fi signals might interfere with the device signals at hospitals thereby affecting the readings. The various devices in the hospitals are connected to each other and may also require to transfer data to cloud for future analysis. As IoT enters the surgery room, Wi-Fi will become obsolete. The Li-Fi devices of Schnell were proven to be compatible with the Huawei and so they just had to plug and play making it easy to assemble and reconfigure. Thus, Li-Fi provides wireless connectivity for telemedicine, lifesaving applications, hospital security systems and vital body sensors. Similarly, Li-Fi indoor positioning system can optimize the navigation within the hospitals [6].

3.2 Li-Fi in Aircraft

For the first time in world, Air France A321 tested Li-Fi Technology during a flight in a 12-seater specially designed aircraft in which the travelers could play video games. By working on it for a short time span of a little of 6 months they built the system and successfully used Li-Fi describing it to be a much simpler technology than the traditional equipment they used and hosted the Air France Trackmania Cup in October 2019. They used fiber optic cables to transmit the light-based Internet access. They installed a baggage compartment which acts as the server that was designated to transmit the data notably the video games. They had installed a dedicated headrest for the screen and a dongle for transmitting Li-Fi communications. A detector was installed for optical transmission. Thus, Li-Fi enabled 10 gamers to play together and it is several times faster than Wi-Fi, thereby provided a more viable experience.

The ability to safely access the Internet at 30,000 ft is becoming commonplace nowadays. However, as passengers place greater demands on the in-flight Internet

bandwidth, the connected experience could become less of a benefit to the experience and more of a frustration, because airplane mode blocks your connection to cellular networks and it is not possible to communicate or make calls using phone calls. The airplane mode will turn off the Wi-Fi connection and thus will abrupt all the services that requires Internet connectivity.

Li-Fi solves a 'congestion' issue. In the data-driven world that we live in, we are running out of radio spectrum. This is a problem in crowded places like airports and aircraft interiors as it means that the current available bandwidth does not support the hundreds of people wishing to use data-intensive applications and the Internet in the same place at the same time. Li-Fi solves this issue by using 1000 times the bandwidth compared with the entire radio frequency spectrum. This is additional free, unregulated bandwidth in the visible light spectrum.

Li-Fi paves the way for local area networks to be established, which means that passengers can make calls, use the Internet and access in-flight entertainment systems more easily.

In a world fast being dominated by big data, safeguarding information is paramount. In the cabin, although Li-Fi signals can leak through windows, the technology offers greater protection to passengers than a Wi-Fi connection. But the biggest gains will be experienced by OEMs. Their manufacturing halls often have lots of LED lighting and few windows, which will enhance data security in their facilities.

3.3 Underwater Communication System Using Li-Fi

The underwater communication system is a research area of great demand as the limitations in bandwidth, energy consumption of the devices used and distance pose a big challenge. The underwater communication system based on Li-Fi technology provides protection against ship collisions on the sea. Most remotely operated underwater vehicles (ROVs) are controlled by dedicated wired connections. Since light can travel through water, Li-Fi based communications could offer much greater mobility. An underwater communication system utilizing visible light communication (VLC) technology will be ideal for military and scuba divers operating under vessels, allowing communication within the light spectrum to a certain radius via an audio system built into their diving suits. This project focuses on the safety of the sea in which the headlights, which consist of LEDs acting as transmitters, communicate with photosensors acting as receivers. White LEDs used in the head and tail lights can effectively be used for short-range communication with the photodetectors. The application is cost effective as LEDs are cheap and simple algorithms are proposed for signal generation and transmission.

A study on the usage of Li-Fi for underwater communication by observing the propagation of visible light which is affected by inherent optical properties absorption and scattering is made in. It describes the bio-optical model which concentrates on the chlorophyll approach of propagation of light in seawater [7].

Recently, SaNoor's Laser Li-Fi Solutions used laser-based rays underwater for data transmission and to link several devices and allow Internet of underwater things. They claim that this technology enabled them to allow transmission at giga bytes per second. This system removed all the hassles created in the several existing underwater data transmission systems which consists of lot many of wires as well as and has limited operational range. The signal was sent from seafloor passing through sea and air in spite of the constant motions of the sea waves as well as the foams and bubbles. They found this solution useful for many applications like underwater pipe leak monitoring, underwater environment monitoring, offshore wind fan, etc.

3.4 Li-Fi in Office Rooms

PureLi-Fi came up with a fully networked Li-Fi system by the end of 2017. In the Li-Fi-enabled boardroom, they equipped six lights and it was more than enough for any kind of uninterrupted streaming services. They had come up with a dongle in 2016 which can be connected via universal serial bus to the laptops or other devices on which we need the data transfer and Internet connectivity. This dongle consists of a photodiode and the Infrared transmitter which is used to transfer data back to the LED source. PureLi-Fi had then revealed their future plan of making of semiconductor technology to neutralize this usage of dongle and make Li-Fi core-integrated.

BeamCastor is a Li-Fi-based local area network which was developed by a Russian company Stins Coman in 2014. In this, they made use of a router which was capable of transmitting signal using a light beam that had a coverage of approximately 7–8 m. It was successfully transmitted to eight devices at same time placed at different positions in the office and achieved a four times faster rate than Wi-Fi. The transmission model has to be installed on the ceiling and the receiver model is configured on the work devices. The key highlights of this system were the mobility and the ease of configuration and it could be easily disassembled.

3.5 Li-Fi in V2V and V2I Communication

Vehicle to vehicle communication (V2V) has an underlying wireless protocol called dedicated short-range communications (DSRC). A lost cost V2V communication system is developed DSRC and global positioning system (GPS). The vehicle controlling information such as transmission rate, brake status, speed, acceleration, global positioning and path history are taken into consideration to prevent crashes. With the help of these information if a vehicle in front puts a sudden brake suitable transmission of warning signal can be sent. Similarly, if a vehicle in front makes a slow movement and the vehicle you are driving is moving at pace faster, it might cause a

collision. V2V communication helps to pass the alert on time using the wireless communication. Li-Fi technology can be clubbed suitable in this system as it is having high speed transmission rate which will help in this time critical situations to prevent accidents [8].

In case of traffic system, Li-Fi can be used to enable the vehicle to infrastructure communication (V2I) as the LED in the traffic lights can act as the medium to pass signal to the first car in the lane. This car can then transmit this information to the one behind it. The one to one point communication technology principle of Li-Fi helps to ensure secure communications without congestion. The usage of Li-Fi in smart traffic net which is soon going to be the upcoming transportation system has been described in [9].

4 A Comparative Study Between Li-Fi and Wi-Fi

4.1 Wi-Fi Technology

Wi-Fi is an existing wireless networking technology which was invented by NCR corporation in 1991 and is widely in use. By using this technology, we can exchange the information between two or more devices. The radio waves act as the medium thereby making the Wi-Fi networking possible. Wi-Fi uses routers and radio frequency and the radio signals are transmitted from antennas and routers. These signals are picked up by Wi-Fi receivers, such as computers and cell phones that are ready with Wi-Fi cards. Wi-Fi is used for Internet browsing with the help of Wi-Fi kiosks or Wi-Fi hotspots. Wi-Fi data transfer speed ranges from 150 to 2 Gbps. It has a coverage area of up to 32 m Wi-Fi radiations that can harm human health. It is not suitable for airlines and undersea communications.

4.2 Comparison with Li-Fi System

(a) System Requirements: Li-Fi only needs lamp driver, LED bulb and photodetector which are not at all expensive. Wi-Fi requires routers to be installed and subscriber devices are referred as stations.
(b) Capacity: The visible light spectrum is several thousand times larger than the spectrum of radio waves. For visible light, the frequency ranges from 400 to 700 THz, but for radio waves, the range is from 3 kHz to 300 GHz. Thus, Li-Fi signals which are based on visible light spectrum will definitely have a larger capacity.
(c) Efficiency: LED lights consume less energy and are highly efficient. Li-Fi can successfully work in a high dense environment, whereas Wi-Fi can flawlessly work in less dense environment due to interference related issues.

(d) Availability: Light sources are present in every nook and corner of the world. Hence, the availability is not an issue. The billions of light bulbs worldwide need only be replaced by LEDs.

(e) Interruption: Light of course does not cross the walls and thus data transmission using light waves is more secure than Wi-Fi where the radio waves can penetrate across the walls. Thus, it is not easy to intercept the data transmitted via light beam, but hackers can eavesdrop the data transmission using Wi-Fi. On observing the electromagnetic spectrum, the bandwidth of the radio waves is up to 300 Ghz. The bandwidth of the visible spectrum alone is up to 300 Thz which approximately thousand times more compared to the bandwidth of the radio waves. Thus, apart from attaining higher speed, there will not be any electromagnetic interference.

(f) Data Transfer Speed: 4G LT and LTE advance have a maximum of 1 Gbps for stationary users and 100 mbps for mobile users which are theoretical figures and the actual speed might be lesser than these. The average 4G LTE speed provided by countries with highest Internet usage is 40–50 Mbps. Researchers have found up to 10 Gbps in Li-Fi prototype models. This speed can be increased more by using array of LED source or by using the multiple color RGB LED's where each of it can transfer at a speed of 10Gbps. In such a manner up to 100Gbps, when the whole visible spectrum can be used. Wi-Fi standards IEEE 802.11.ac have a maximum 1.3 Gbps transfer speed which comes under 5 GHz band and IEEE 802.11.ad provide a maximum speed of 7Gbps as defined theoretically. Though these speeds are enough to meet our daily need now, as we step into the era of Internet of things, these might not be enough and there comes the urge of maybe 100 Gbps where Li-Fi comes into effect. Thus, Li-Fi is ten times better than the current Wi-Fi on the basis of speed [10].

(g) Coverage: Li-Fi coverage depends on the intensity of the light but expected coverage is 10 m. Wi-Fi provides about 32 m (WLAN 802.11b/11 g) and it will vary based on the transmit power and antenna type.

(h) Technology: Li-Fi present Infrared Data Association (IrDA) compliant devices and Wi-Fi presents WLAN 802.11a/b/g/n/ac/ad standard compliant devices [11].

Specification	Li-Fi	Wi-Fi
System requirement	LED bulb, photodetector	Router, subscriber devices
Capacity	400–700 THz	3 KHz–300 GHz
Efficiency	Consume less energy and highly efficient	Affected by inference and less efficient
Availability	Light sources and widely available	Need special requirements
Data transfer rate	Very high (~1Gbps)	Low (100 Mbps–1 Gbps)
Cost and power consumption	Low	High

(continued)

(continued)

Specification	Li-Fi	Wi-Fi
Coverage	~10 m (depending upon the intensity of light)	~32 m (depending upon the transmitting power and antennae type)
Technology	Infrared data association (IrDA) compliant devices	WLAN standard compliant devices

5 Li-Fi in the Industry and Convergence of Li-Fi with Emerging Technologies

There are many companies that have started to bring the Li-Fi-based products into the markets.

PureLi-Fi, co-founded by Professor Harald Haas, provides kits to support the evaluation of high speed Li-Fi components, light antenna technology for integration into the mobile devices and the systems that allows to deploy Li-Fi.

Oledcomm is providing Li-Fi network interface devices. And they are concentrating on improving the design of Li-Fi router solutions for LED-based systems.

LightBee is working on automotive control access and car2car communications modules.

Velmenni, Firefly, Lucibel, LightBee, LVX System, Signify, Vlncomm, LIFX, Luciom are a few of them which are all concentrating on Li-Fi technology. According to the survey made by marketresearchfuture.com, Li-Fi market is expected to grow at approx. USD 51 Billion by 2023, at 70% of CAGR between 2017 and 2023. Because of the revolution in the technical world where all the devices are getting connected high speed of data transmission is going to be a matter of prime concern and foreseeing this many companies like General Electric and Philips are investing into Li-Fi market.

5.1 Li-Fi and IoT

Internet of things is a system of interrelated computing devices which can exchange information and transmit data without human interaction. IoT devices comprises of several sensors, actuators, connectivity/communication electronics and software to capture, filter and exchange data about themselves, their state and their environment. However, this widespread development in IoT which interconnects larger scale of heterogeneous devices creates a big challenge so as to how to safeguard the hardware and the networks in the IoT system and transfer data without interferences and delay [12]. Thus, integrating the Li-Fi concept with IoT provides solutions to a wider

variety of problems in different domains. Unipolar orthogonal frequency division multiplexing (U-OFDM) which is used in Li-Fi technology gives high speed data transmission along with room illumination. As a result, enough bandwidth is obtained to accommodate large number of IoT devices [13]. Massive multiple input multiple output (MIMO) which consists of several antennas at the transmitter and receiver based on visible light spectrum will have higher bandwidth [14].

5.2 Li-Fi and Cloud

Cloud acts a centralized storage and it allows to store, manage and process data over the Internet using large group of servers based on virtualization technology. The data is stored and retrieved in a data center, instead of locally on the user device. As IoT-enabled environment requires large amount of data to be stored and processed frequently, cloud makes it possible to enable access of the same data and applications from any part of the world. The increasing demand of wireless communication has posed a problem of acquiring real-time data without latency delay and bandwidth bottleneck problems from cloud. In the existing IoT network, especially in highly dense environment, the available radio spectrum becomes insufficient. Li-Fi due to its high speed and greater bandwidth can be a stand in such a scenario. The challenges of the existing cloud IoT paradigm and a Li-Fi-based hybrid cloud framework study are described in [15]. In their study, a layered architecture comprising of infrastructure layer or the physical layer, local or private cloud layer and global or public cloud layer is proposed. The communication between the local cloud and the IoT devices in the physical is established using Li-Fi enabled access point which acts as a forwarding device. The IoT devices will be embedded with LED and photodiode which will make the light communication possible [12].

5.3 Li-Fi and Real-Time Analytics

Time critical applications such as tracking and navigation are mainly based on real-time analytics. The large amount of data gathered is analyzed by applying logic and mathematical concepts to make conclusions, decisions and future predictions. The current business world which concentrates on making all the services much easier for customers keeps a constant watch on the data which can be the customer behavior pattern and gives suggestion for the next activity based on the analysis. This can be applied in the area of online shopping, medical sector, traffic system and so on. The Li-Fi-based companies have already started working with the real-time data analytics using the data which gets stored on their cloud using indoor positioning system (IPS). IPS is a system similar to global positioning system (GPS) but it is within the indoor environments where the satellite technologies are less efficient.

There are different technologies for IPS like acoustic systems, proximity based, infrared systems, Bluetooth based and so on. GeoLi-Fi is a Li-Fi-based geolocation platform by Li-Fi supporting companies like Basic6 and Oledcomm for indoor environments. Light fidelity access point installed in a dense network will gather accurate location information and create a map. The system comprises of Li-Fi LEDs that stream information as unique identifiers, LED Li-Fi modulator which transforms LED lights into a very simple Li-Fi antenna, Li-Fi-enabled tablets utilizing software communicate to consumers, centralized managerial interface and tools to perform the analytics, planning, forecasting and management. Each of the light source has a unique identifier and a mapping is defined of where all these lights are located and a unique identifier for those positions [16]. The tablets which are customized with the photodiode, and therefore whenever the tablet is under the Li-Fi enabled light its location is accurately identified. Instead of customized tablets, it is also possible to make use of Li-Fi-enabled dongle which can be easily plugged into our smartphones.

This system can be used in big supermarkets and the customer shopping pattern which is tracked using IPS is sent to cloud, real-time analytics can be applied, and thus the future shopping pattern can be predicted accurately. It can also make the shopping process much easier by giving information regarding the necessary item's location in the store and any additional information regarding it. This Li-Fi-based IPS can also be installed in emergency places like hospitals so that optimized navigation can be made without any delay [6].

6 Prototype Description

In this prototype, light is used as a medium of transmission. With the advent of Internet of vehicles, the entire traffic is going to be automated soon. Hence, using the headlights of the vehicles, an automated brake system can be implemented with Li-Fi support [2]. Earlier spread spectrum mechanisms were used in order to meet the needs of communication between vehicles. The military vehicle services are maintained and scrutinized based on the spread spectrum methodology.

A major drawback of the traditional system is that it requires the complete attention of the driver to control the speed and occurrence of a collision. But according to the proposed system in [2], the alert signal send to the vehicle as demonstrated with the help of light signals. Here, automation can be achieved as the distance between the vehicles if reduces below a specific limit and the controller reacts and hence avoid the accident. Basically, the light rays emitted by the car at the front through the brake light/stop light will be received by the car behind through a receiver at the front bumper which triggers the car according to the situation. As the emission is purely based on light rays, there is no chance of environmental issues or scattering of important signals.

6.1 Hardware Requirements

(a) Arduino UNO: The Arduino Uno is a microcontroller board based on the Microchip ATmega328P microcontroller and it is programmed with the help of an open-source Arduino software. This software acts as an integrated development environment (IDE) which will help to perform coding on the computer side and upload it to the physical board. Thus, we can say that Arduino UNO has hardware and software parts. The hardware section of the board comprises of digital and analog input/output (I/O) pins that may be interfaced to other circuits. This Arduino UNO is enough for the data transfer from one device to another.
(b) LED: Li-Fi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. Light emitting diodes (LEDs) are used in Li-Fi as visible light transmitters. Li-Fi data is transmitted by the LED bulbs and received by photodiodes. The LED is connected to one of the digital pins. The LED blinks according to the binary logic sent from the processing software.
(c) LDR: An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. It is a passive component, which uses the concept of photoconductivity and has a resistor whose resistance value decreases when the intensity of light decreases. This optoelectronic device is mostly used in light varying sensor circuits. The light from the LED is identified by using LDR and the data is transmitted to the Arduino.
(d) Solar Panel 5v: In our system, it acts as a data receiver of analog digitals. Here, we have used 5v solar panel. In our system, solar panel acts as a data receiver of analog signals and not a power source. The LED light source combined with a solar panel can form a transmitter-receiver system. LED transmits encoded information which is received by the solar cell and made available where the information is required.
(e) Ultrasonic Sensor: An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves and converts the reflected sound into a signal. In our system, the ultrasonic sensor is fixed in front of our vehicle and it measures the distance between the car and obstacle in front and gives an alerting signal if the distance is beyond a certain limit.
(f) Speaker and audio amplifier
(g) LCD display and batteries.

6.2 Software Requirements

(a) Arduino programming language: Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or integrated development environment (IDE) that runs on your computer, used to write and upload computer code to the physical board. The

IDE supports C and C++ and includes libraries for various hardware components, such as LEDs and switches. The program which is also known as sketch is uploaded to the Arduino board via a USB cable. Here, it can be run and will remain in memory until it is replaced.

(b) Python IDLE: Python IDLE is an integrated development environment (IDE) for Python. The Python installer for Windows contains the IDLE module by default. IDLE can be used to execute a single statement just like Python shell and also to create, modify, and execute Python scripts.

(c) Tinkercad: Tinkercad is a free, online 3D modeling program that runs in a Web browser, known for its simplicity and ease of use. We have used it to stimulate circuits and to generate Arduino codes.

7 System Design

The system uses the ultrasonic sensor which reads the distance to the obstacle in front of the vehicle where the sensor is fixed. The distance is then sent to the Arduino UNO. Basically, the light rays emitted by the car at the front through the brake light/stop light will be received by the car behind through a receiver at the front bumper which triggers the brake according to the situation. As the emission is purely based on light rays, there is no chance of environmental issues or scattering of important signals.

The prototype makes a study on digital and analog data transmission. For analog data transmission, we made use of audio source, LED, solar panel and audio amplifier.

7.1 Analog Data Transmission

See Fig. 3.

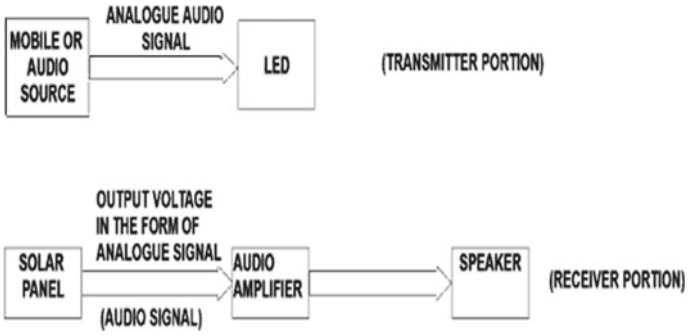

Fig. 3 Block diagrams of analog data transmission

7.2 Schematic Diagram for Analog Data

(a) Transmitter Section:

Depending upon the change in the music which is the analog signal the LED glows and its light intensity varies according to the fluctuations in the analog signal (Fig. 4).

(b) Receiver Section

At the receiver side, solar panel is used for light detection from the transmitter side and it then given to an audio amplifier followed by the speaker (Fig. 5).

8 Digital Data Transmission

The light signals emitted from the vehicle at the front will be received by the car behind via an LDR. Light-dependent resistors are very sensitive to light. When the required signal reaches the LDR, the input is also obtained. Ultimately when the distance between the vehicle or vehicle and the object is less than or equal to predefined limit known as safe distance, and the vehicle itself will apply brakes to

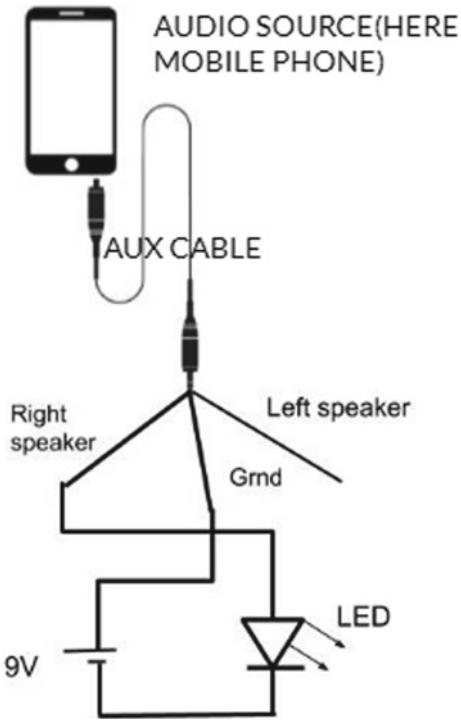

Fig. 4 Block diagram of transmitter section

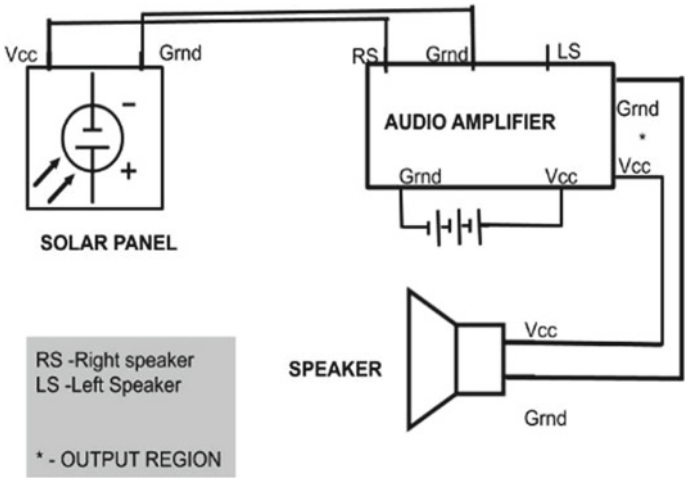

Fig. 5 Block diagram of receiver section in analog data transmission

avoid the accident. If the distance between the vehicle are more than the defined safe distance, then the system will give a warning and emergency notification to the driver as a safety measure. The distance between the car and obstacle is measured by the ultrasonic sensor and then passed on to the Arduino UNO. Then, if it is less than the limit, then it is passed on to the LED and then the LED blinks accordingly.

8.1 Transmitter Section

The value measured using ultrasonic sensor is stored into a variable, say 'time'. We then take the half of it and store it in a variable 't'. This value is used to compute the distance which is calculated as 340/t, as 340 m/s is the speed of the sound in air. The safe distance between car and the object is taken as 15 or above for our study. Here, a checking is done again to find if it is less than or equal to 5 and if so the LED glows for a time duration of 25 ms indicating brake should be applied otherwise the LED will glow for a time duration of 20 ms which is a warning sign. This is how the transmitter gets activated and starts sending data as Li-Fi signals and is depicted in the flowchart of the transmitter section (Fig. 6).

Fig. 6 Block diagram of transmitter section in digital data transmission

8.2 Receiver Section

The LDR records data from the LED blink in 0 s and 1 s. It is then passed on to Arduino UNO and the alert or the warning message is sent. Here, instead of buzzer system, we used an LCD display. The value read from LDR is stored in a variable 'd'. In the next 20 ms, LDR value taken is stored to the variable val2. A string variable duration is concatenated with this val2. If val2 value is 1, then we perform a checking of whether duration is '0001' and if so it displays a warning in the LCD Display else if the duration is '00001' it causes the braking system to be enabled. The flowchart for the receiver section depicts this process (Figs. 7, 8 and 9).

The digital data transmission is represented as depicted in the flowchart (Figs. 10 and 11).

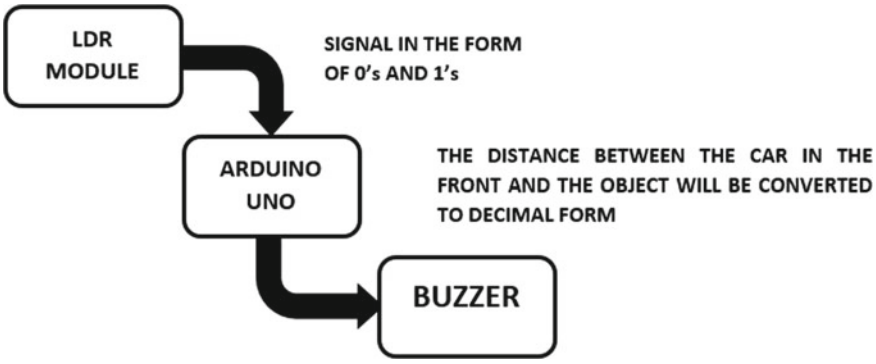

Fig. 7 Block diagram of receiver section in digital data transmission

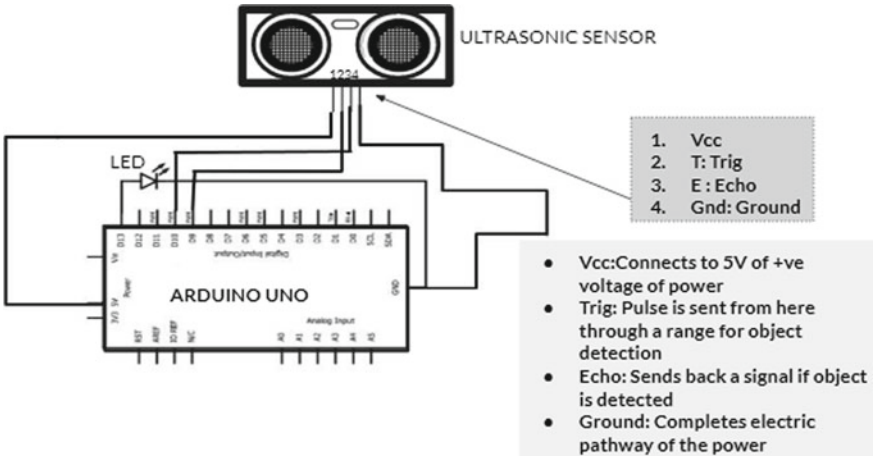

Fig. 8 Schematic diagram of digital data transmission section

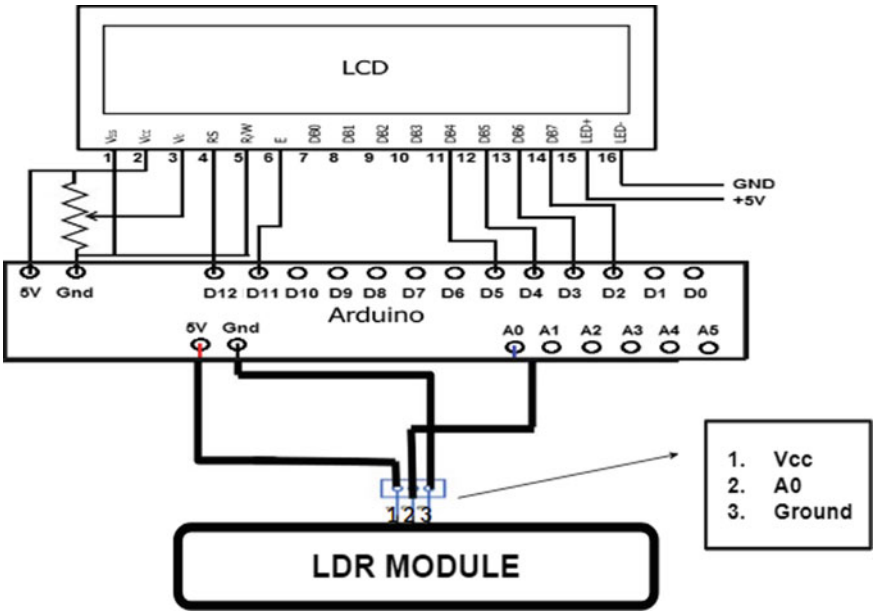

Fig. 9 Schematic diagram of digital data receiver section

9 Results

In the system showing analog data transmission, we inferred that the speaker produces sound only when it is exposed to a light which is having Li-Fi signals. In the digital data transmission system, the audio signal from the mobile phone using AUX cable and was given to the Arduino. And this is the output waveform which we got from the Arduino. Now, it is clear that Li-Fi is an ideal point to point communication medium among two vehicles.

The plot that the signals have a voltage level variation depending upon the light signals. Similarly, the pattern was observed by varying the sensitivity of the LDR module to ensure the promptness of Li-Fi. We have voltage measured in the *y*-axis and the time taken in the *x*-axis.

The first plot shows output from solar panel when there are no variations (Figs. 12, 13 and 14).

10 Limitations and Challenges

1. Difficulty in calibrating the Li-Fi receiver in presence of ambient light.
2. The distance between the Li-Fi transmitter and receiver affects the visible light communication (VLC) technology.

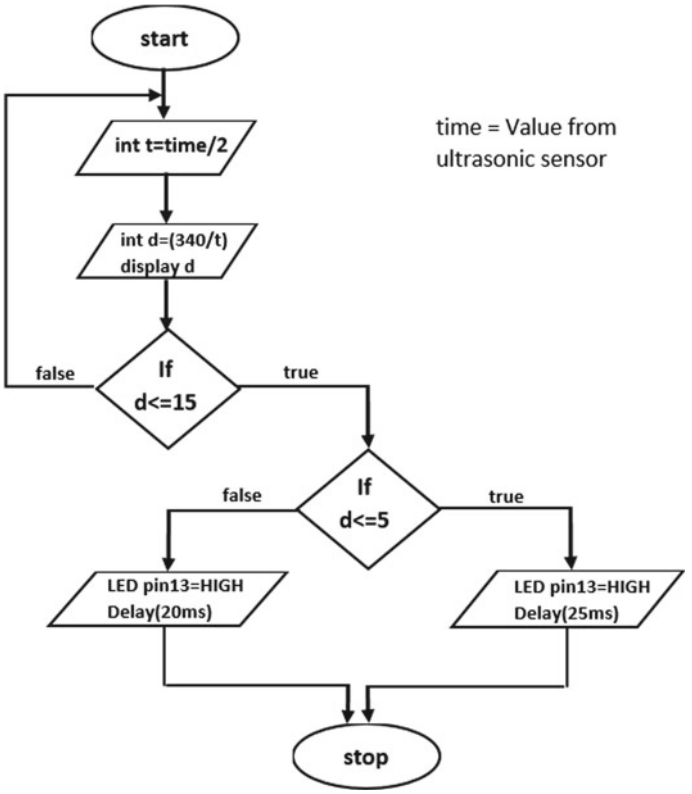

Fig. 10 Flowchart of transmission section

3. In some cases, the shorter range of Li-Fi communication, Li-Fi put forwards security features.
4. We can use laser for long-range Li-Fi communication/data transfer, but in this case, the components of the setup should be in a fixed position.
5. Refraction cases Li-Fi signal loss
6. The modulation in Li-Fi is a challenge when the light illumination is low.
7. Li-Fi should need line of sight for effective data transmission. Small difference leads to interruption in the transmission.

11 Conclusion and Future Works

Li-Fi era is not too far and there are many companies who have started marketing products based on Li-Fi technologies. There are many countries where Wi-Fi usage is narrowed due to its harmful effects especially for children and health sectors. Li-Fi will predominantly gain wide spread popularity in those places because of its secure

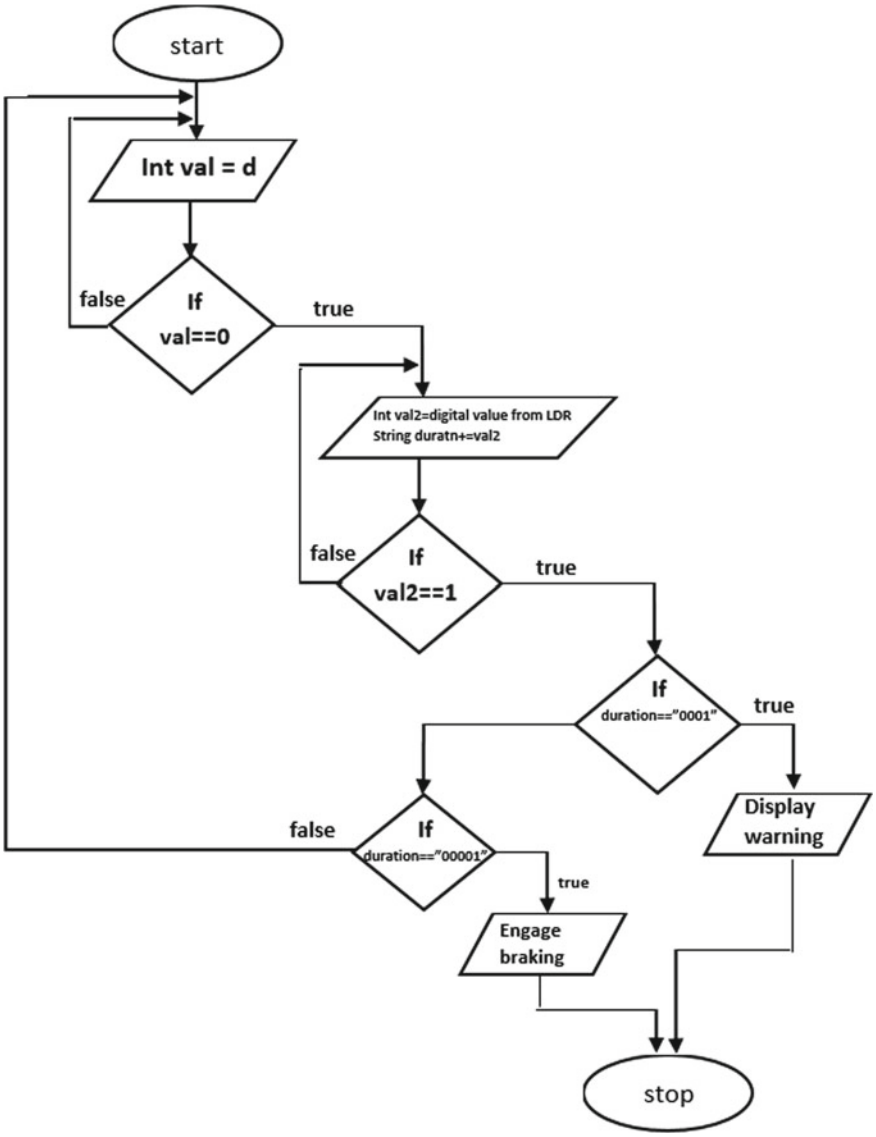

Fig. 11 Flowchart of receiver section

and environment-friendly nature. It will gradually conquer the whole world and as predicted by the researchers working on it. As the wave made by photon produced by a light emitting diode has no power to penetrate through the skin it will soon be a safer substitute for the electromagnetic waves in the field of communication which can penetrate through even walls. In hospitals, where real-time health monitoring is

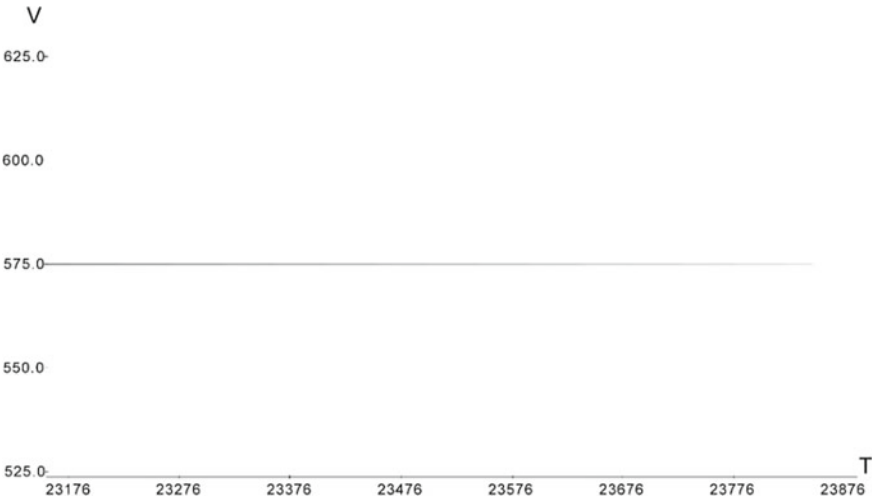

Fig. 12 Graph showing the output from solar panel under a tube light (i.e., when there is no variation)

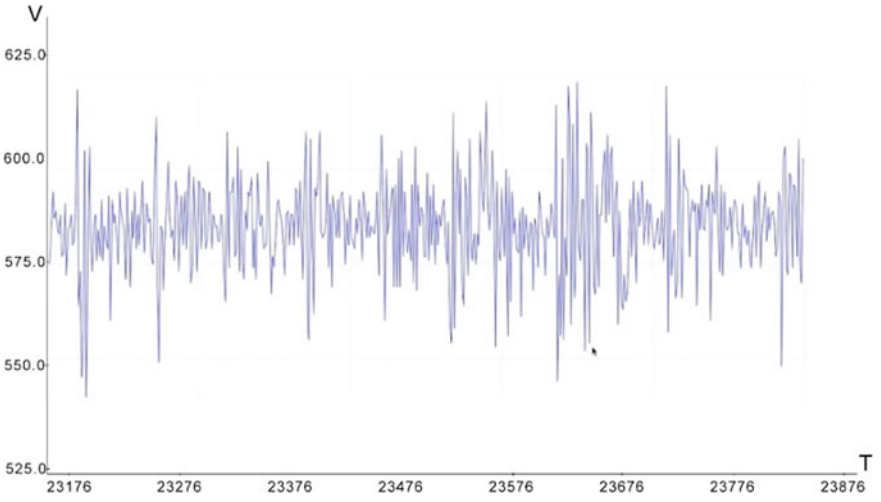

Fig. 13 Graph showing the output from solar panel under a light integrated with audio signal

extremely time critical, Li-Fi can be used as it provides high speed. Li-Fi as elaborated in the applications can play predominant role in aircraft, underwater systems, vehicle to vehicle communications and other infrastructures. Even our street lamps can provide us with high speed Internet with the Li-Fi technology.

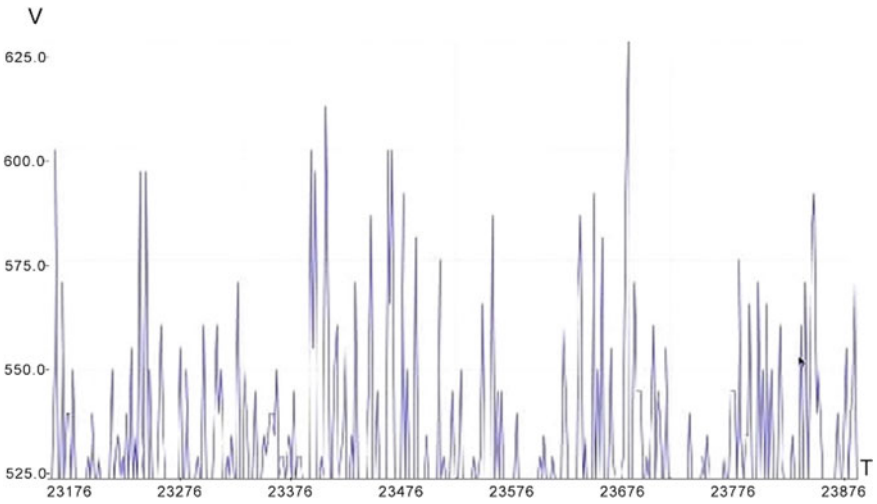

Fig. 14 Graph showing the output from Arduino when audio signal from a mobile phone using AUX cable

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Approaches in Assistive Technology: A Survey on Existing Assistive Wearable Technology for the Visually Impaired

Lavanya Gupta, Neha Varma, Srishti Agrawal, Vipasha Verma, Nidhi Kalra, and Seemu Sharma

Abstract People with visual impairment face a lot of challenges in their daily lives, be it small or big. This is mainly due to the lack of assistance provided by the modern assistive devices in terms of providing self-independence and the cost matching it. The main aim of this article is to research and explore the existing assistive technologies in the domain of visual impairment aid. The main objective of the assistive technology is to provide assistance in the day-to-day tasks, with a simple and wearable design to deliver a better user experience. This paper focuses on different approaches that will help the visually impaired through technology and learn those technologies that leverage a comfortable experience to the user. The primary objective of this survey is to navigate through the different approaches to find out the best suite for the authors in developing their technology.

Keywords Visually impaired · Assistive technology · Wearable device

1 Introduction

Human communication is at its root, where it is completely based on the text and speech [1]. While this communication has been accepted as a daily part of our life that requires little effort, it is not as easy for some. According to World Health Organization [WHO] report on vision [2–4], the number of visually impaired people present across the globe is approximately 2.2 billion, of whom at least 1 billion have a visual impairment not yet been addressed or prevented. According to a study published as of 2010 in the Global Estimates of Visual Impairment [5], almost 20.5% of the world's unsighted [6] are Indian citizens, along with 22.2% of the world's low vision population, and 21.9% of those are with vision impairment [7]. Disability takes a toll on

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a person's day-to-day life. With the ever-expanding and unparalleled technological growth, this part of the population will actually require a modern device that helps them to be more self-reliant and efficient without increasing the cost/expense [8]. Such modern devices are termed as 'assistive devices', and as the name suggests, they assist the user in partially or wholly for overcoming a problem/disability. Among all the other available assistive devices, wearable devices have been proven as the most efficient and helpful, out of which the head-mounted display [9] devices and clip-on devices remain as the most popular consideration. Recent studies and technologies in clip-on devices [10] have also shown promising results. A large fraction of the devices are available for assistance and are either focused on a singular aspect of the problem, or it is not efficient as expected [11].

This paper focuses on different approaches that are considered to aid the visually impaired through technology and compare the solutions with a new concept (focusing specifically on the user) to see how it is different, or in some cases, better than what is already available in the market.

1.1 Types of Computer Glasses

Different types of computer glasses exist, and this adds information alongside what the user can see, or in this case, it will not be able to view. Like other computers, smart glasses may collect information from external or internal sensors. Using the sensors, smart glasses can guide the wearer, inform the user about his/her surroundings, warn them of threats and generally assist them in carrying out simple tasks that would otherwise be difficult for them [12, 13]. Various types of computer glasses are mentioned below.

1.1.1 Monocular Smart Glasses [14]

Monocular smart glasses as the name suggests are glasses in the form of HMDs where an optical engine is placed on one of the lenses [15, 16]. Vuzix M300, Google Glass [17], Optivent's Ora-2 and the Lumus Sleek are some examples of such devices.

1.1.2 Binocular Smart Glasses [18]

Binocular smart glasses are another form of a head-mounted display system which consists of two transparent displays, which deliver a stereoscopic view to the users. The advantage of such HMDs over monocular glasses is that a more diverse enhancement of the overall view perspective of the wearer is conceivable because of the optical engines mounted before each eye. Much like monocular glasses, these also display the information just beyond the user's line of sight, but to both eyes. Verge

IT [19], Epson Moverio [20], the ODG R-9 [21], the Sony SED-E1 [22, 23] and SED-100A [24] are some of the current binocular smart glasses in the market.

1.1.3 Audio Augmented Reality Smart Glasses [25]

ARSG are basically head-up transparent displays that add virtual information to what the user sees with an integrated wearable miniature computer [26]. As the name suggests, the glasses provide the users with augmented reality by overlaying virtual data on the real worldview of the wearer, and doing so makes it conceivable to enhance a human's perception of reality [27]. ARSG are an ideal user interface for industry usage by workers since they are hands-free gadgets that show information at eye level, right where it is required.

1.1.4 Immersive or Mixed Reality Smart Glasses [28]

Mixed reality is the combination or merger of the real-world view with the virtual world to create new environment. A real-world environment is superimposed with virtual objects with the help of computer graphics. The objects visually act like a physical object in the real-world environment, change shape, and appearance according to the angle and position of where they are interacted from and also, based on the external environment or actions/movements of the user. Hence, a user can view the virtual object from different bearings and directions by moving around spatially in a room, as if it were a real object [29].

Some mixed reality glasses are Microsoft HoloLens, ODG-9 AR and VR glasses and the Meta Space glasses. These gadgets are fully immersive and inclusive standalone systems with outstanding displays, allowing you to render 3D objects on board [30].

A field that has not been utilised to the best of its capacity is that of **audio augmented reality** [31]. Audio augmented reality is when the real or physical world can be augmented with a virtual layer of auditory signals, which allows the user to acquiescently interact with it. In certain glasses, the sensors on the glasses gather appropriate information and the focused speaker directly informs the user. The technology in this field can be used to provide maximum utility to the user.

1.2 Motivation for Conducting the Survey

The motivation for this survey was to clearly analyse the existing technologies/devices that exist, which aid the visually impaired and the features incorporated in them. This analysis helps to identify the problems that were solved by these technologies and the ones that could not be. Along with that, it provides a

detailed overview of how these technologies can be better utilised to serve the visually impaired and make it easier for them to participate in their day-to-day activities. An exhaustive survey was conducted, particularly motivated from these facts:

- The need and demand for understanding the benefits and drawbacks of the impact of existing assistive devices for the visually impaired.
- The need and demand for understanding the various technologies these devices use.
- Can these technologies be utilised in a better way to suit the needs of the customer base?
- Can newer technologies be incorporated in such devices to provide an enhanced product?

Thus, there is an immediate need to understand and explore technologies that can be used to assist the visually impaired and the status of their applications in the physical world. Not only does the technology assist the visually impaired, but its application also includes safety; thus, it is our duty to work towards the enhancement of this area, so as to make it a better place to live in for those with disabilities. However, to gain an understanding of technologies that can be used, it is highly required to analyse the use of existing technologies and their applications, and only then it can contribute towards making a change in this field.

1.3 Outline

The remaining article is designed as: Sect. 2 presents the background. Section 3 goes into a detailed analysis of the existing devices and technologies, highlighting their use in the device and their impact. Section 4 highlights the inferences made by conducting researches on the existing devices and what better technologies can be used in those devices. Section 5 presents the concept of a prototype device that could be used to effectively solve various problems faced by the visually impaired population, in a single device. The proposed research work is concluded in Sect. 6.

2 Background

Until recently, solely medical solutions and practices used for treating disabilities have become more popular. Any assistive technology will only be considered as a branch of that medical practice. It is only in the past few years that assistive devices have really taken the centre stage in not just aiding people with visual disabilities but also making them largely autonomous and independent [32].

Particularly, the problems like navigation, reading and providing visibility to people with partial visibility problems are considered as the different challenges associated with the technologies.

Society today has changed considerably to eradicate the discrimination against impaired population. The combination of new laws and awareness has asserted the idea of acceptance and independence of the impaired. But with that, there is a need to devise a highly effective way to help the visually impaired in order to move a step closer towards normalcy by asserting self-dependence. This can only be done by implementing various advanced technologies. Various products have been integrated in the past few years to help the visually impaired to deal with these problems. This article will extensively explore these products along with the technologies employed and how they evolved over the years.

2.1 Review Process

Figure 1 shows the growth of research in the field of assistive technologies for the visually impaired since 1990 until date. The graph shows a tremendous increase in research contributions in the last decade (Table 1).

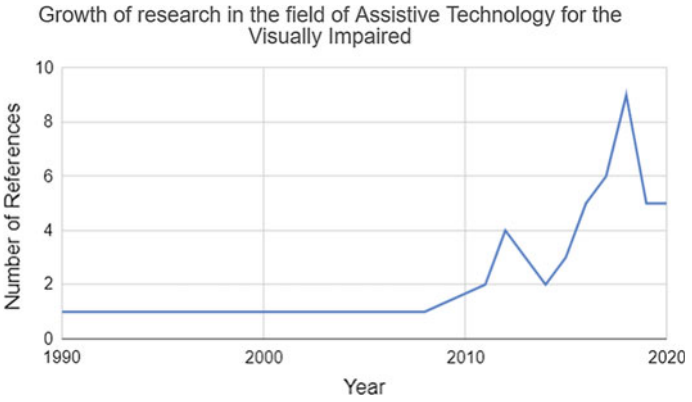

Fig. 1 Graphical representation of the growth of research in the field of assistive technology for the visually impaired

Table 1 Classification of papers

Property	Categories
Year	1990–2020
Methods	Ultrasound-assisted obstacle detection [33], human assistance, sonar sensors, visual sensors
Targeted problems	Travel/navigation, reading [34], enhancing vision [35]
Publication type	Research paper, journal article, conference proceedings, Web article, magazine article

Figure 2 shows a graphical representation of the distribution of research articles in various sources such as journals, conferences and proceedings. The graph depicts the maximum contribution of research articles in journals followed by Web articles.

The proposed research work has framed 6 research questions as shown in Table 2. These research questions helped the authors to explore the literature and collect all the information related to assistive technologies for the visually impaired.

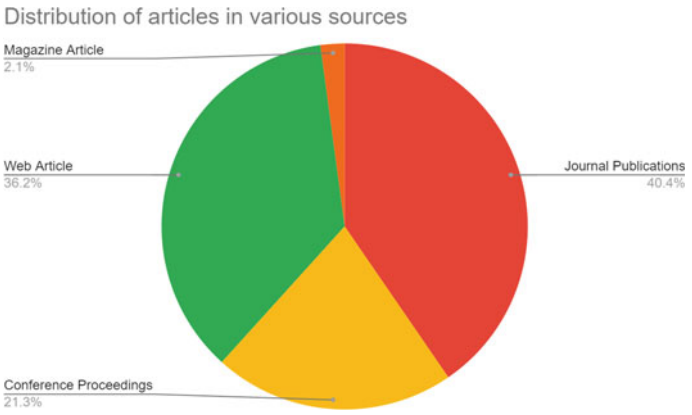

Fig. 2 Graphical representation of the distribution of articles in various sources, used for the review process

Table 2 Research questions

Research questions	Main motivation	Section referred
RQ1. What is assistive technology?	Identify the meaning of assistive technologies and to understand the current and existing technologies	Sect. 1
RQ2. What is the need for such technologies?	Identify the needs of the people using such technologies. Assessing existing technologies features with respect to the needs of the people identified	Sect. 1.2
RQ3. What are the different types of assistive technology being used?	Identify the different types of assistive technology	Sect. 1.1
RQ4. How has assistive technology evolved?	Identify the evolution of assistive technology and finding the latest trends	Sect. 3
RQ5. How helpful is the current technology in aiding the user?	Identify the pros and imperfections of the current assistive technology	Sect. 4
RQ6. Can the loopholes in current technology be overcome by a new device?	Identify what better technology can be used to reduce the cost and increase the effectiveness of devices	Sect. 5

3 Related Works

3.1 BuzzClip [36]

BuzzClip caters to that part of the society that lives with blindness or partial sight. It aims to reduce the dread and anxiety related to navigation by providing a dependable way to make the user aware of their immediate surroundings and obstacles.

Construction: BuzzClip is a small and discreet wearable device. It aids in navigation by detecting obstructions in the wearer's path using ultrasound. It is an additional supportive device to the cane and can also be used on its own for those with partial sight looking for a subtle solution.

Methodology: It informs the user of the hindrances through instinctive vibrations and helps them safely navigate their way around these objects. It additionally offers fundamental obstruction detection at head level and can be attached to clothing, proving it exceptionally adaptable and helpful.

3.2 Aira AR Smart Glasses [37]

The Aira smart glasses, developed by La Jolla, are augmented reality smart glasses that are intended to aid users who are completely or partially visibly impaired, to read significant text (expiration date on grocery items, information on medicines, etc). It is the blend of cutting-edge technology, hardware and live assistance support provided by highly attentive aides.

Construction: The glasses are equipped with a camera and inbuilt earpiece.

Methodology: With these smart glasses, Aira has built a service that fundamentally places a human assistant into a visually impaired user's ear and sends live video of the surroundings of the user through the camera on the glasses to the assistants, who can then give instructions to the end-users and help them with their basic tasks, be it directions or describing scenes.

3.3 Sunu Band [38]

Sunu manufactures the Boston-based wearable, one of which is Sunu Band: a sonar sensor device that helps the visually impaired not collide with people and objects by guiding them.

Construction: Uses sonar sensors for obstacle detection portable system [39].

Methodology: When the sensor detects an object or person 15 feet away from the user, the device vibrates to let the user know of a potential collision, and with increasing proximity, the device vibrates with increased frequency and intensity.

3.4 Maptic [40]

Maptic devices are wearable navigation systems.

Construction: A necklace that acts as a visual sensor and a device that clips around the wrist of the user acts as a series of feedback units. A voice-controlled iPhone app uses GPS to direct the user.

Methodology: The device vibrates to guide the user to desired destinations. To steer the user towards either direction, the device sets off a series of vibrations to either side of the body.

3.5 MyEye2 [41]

The aim of these low-vision electronic glasses is to make day-to-day activities like reading, writing, recognising faces and items easier for the visually impaired.

Construction: Using a magnetic mount, the device is attached to any pair of glasses. A light camera is attached to the sides of the glasses' frame as well.

Methodology: The power button of the OrCam device is near the speaker, which is located on the flat underside. A touch bar (raised for easy location) is placed on the top side of the device which is rounded. It allows the user to read multiple languages, identify currency and also face recognition. OrCam also learns to identify objects, as it does with faces.

3.6 NuEyes Pro [42]

NuEyes Pro is a pair of head-mounted smart glasses that are lightweight and wireless. It is specially designed to aid the visually challenged to see better. NuEyes Pro can help with conditions like glaucoma, diabetic retinopathy and macular degeneration. It converts print to speech and allows users to carry out daily activities like watching TV, writing and reading.

Construction: An image is captured by the camera placed at the front of the glasses and then shown in a magnified form inside of the lenses. Magnification of up to 12

times can be obtained on images, which helps the user see the finer details more clearly. NuEyes also has a 30° field of view (FOV) and a 1080i stereo display.

Methodology: A remote-handheld controller and vocal orders are used to control the device.

3.7 OXSIGHT [43]

In 2016, OXSIGHT was established based on the effort of a team of Oxford University, who started researching and working closely with the low-vision community a decade ago. Their main aim was to bring out an innovative device to help this community. Its main features include expanding field of vision, enhancing light and shape detection. At Oxford University, Dr Stephen Hicks and his colleagues researched and came up with the idea of these smart assistive glasses that would be able to present essential information about the proximity of obstacles from the wearers. This was achieved with the help of a camera and display option. Along with that, the glasses are also capable of increasing the brightness and clarity of obstacles.

3.8 Intelligent Reader for the Visually Handicapped [1]

This Raspberry Pi-based reader captures an image of some textual material and enables visually challenged users to passively interpret the text present in that image.

Technologies used: Raspberry Pi Camera [44], to capture the image; ImageMagick software is used to get a scanned image from the picture obtained; Tesseract Optical Character Recognition software obtains text converted from the image; Text to Speech (TTS) engine is used for the transfiguration of text into speech.

Table 3 effectively summarises these latest technologies and works in the field of visual aid devices and provides an efficient comparison between the same.

4 Discussion

The existing technology has greatly helped aid the visually impaired in providing them independence in day-to-day activities. They have immensely impacted their social status and mental well-being. While the contribution of these devices in bringing technological advancement (as in present day) to help the visually impaired is significant, there is always scope for improvement. Most of the existing wearable devices are not effectively solving the root of the problem. They focus only on subsets rather than the main obstacle. The most popular devices for smart glasses are Braille readers [45] which can read and write using the arrangement of dots.

Table 3 Existing technologies to aid the visually impaired

Device	Proposed technology	Year proposed
BuzzClip	Wearable device that aids the visually impaired by informing the user of hindrances in their path through instinctive vibrations and helps them safely navigate their way around these objects	2018
Aira AR smart glasses	Augmented reality smart glasses that are intended to aid users to read significant text. This is achieved by providing live assistance through human aid into a visually impaired user's ear and sending live video of the user's surroundings through the camera on the glasses to the assistants, who can then give instructions to the end-users and help them with their basic tasks	2018
Sunu Band	A sonar sensor device that helps the visually impaired not collide with people and objects by guiding them	2018
Maptic	A tactile assistive navigation device that works like a cane, without the stigma. It uses a necklace that acts like a visual sensor, a voice-controlled app on the phone and vibrations to help the user to navigate	2018
MyEye2	These are low vision (partial visual impairment) electronic glasses that help make day-to-day activities like reading, writing, recognising faces and items easier for the visually impaired	2017
NuEyes Pro	Head-mounted smart glasses designed to aid the visually challenged to see better. NuEyes Pro can help with conditions like glaucoma, diabetic retinopathy and macular degeneration. It converts print to speech and allows users to carry out daily activities	2018
OXSIGHT	The aim of this device was to improve low vision. Features include expanding field of vision, enhancing light and shape detection. Along with that, the glasses are also capable of increasing the brightness and clarity of obstacles	2016

(continued)

Table 3 (continued)

Device	Proposed technology	Year proposed
Intelligent reader for the visually handicapped	This Raspberry Pi-based reader captures an image of some textual material and uses text recognition algorithms to identify texts in those images and provide the user with an audio cue (using text to speech)	2020

Another device commonly used is an audio reader which reads out books and papers saved in the audio format. This would essentially point to the fact that for each task, there exists an individual product solving only one part of the problem. Both these devices being costly, it leaves a huge dent on the pocket of those who really need them, especially those who will need to buy different assistive devices for different tasks. This ultimately leads to sacrificing basic comfort in their day-to-day lives.

Figure 3 gives a summary of the problems current assistive technology is solving. With the help of this figure and further research, one can conclude that there are only a few devices (35–44) that solve a multi-purpose function.

Moreover, most of the devices explored in this article focus on improving visibility for those who are only partially visible. The devices that claim to provide aid to all visually impaired, like Aira smart glasses, do not provide autonomy to the user and force them to lean onto a person that is aiding them through a live call feature. These techniques are not just outdated, but also unattractive to the visually impaired.

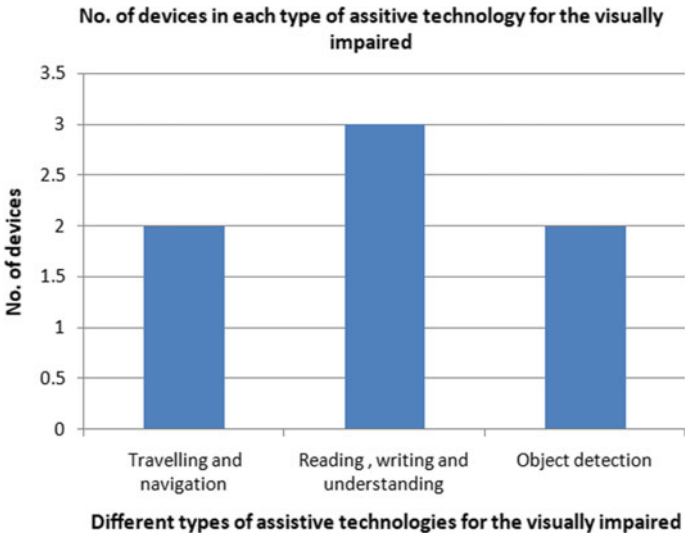

Fig. 3 Graphical representation of the number of assistive technology devices for the visually impaired in each type of field

A few devices target text reading, others target object detection in the path of the user, and a minute number of devices help in recognising objects or faces using machine learning or artificial intelligence tools, but these are limited to partial visual impairment. And to date, no device exists that combines all the features into a single device. There has been no development of even a costly all-round device, let alone a cost-effective solution.

The technology is assistive devices started with object detection solutions using ultrasound and moved onto braille readers, and even after leaps of technological advancement, it seems that assistive devices have only progressed to improve or build upon the technology of existing object detection devices and text readers. Assistance in the form of recognition of faces or objects is largely absent. Artificial intelligence and machine learning have rarely been incorporated into these devices, and when they have been, the devices do not seem to include the most necessary features of navigation and obstruction detection.

Among existing features, there can be multitudes of advancement. Technologies like IoT can be used for wireless detection (similar to how it might be effective in vehicle collision detection [46]) instead of ultrasound. For live video assistance technologies, instead of limiting to verbal assistance by a human aid, motor control systems for wireless automation [47] can be explored to help navigate the user.

While object and face recognition is trivial in these devices, recognition models like R-CNN, fast R-CNN (and YOLO—you only look once) should be implemented for faster results, as real-time recognition requires speed.

Most importantly, there is still scope for technology that can combine various factors into a single device and provide immense autonomy to the visually impaired for most activities.

Research and studies have found out that as the number of assistive products and related technology increase, so does product suspension. When asked, visually impaired users of such products communicated disapproval of most assistive devices currently used because of the factors of tactile feeling and visual balance. Many complain of self-consciousness linked with the design of the device and its functionality. There has yet to be a breakthrough that can model a device according to the user's feedback and advice.

5 Device Concept

The main aim is to investigate the dynamics of converging mobile devices and their accessibility features with wearable devices coming into the market. This shall make the lives of visually impaired more comfortable and closer to that of the people around them.

In addition to that, the main focus is given to the possibility of developing a new technology, which would be able to accommodate the most crucial aspects of the problems faced by these people as well as manage to stay efficient by keeping its cost low.

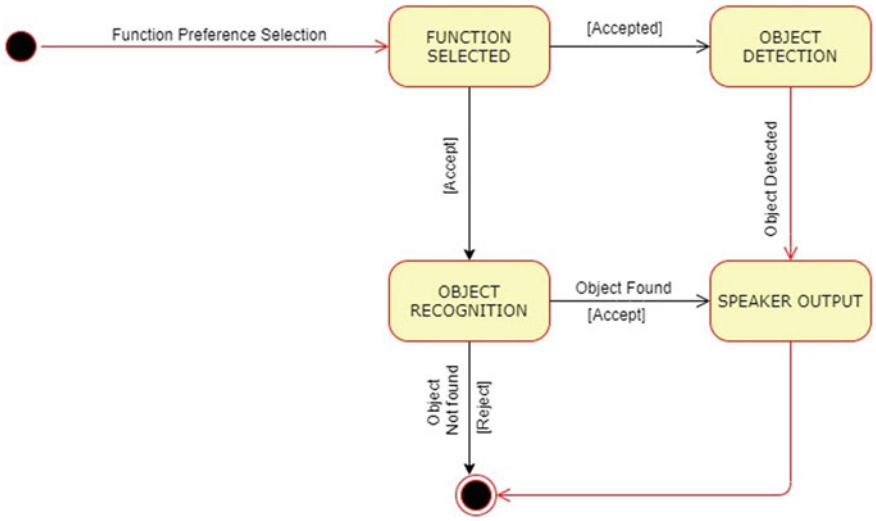

Fig. 4 A general state chart representation of the proposed ideal assisting device

Figure 4 represents a state chart (flow chart) of the working of a close to ideal assistive device. Current devices only include the object detection flow path or a branch of the object recognition flow path (as text recognition).

6 Conclusion

The proposed research work leverages a new concept of smart device that aims to study the existing assistive technologies that were developed, to analyse their drawbacks, and furthermore it creates a technology that overcomes the challenges that were previously faced. While performing a detailed study, many research gaps are observed in the existing designs of this field. Most of these technologies focus only on one aspect of the problem; for example, the majority of the devices work on assisting the visually impaired with reading, or to an extent, identifying limited objects. With this device, it will always provide a comprehensive product that not only assists in their day-to-day lives but gives a wholesome experience to the user which they can enjoy without being constantly reminded of their disabilities. Most of the devices discussed above are focusing on just a fraction of the problem, making it difficult for users to have a better experience. This research work can be concluded with some findings that are listed below:

(1) Larger parts of the technologies already present in the market do not highlight all the problems and instead develop a product focusing on only one aspect of the issue.

(2) After finishing our research, it has been realised that out of all the technologies that has been analysed, where it cannot find any device, which addresses all the problems in one device.
(3) All the devices mentioned are very heavy on a middle-class person's pocket in comparison with the features it provides, making it very difficult to afford. This makes it really difficult for the disabled to even participate in day-to-day activities without proper assistance, and as a result of this situation it makes them feel dependent and liable.

The emerging innovative perspectives of different existing technologies can be incorporated into the making of new wearable technology. This work served the purpose of gaining insight into designing a new technology for smart devices which strives for maximum potential associated with minimum cost [48].

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Stateless Key Management Scheme for Proxy-Based Encrypted Databases

Kurra Mallaiah, Rishi Kumar Gandhi, and S. Ramachandram

Abstract To preserve the confidentiality of important data stored in third-party managed platforms like public cloud databases is continuously raising security concerns. Such databases need to be shielded from malicious administrators or malicious software attacks, so as to increase the trust of the potential customers of such security. Therefore, it is very important that the data must be protected at rest, in transition and also while in operation to achieve full confidentiality for the data stored in databases. Shielding the confidentiality of data at rest and in transition is adequately addressed but shielding the confidentiality of data while in operation is still a big challenge. CryptDB provides confidentiality for relational databases by supporting the computations on encrypted data. The keys which are used in CryptDB are stored in the proxy. This paper proposes a stateless key management scheme, inversely the statefull key management scheme of CryptDB. The security proof is presented along with cryptographic security definitions and that the security of our key management under the random oracle model security assumption. The proposed key management scheme is the first of its kind that is a stateless key management. The scheme eliminates the storing of user cryptographic keys in the proxy and, hence, avoids possible attacks and analysis on keys in the proxy and also various other problems such as key backup, key loss, and key audit. Our proposed solution also satisfies regulatory compliance by not storing the cryptographic keys anywhere.

Keywords Trusted proxy · Security · Stateless key management · Database · Cloud computing

1 Introduction

In context of cryptographic solutions, key management refers to protection, storage, backup, and administration of encryption keys. The confidentiality of critical data stored in the cloud databases should be maintained against malicious administrator and malicious software attacks. While using these services managed by third parties,

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the physical control over data moves beyond the premises of user's organization into that of third-party administrator. The encryption techniques ensure the confidentiality of data, if and only if, encryption/decryption keys are accessible only to authorized entities. Therefore, the cryptographic keys used for encryption of data should be protected from malicious administrators or software hackers. The problem is that a single enterprise may end up using various different and maybe incompatible algorithms to protect confidential data. Subsequently, a vast number of cryptographic keys are generated which are in turn needed to be protected and used efficiently. Besides, separation of keys and data storage is challenging task. For example, the server compromised by an attacker where cryptographic keys along with encrypted data are stored, and then confidentiality of sensitive data becomes a bigger threat. Therefore, the keys along with sensitive data never be stored together. User or user's authorized entities should manage keys but not third-party administrator. So, the key management has become critical research in cloud computing. According to Verizon [15], about 42% companies have trouble in implementing a proper key management policy to protect data. Experts say, appropriate key management is becoming more important than encryption itself. So, keys speak for '*the keys to the kingdom,*' if anyone access to the cryptographic key, they may access to the most important data in the company. Appropriate key management is a requirement for compliance to PCI-DSS [16]. Even auditors scrutinize how companies govern cryptographic keys [5].

Nowadays, organizations are migrating company databases to cloud data centers rapidly. In cloud service, cloud provider controls IT infrastructure, and clients have to trust them [26]. There are number of challenges associated with utilizing cloud computing such as data security, abuse of cloud services, malicious insider, cyber-attacks, and advanced persistent threats (APTs) as discussed in [4, 10, 14, 28, 54, 55]. The various cloud database service providers such as Google Drive, OneDrive, Amazon Cloud Drive, DropBox, etc., [25] are storing the encryption keys in their data centers. According to the 2014 Verizon data breach report [36], databases are one of the most compromised assets. There are some schemes which support certain types of computation on encrypted data for databases. In [3], statistical discloser control techniques are discussed to maintain the privacy of the sensitive data, while allowing the external researcher to compute some statistical values from the patient's databases. Fully homomorphic encryption [6] scheme which supports random calculations on encrypted data. But, this technique is prohibitively slow, therefore, for database intensive applications may not be appropriate. The available proxy-based solutions CryptDB [1], DBMask [7] and non-proxy-based solutions MONOMI [29, 31] which supports to perform computations on encrypted data for relational databases are storing the required keys in the system. If keys are stored, they may create security issues when the server compromises such as cryptanalysis on stored keys, and also issues related to key loss, rollover, backup, recovery, and audit are possible. To mitigate key-related problems, a scheme called 'Stateless Key Management for Proxy-based Systems (SKM-PS)' are presented. In our proposed scheme, the required keys are generated on the fly when user logs in the system, no need to store any key anywhere. Paper is organized into related work, threat model

and security overview of proposed scheme, different possible approaches for protection of third-party managed databases, proposed stateless key management scheme and its performance evaluation, comparison of stateful (stored) and SKM-PS key management, security analysis of SKM-PS scheme, other practical considerations, and conclusion and future scope.

2 Related Work

The various key management techniques which protect critical data discussed in literature [18–24] are storing required keys in the system. The key management solutions specially proposed for cloud-based databases in [30, 32–34] are also storing the required encryption/decryption keys in the system. Inspired by CryptDB [1], a proxy-based system, which supports operations on encrypted data at the database server side using SQL aware encryption algorithms with all required encryption keys stored in proxy. Key management of CryptDB [1] is based on chaining of password to the encryption key, which is used for encryption of data for that user. Each user encryption key is protected with his/her own password, and all these keys are stored in the proxy [1]. Using the application login password of user, the stored encryption key of that user is released in the proxy. This concept is known as key chaining. For shared data, CryptDB maintains a SPEAK-FOR relation [1]. CryptDB also uses public-key encryption when user not logged into the system. This system uses both symmetric and public-private key encryption techniques. In this solution, all the keys that are used to apply the security in the system are stored in the proxy.

- In this solution, the keys of unlogged users may be revealed if the proxy is compromised using cryptanalysis techniques by the attacker because keys are stored in the proxy.
- Also this key management scheme suffers from the problems related to key loss, rollover, backup, recovery, and audit.
- The public–private key usage mechanism also adds up overhead in users' transaction used to encrypt and decrypt message key.
- There is an additional overhead of encrypting and storing keys in database. Same amount of overhead is added while retrieving and decrypting the stored encrypted key from database. For example, to store user data in encrypted state, proxy generates a key from user's login credentials, fetches the stored encrypted symmetric key of that user, and decrypts it by generated key. Then, proxy uses user's symmetric key to encrypt the data and sends to database server. So, for executing single transaction, it requires at least three cryptographic operations and two database transactions.
- The various proxy-based security solutions in-line with CryptDB or extension to CryptDB reported in [37–52] are also storing required cryptographic keys in the system.

In [17], voltage security *Inc.* company mentioned about stateless key management solutions but the implementation details are not available. As per Gartner, the proxy-based security solutions (Cloud Access Security Brokers) [35] are going to evolve more and more for the protection of cloud database service. To the best of our knowledge, stateless key management scheme (Not storing keys in the proxy) proposed in this paper is first of its kind for protection of sensitive data using a trusted proxy for cloud-based relational databases. The proposed key management scheme is also applicable to non-relational databases, but the scope of this paper is restricted to relational databases. In most cases, organizations critical data is stored in the relational databases. Therefore, in this paper, our focus is on key management for relational databases.

2.1 Threat Model

The proposed key management scheme addresses the following threats.

i. The first threat is a malicious administrator or IT manager who tries to acquire the stored keys in the proxy by snooping on the key storage server; here, the proposed SKM-PS scheme eliminates the malicious administrator or IT manager from acquiring the stored keys.
ii. The second threat is an external attacker who compromise the proxy. In this case, SKM-PS does not prevent accessing the keys of those users who are already enter into application during an attack, nevertheless ensures the confidentiality of logged-out users keys because keys are not stored in the compromised proxy.
iii. The third threat is related to key loss, key rollover, key backup, key recovery, and audit of the keys; here, the proposed scheme eliminates all these issues by simply not storing the keys. The stateless systems are in general less likely to suffer from the distributed denial of service (DDos) attacks compared with stateful systems.

2.2 Security Overview of Proposed Scheme

In our proposed model, there is a set of users using an application, a trusted proxy, and database server. The database stores encrypted data. Each user's data is encrypted or decrypted with keys generated using login credentials of respective users by trusted proxy. These keys are generated on the fly by trusted proxy when user logs in the system through application and deleted when user logs out from application. In our proposed scheme, since keys are generated dynamically on user login, there is no need to store the keys in the proxy. The issues related to key storage, key loss, key rollover, key backup, key recovery, and audit, thus, becomes null and void with our proposed scheme. There are other types of proxy systems which store keys in encrypted state. But these systems are also susceptible to attacks even though the keys are in encrypted

state. An attacker who gets entry into proxy can try to extract plain keys by employing different cryptanalysis techniques. These cryptanalysis techniques become invalid if the proxy system does not store any key.

3 Approaches for Protection of Outsourced Databases

Three approaches are discussed in this section which are used to protect data in the cloud environment.

3.1 Approach-1: Security at Client Side to Protect Confidentiality of Data

As per this scheme, Fig. 1, data is encrypted at the client side before sending it to the cloud database server. All the security modules and keys are with the client. The encrypted data is retrieved from cloud database server and is decrypted at the client side for any manipulations. If there are any modifications in the database, whole database encrypted again and stored. This scheme demands whole database required to be fetched for any OLTP and OLAP transactions, which results in high inefficiency and resource consumption. SPORC [8] and Depot [9] systems follows this scheme.

3.2 Approach-2: Security at Server Side for the Protection of Sensitive Data

In this approach, as shown in Fig. 2, the required security modules resides in the database server system. In this scheme, data decrypted in the server for execution of query and keys is managed at the server side. Unencrypted data is accessible to

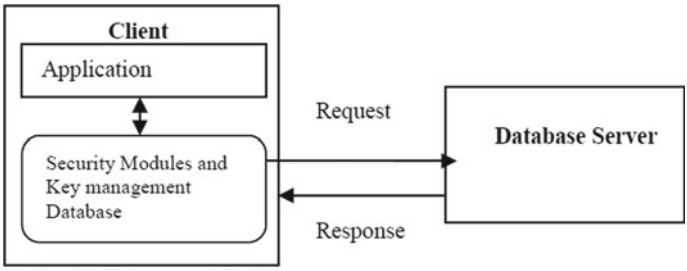


Fig. 1 Security module at client side

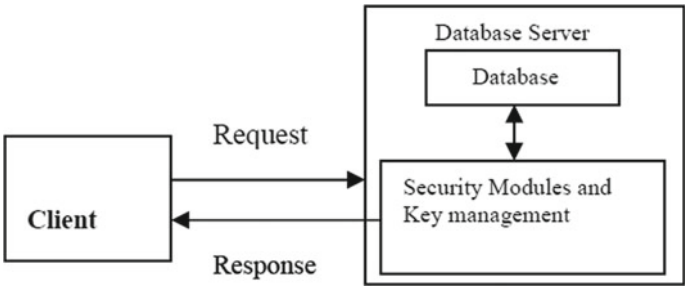


Fig. 2 Security module at database server side

third-party cloud database service providers during the computations. So, malicious administrator may exploit data. Oracle's TDE [11] and SUNDR [27] follow this scheme.

3.3 Approach-3: Security Modules Reside in Proxy

As per this approach, the client, proxy, and database server are places as shown in Fig. 3. In proxy, data is encrypted before storing into database server. The security mechanisms which allows directly execution of queries on encrypted. This approach does not demand any changes in database server and client applications. The entire cryptographic keys are managed by the proxy which eliminates the need to share or store any keys with database server. This approach promises confidentiality of sensitive data from malicious administrators. Based on this approach, CryptDB has presented the technique to preserve the data confidentiality for SQL database applications. Cipher cloud [12] and Navajo systems [13] follow this scheme. Among the

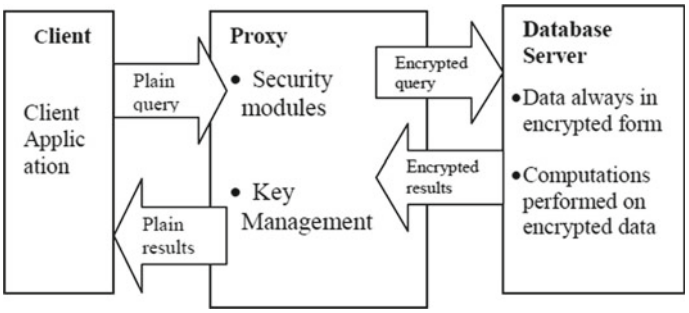


Fig. 3 Security module at intermediate (proxy) Level

discussed four approaches, the approach four(proxy based) looks very promising for providing the security to the outsourced sensitive data in an untrusted service environment.

In this approach, neither client application nor database schema is required to change. The solution is completely transparent to user and database service providers.

4 Proposed Stateless Key Management Scheme for Protection of Outsourced Databases Using TRUSTED Proxy

4.1 Architecture Overview

This para describes the overview of proposed stateless key management as depicted in Fig. 4. The main idea of this scheme is to generate the required keys on the fly when user logs in the system and manage the usage of these keys to protect sensitive data in the proxy without storing the keys. There are three logical entities in the proposed SKM-PS scheme such as client, proxy, and database server. The cryptographic keys are generated and managed in the proxy. On user login from an application using username and password, then an SQL request comes from the application to the proxy to fetch that user credentials from database. The proxy captures this SQL statement, and by using that user credentials, proxy creates cryptographic key for that user. The data encryption and decryption take place using this key in the proxy crypto module engine. The proxy generates and manages all the cryptographic keys that

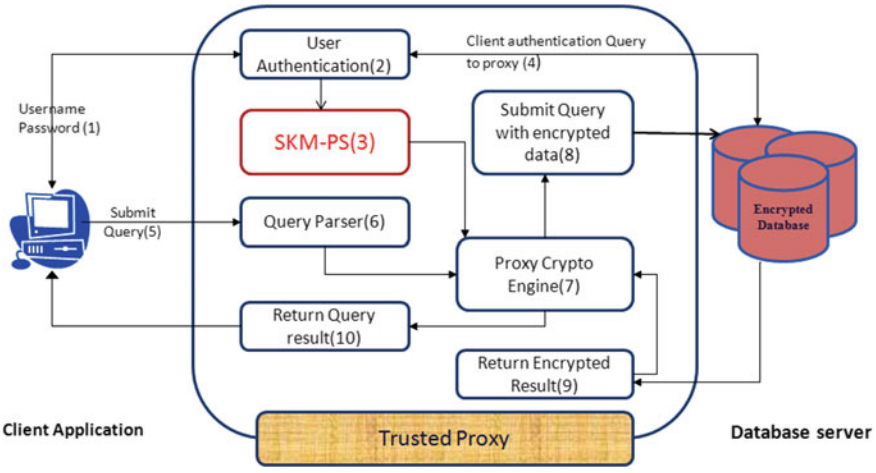


Fig. 4 Stateless key management scheme for proxy-based systems (SKM-PS) architecture

are used to access data items from the database. The application developer annotates the application's database schema and each user roles and their access rights in the system in the proxy.

4.2 Key Derivation Using PBKDF

SKM-PS scheme uses a NIST recommended password-based key derivation function for generating the intermediate in the process of key generation. Key is derived using the user provided password with NIST Special Publication 800-132 [2] as depicted in Fig. 5. The US government uses PBKDF2 to generate strong encryption keys for their systems using user provided passwords. It is a lightweight algorithm that uses only standard and proven hash functions such as NSA's SHA. Key derivation functions are used to derive cryptographic keys information from a secret value, such as a password. Each password-based key derivation function (PBKDF) is defined by the choice of a pseudo random function (PRF) and a fixed iteration count (C). The input to PBKDF includes a password (P), a salt (S), and required length encryption key in bits (kLen).

Symbolically:

$$MK = PBKDF_{(PRF, C)}(P, S, kLen).$$

The minimum length of kLen value is 112 bits. 1000 iteration count is minimum recommended, and for critical keys, iteration count of 100,000 may be appropriate.

4.3 Procedure for Generation of Keys in the Proxy

4.3.1 Member Key (KM) Generation

i. When user enters credentials in login interface of application, application passes login credentials to proxy in form of SQL statement. The proxy parses the query, extracts the credentials, and generates the required cryptographic key (KM) from credentials using PBKDF2 and AES.

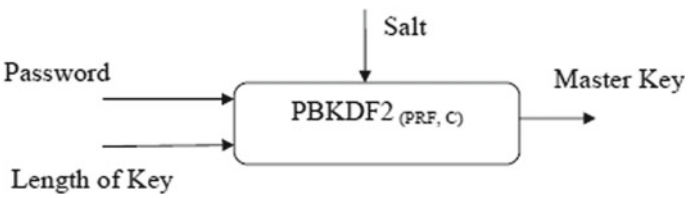


Fig. 5 Password-based key derivation function 2

$$\left.\begin{array}{ll} \text{K1} & = \text{PBKDF}_{(\text{PRF,C})}(\text{P, S, kLen}) \\ \text{K2} & = \text{truncate}(\text{K1, reqkLen}) \\ \text{KM} & = \text{AES}(\text{K2, keyStr}) \\ \text{P} & = \text{user credentials,} \\ \text{S} & = \text{salt,} \\ \text{kLen} & = \text{key length} \end{array}\right\} \quad (1a)$$

Truncate function generates the required key of length, reqkLen by truncating K2.

ii. The generated key (KM) is used for encryption and decryption. It may also be used for obtaining keys for databases, tables, and columns for those user which are logged in the proxy.
iii. Shared sensitive data should be encrypted as per OPEN_TO relation.

4.3.2 OPEN_TO: Relation for Shared Data

OPEN_TO: *Indicate that if data 'D' is accessible to the users* U_1, U_2, … U_n, *then data item 'D' is encrypted with a common key (CK) of that user's group.*

▹ **Generation and usage of Common Key (CK) scheme in the proxy for shared data**

This section describes the common key (CK) generation and usage for accessing the shared data in the proxy. The generation of common key (CK) is devised in three different ways. Depending on the user application requirement and availability of the resources, one of the proposed schemes may be adopted to generate the common key in the proxy.

4.3.3 Scheme-1: Preparation of Groups and Generation of Their Respective Keys [Member Key and Common Key (CK)]

In the scheme-1, application users in the proxy are categorized into different groups depending on their role. Here, four application user roles are considered in the system for the sake of simplicity. The roles are administrator, manager, accountant, and financier. Administrators can access data owned by managers, accountants, and financiers. Likewise, manager can access accountants' and financiers' data, and lastly, accountant can access financiers' data.

Definition 4.1 (*Access graph, Fig.* 6) An access graph G having four nodes G1, G2, G3, and G4 each representing a role and $G = (R, D, E)$ having a set of user roles R, a set of user's data D, and also a set of edges E, where an edge e is a pair (i, j) for $i, j \in R$ denoting user i has access to data 'D' owned by user j.

Each data item access rights are maintained in the proxy. When a request is received from an application, the proxy first determines the access rights of the user. And accordingly, keys are generated and used in the system for accessing the shared

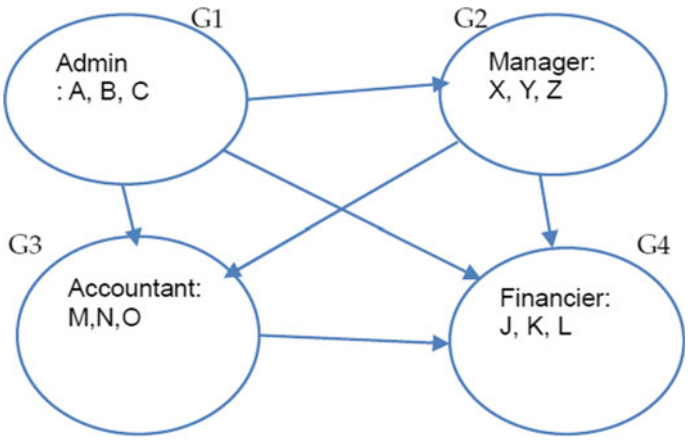


Fig. 6 Access right graph

data. Table 1 depicts the members of the group, Table 2 depicts the group access rights across other groups, and Table 3 depicts group access rights for common keys.

4.3.4 Preparation of groups and their respective keys (member key and Common key (CK))

i. Initially, administrator annotates one time configuration data to proxy. This data contains information pertaining to users, their roles defining group, relation between groups, and their application login credentials.

Table 1 Group members

Group	G1	G2	G3	G4
	A	X	M	J
	B	Y	N	K
	C	Z	O	L

Table 2 Across group access rights

Group	Access rights		
G1	G2	G3	G4
G2	G3	G4	–
G3	G4	–	–
G4	–	–	–

Table 3 Group access matrix for common key (CK)

Group	Common key access rights			
G1	CK1	CK2	CK3	CK4
G2	CK2	CK3	CK4	–
G3	CK3	CK4	–	–
G4	CK4	–	–	–

ii. Proxy categorizes users into different groups according to the roles defined in the configuration data. And each group is assigned with one random secretID.

$$G_{i=1}^{4} = \text{secretID}_{i=0-4}$$

Group	secretID
G1	SecretID1
G2	SecretID2
G3	SecretID3
G4	SecretID4

iii. Each user has their member key which is generated on the fly by using their application login credentials.
iv. Here, it is to be noted that login credentials are used only one time to generate member keys KM. The assigned secretID$_i$ for each group is stored in the database by encrypting with each group member key and other group member key based on access rights.

Member key generation

$$K1 = PBKDF_{(PRF,C)}(P_i, S, kLen)$$
$$K2 = truncate\ (K1, reqkLen)$$
$$KM = AES\ (K2, keyStr)$$

P_i = *user credentials, S = salt, kLen = key length,*
keyStr = Fixed key string, reqkLen = desired key length

Truncate function generates the intermediary key having length reqkLen by truncating intermediate key K1. Algorithm AES encrypts fixed key string by the intermediary key K2 to generate member key KM.

Storing of SecretID in Database:

$$CiphersecID_i = Enc_{Ki}(secretID_i)$$

The CipherID$_i$ are stored in the database.

Group members	Encrypted secretIDs with member key stored in the database
U_1	$CiphersecID_1$
U_2	$CiphersecID_2$
U_3	$CiphersecID_3$
U_4	$CiphersecID_4$
…	…
U_n	$CiphersecID_n$

v. The proxy generates a common key (CK_i) depending on the user belonging group using assigned $secretID_i$ to access shared data in the system. The stored $CipherID_i$ is retrieved from the database and is decrypted using respective user's member key k_i to get corresponding $secretID_i$.
$secretID_i = Dec_{ki}(CipherID_i)$

The common key (CK_i) is generated in the proxy in following way

$$\left.\begin{array}{ll} K1 & = PBKDF_{(PRF,C)}(secretID_i, S, kLen) \\ K2 & = truncate(K1, reqkLen) \\ CK_i & = AES(K2, keyStr) \\ S & = salt, \\ kLen & = key\ length, \\ CK & = Common\ Key \end{array}\right\} \quad (2a)$$

vi. The common key (CK_i) is used to access the shared data between the users belonging to their group G_i.
vii. When user U_i has to access shared data that belongs to other group G_j, then common key CK_j belonging to that group is generated by the proxy using that group's $secretID_j$.

In the following example, the encrypted shared data 'xyz' belonging to user Alice from the group manager, i.e., G2. This shared data is OPEN_TO the users John and Dan which belongs to group G1. The data 'xyz' is encrypted with common key of group G2, i.e., CK2. Common key CK2 gets generated by using $secretID_2$ of group G2. This $secretID_2$ is also encrypted with John and Dan member keys and stored in the database. If Alice wants to access the encrypted data item 'xyz,' she logs in the system by using her credentials. The proxy generates Alice member key KM_3, retrieves $secretID_2$ of group G2, and decrypts using Alice member key KM_3. Using this $secretID_2$, proxy generates the common key (CK_2) and access the encrypted data item 'xyz.' If John wanted to read the data item 'xyz,' then proxy generates John member key KM_4 using his login credentials and retrieves group G2's $secretID_2$ which is encrypted and stored by the John's member key KM_4. Now, proxy decrypts $secretID_2$ and uses to generate the common key (CK_2). Using CK_2, John decrypts

and reads the data item xyz. The OPEN_TO procedure avoids use of the public-key concept of CryptDB when user is not online. In CryptDB, the shared data 'key' of owner is encrypted and stored with user's public key when she is not online. When user logs in, she decrypts the 'key' using her private key and re-encrypts owner's shared data key with her own symmetric key. When user is not online, two times encryption and decryption of shared data owner's key takes place. In our OPEN_TO relation technique, it is required to decrypt only once to generate CK to access the shared data. Also, OPEN_TO procedure avoids encryption and decryption using asymmetric key. Asymmetric key algorithms are more expensive than symmetric key algorithm.

viii. When user logout from application, all keys will be deleted from the proxy which are belonging to that user.

4.3.5 Scheme-2: Member Key and Common Key generation

In scheme-1, there is a 'secretID,' which is used in generation of common key (CK) in database by protecting with member keys which are generated using their login credentials. Scheme-2 avoids the storing of 'secretID' in database. In scheme-2, as depicted in Fig. 7, a 'secretID' for each group is pre-created and shared with all the group members in the system. The user provides secretID using other medium than username and password application interface at the time of login in the system. The secretID along with username is sent to proxy by user via other communication channel such as mobile network. The username and password reach the proxy in the form of SQL statement. Proxy parses the query and creates member key for that user using username and password and also creates common Key (CK) using 'secretID' for accessing shared data. In this scheme, proxy needs to run a daemon which interfaces with other communication channel through which user provides the secretID to the proxy.

i. Member key (KM) is generated using login credentials of user with the help of the procedure explained at (1)

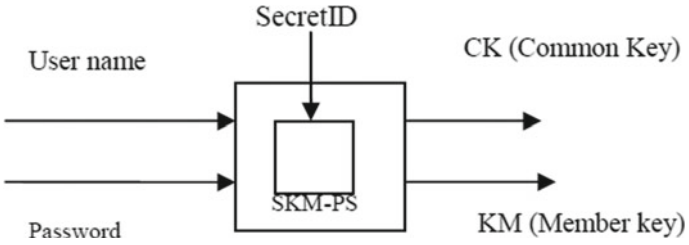


Fig. 7 Illustration of scheme-2 of SKM-PS

ii. The common key (CK) is generated with the help of the procedure explained at (2).
iii. Shared data can be accessed as per OPEN_TO relation as described in Scheme 1 at points *vi* and *vii*.

All the access rights of the users for shared data are maintained like scheme-1 in the proxy. All the keys are generated on user logs in the system through application. In this scheme, the 'secretID' has to be passed to proxy via other communication channel when user logs in the system along with username and password.

4.3.6 Scheme-3: Member Key and Common Key generation

In scheme-3, as depicted in Fig. 8, further the passing of 'secretID' is avoided via other communication channel to proxy for generation of common key (CK)to access the shared data. In this scheme, the password of user is created such that the assigned '$secretID_i$' to the user U_i and user own pass phrase (uP) is concatenated in a fashion to generate password.

Password = 'uP_i + $secretID_i$'

i. In this scheme, also users are assigned secretIDs and user's pass phrase (uP) are combined with respective users secretIDs to create a password for that user. When user login the system using this password, the proxy, segregate user's pass phrase, and secretID from the user provided password.
ii. The proxy generates member key (KM) using login credentials (username and pass phrase portion of password (uP) with help of the procedure explained at (1a).
iii. The proxy generates common key (CK) using 'secretID' extracted from user login password with the help of the procedure explained at (2a).
iv. Therefore, this scheme eliminates storing of secretID in the database.

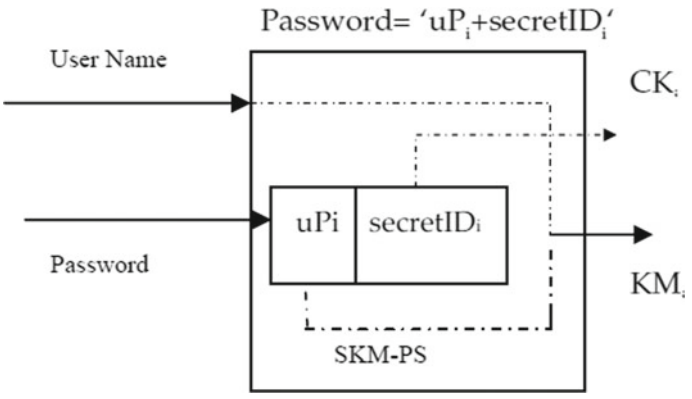


Fig. 8 Illustration of scheme-3 of SKM-PS

All the users in the proxy as per OPEN_TO relation use CK for encrypting and decrypting shared data. When users logout from application, all the keys including common key are deleted from the proxy. In our proposed key generation scheme, neither user member keys nor common keys are required to store in the proxy. All the required keys are generated on the fly when user login the system. The proposed scheme of key management technique eliminates the requirement of keys storage. Hence, attacks on keys which are stored at proxy level become invalid. These techniques also adhere to many regulatory compliance by not storing the encryption keys. There is no requirement of backup the keys periodically. And there is no fear of keys loosing. A key copying among different servers is not required, and keys can be re-generated or derived in every server as and when it is required dynamically. The proposed stateless key generation procedures is not only applicable to the proxy-based protection system for databases, but also useful in many applications where users are sharing documents.

- **Remarks: Public-Key pair generation using SKM-PS**

  i. The proposed scheme generates the symmetric member key and common key on the user logs in the system. There may be certain application cases where public-key encryption mechanism only applicable to encrypt and decrypt the data in the proxy. In such application scenarios, to generate the member key pair (public and private) for asymmetric algorithms, an alternate syntax is defined; a key pair (KP) is generated using user application login credentials.

$$\textbf{\textit{Member key pair generation}}:$$
$$K1 = PBKDF_{(PRF,C)}(P_i, S, kLen)$$
$$K2 = truncate\ (K1, reqkLen)$$
$$KP = RSA\ (K2, keyStr)$$
$$P_i = user\ credentials,\ S = salt,\ kLen = key\ length,$$
$$keyStr = Fixed\ key\ string,\ reqkLen = desired\ key\ length$$

  ii. To access the shared data, as per OPEN_TO relation, the common key pair (CKP) is generated with PBKDF2 and asymmetric key algorithm using $secretID_i$.

$$\textbf{Common Key Pair Generation}:$$
$$K1 = PBKDF_{(PRF,C)}(\text{secretID}_i,\ S,\ kLen)$$
$$K2 = truncate\ (K1, reqkLen)$$
$$CKP = RSA\ (K2, keyStr)$$
$$S = salt,\ kLen = key\ length,$$
$$CKP = Common\ Key\ Pair$$

For accessing the shared data, secretIDs are generated and assigned to each group as mentioned in scheme-1. These secretIDs are used to generate the common key pair (CKP_s) for each group, and $secretID_s$ are encrypted with public key of each group members, and other group members as per data access rights stored in the database. To access the shared data for a user U_i of group G_i, the $secretID_i$ is retrieved from the database and decrypted with private key of user U_i and CKP_i is generated using this $secretID_i$, and then shared data is accessed using these keys. Similarly, like scheme-2,

to access the shared data, the secretID is passed using other communication channel to the proxy. Similarly, like scheme-3, the secretID is combined with pass phrase to form a user login password.

4.4 Choice of Scheme for OPEN_TO Relation

This paper presented three schemes to generate the common key to access the shared data as per the OPEN_TO relation. The proposed three schemes to generate the common key are relevant in the following three different application scenarios. Therefore, these schemes need to be adopted depending on the application requirements and resource availability.

- **Scenario-1**
  Consider a case where there is no other communication channel (mobile network) is present in the system (client side application) to send secretID to the proxy that is in turn used to generate the common key (CK). In this case, the scheme-1 is relevant where secretID is stored in the database server by encrypting it with the member keys.
- **Scenario-2**
  If application has a provision of using other communication channel (mobile network) to connect the proxy, in this case, the secretID can be obtained from the user via this channel and used to generate the common key (CK).
- **Scenario-3**
  If application has no other communication channel (mobile network) to connect to the proxy and also does not have the provision to store the secretID. Then, the third proposed scheme is useful to generate the common key.

4.5 Advantage of SKM-PS Scheme over CryptDB Key Management (stored Key)

Here, it presents advantages of the stateless key management over the stateful key management scheme (CryptDB). The proposed SKM-PS have many advantages over the stateful key management for proxy-based systems. The comparison of these two schemes is shown in Table 4. The summary of the proposed scheme is as follows: It mitigates many issues related to the stored key management of proxy-based systems. On the fly, keys are generated in the proxy at the time of user login into the application. This scheme completely eliminates accessing the keys of unlogged in users in the system by not storing keys in the proxy by the malicious administrators or hackers. Various other key management issues such as key backup, key recovery, key rollover, auditing of the keys, and denial of key access services become null and void with our proposed key management.

Table 4 Advantage of Stateless Key Management (SKM-PS) over the stored key management (CryptDB)

Stateful key management (CryptDB)	Stateless key management (SKM-SP)
Key is generated at the time of proxy setup and available in the proxy system even after user logout from application	Key is generated when it is required and not available in the proxy after user logout from application
Key is required to store	Eliminates key storage
Key is used by accessing from the stored location	Key is generated dynamically and used
Key is required to backup	Eliminates the key backup
There is a possibility of stealing the stored keys using cryptanalysis by malicious administrator or hackers	No cryptanalysis is applicable, since no key is available in the proxy after user logout from application
Possibility of insider abuse on stored keys in the proxy	Eliminates insider abuse for the keys which used to encrypt the sensitive data
Unlogged user data may be in threat because stored keys may be accessed by the attacker using some cryptanalysis	Eliminates the possibility of accessing the unlogged user data by an attacker
Physical attack/damage of keys is possible	Eliminates the physical attack/damage for the keys
Does not comply to many security standards	Compliance to many security standards
Keys used for encryption of sensitive data may be lost	Guarantees that key cannot be lost
Extra infrastructure is required to store the keys and its management	Eliminates extra infrastructure for key storage
Key retrieval servers are congenitally in-secure, costly, and highly strain to use	Key recovery is not required; when key is loss, it can be generated using user logs in credentials
Key recovery reduces the protection of encryption techniques available to control over decryption data	Not applicable
Third-party service may require for the enterprises to manage the keys	No requirement of third-party services for key management
Client need authentication to retrieve key from central server	Not applicable
Ensuring that keys will still be available for long duration when access to archived data is required will be under question?	Keys can be derived after any number of years having only user login credentials
It is very difficult to ensure that an authorized staffer be able to access keys in a disaster when servers must be rebuilt from encrypted backups without the original backup software or tape drive that did the encryption?	Only authorized user with right login credentials can only access to encrypted backup
Key recovery systems are particularly vulnerable to compromise by authorized individuals who abuse or misuse their positions	Not possible
Performance overhead is higher when accessing the stored key from remote location	Performance of generation of key dynamically is better than accessing and using the stored key
Requires dedicated manpower to manage the key backups	Eliminates the need for dedicated IT head count for key management because it removes the need to constantly backup key stores
Auditing of the keys required regularly	Eliminates the key auditing
There is possibility of denial of service while accessing key from stored location	Avoids denial of service

4.6 Stateless Key Management Performance Statistics

Here, the performance analysis of the stateless key management scheme has been presented. C language is used to implement the presented key management scheme using OpenSSL and Mysql libraries. The experiments are carried on Linux platform running on 16-core Intel Xeon processor @2.60 GHz system with 64 GB of RAM. The key length 128, 256, and 512 bits have been considered to generate. The member key (KM) generation performance timings are shown in Table 5, and common key (CK) generation performance timings are shown in Table 6. The keys are generated when user logs in the system and key remains in the proxy complete session until user logout from the application. Therefore, key generation timings are shown in Tables 5 and 6 realistic and even performing better compared to storing and accessing the key in the proxy. The key generation parameters such as user login credentials are fixed to 8 bytes and secretID for Common key generation is fixed 60 bytes. Table 7 shows accessing and decryption timings of stored encrypted key in the proxy. The member key and common key are generated using AES algorithm along with PBKDF2. The default parameters of PBKDF2 such as number of rounds 1000, 128 bits salt, and SHA512 are used. In this implementation, all three entities such as application, trusted proxy, and database are residing in the local system. Apart from avoiding the key-related issues with stored key in the proxy, the proposed SKM-PS scheme is performing better timings in key generation than stored key access process. The performance comparison of SKM-PS and stored key usage in the proxy are depicted in Tables 8 and 9, and Fig. 13 shows graphical representation. Figures 9, 10, and 11 depict the timings of member key, common key, and decryption of stored key, respectively (Fig. 12).

Observations

→ Performance overhead is higher in stored key management (CryptDB) compared to stateless key while data encryption.

→ Apart from mitigating the various key management issues with stored key, the

Table 5 Performance statistics of member key generation using SKM-PS

S. No.	Key length	Key generation timing (s)
1	128	0.004457
2	256	0.008911
3	512	0.017732

Table 6 Performance statistics of common key (CK) generation timings using SKM-PS

S. No.	Key length	Key generation timing (s)
1	128	0.004885
2	256	0.009312
3	512	0.018093

Table 7 Performance statistics of decryption of stored key in the proxy

S. No.	Key length	Key generation timing (s)
1	128	0.019698
2	256	0.021047
3	512	0.024605

Table 8 Performance comparison of stored key and member key(SKM-PS)

Key length	Stored key decryption in the proxy	SKM-PS member key generation
128	0.019698	0.004457
256	0.021047	0.008911
512	0.024605	0.017732

Table 9 Performance comparison of stored key and common key of SKM-PS

Key length	Stored key decryption in the proxy	SKM-PS Common key generation
128	0.019698	0.004885
256	0.021047	0.009312
512	0.024605	0.018093

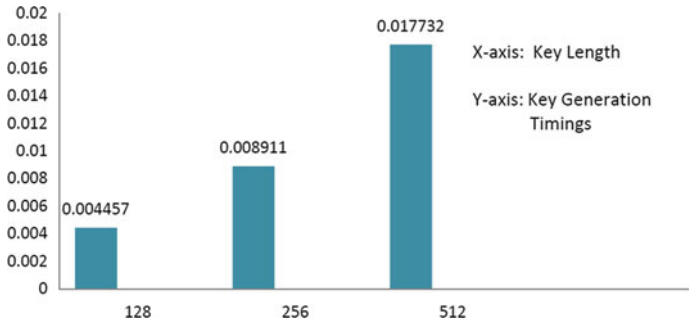


Fig. 9 Member key (KM) generation of 128, 256, and 512 bits timings in seconds

proposed stateless key management achieves better performance gain compared to stored key management. The performance gain is shown in Table 10, and same has been illustrated in Fig. 14. The performance gain is higher side with lower key length and lower in higher key length.

→ The number of cryptographic operations and database transaction required to store a given user data item (for example) in an encrypted state with CryptDB key management, and proposed stateless key management scheme is discussed below.

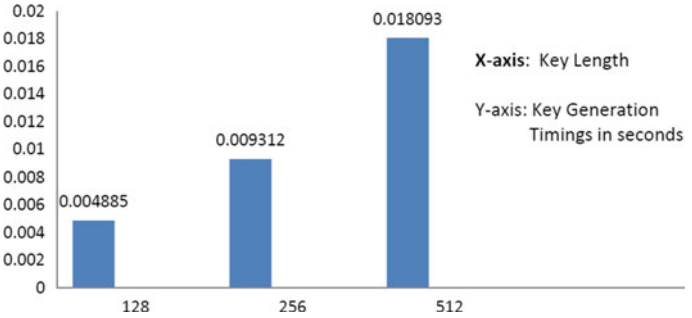


Fig. 10 Common key (KM) of 128, 256, and 512 bits generation timings in seconds

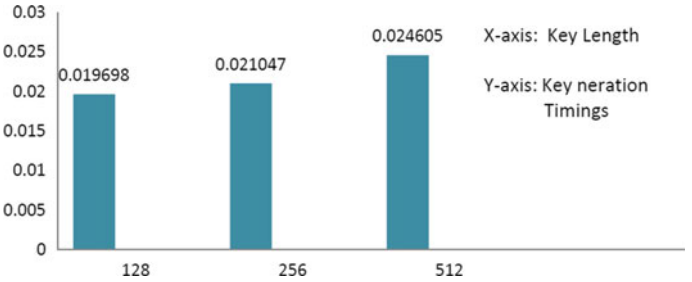
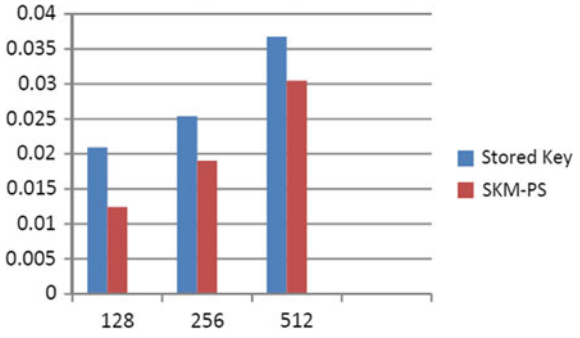


Fig. 11 Decryption timings of stored key in seconds

Fig. 12 Performance Comparison of common key and stored key. *X*-axis: key length and *Y*-axis: timings in seconds



With CryptDB

- Proxy generates a key from user's login credentials.
- Fetches the stored encrypted symmetric key of that user and decrypts it using generated key.
- Then proxy encrypts data using user's symmetric key and dispatches to database server to store.

Table 10 Performance gain with SKM-PS compared to stored key

S. No.	Key length	% of gain with SKM-PS
1	128	441.9
2	256	236.19
3	512	138.76

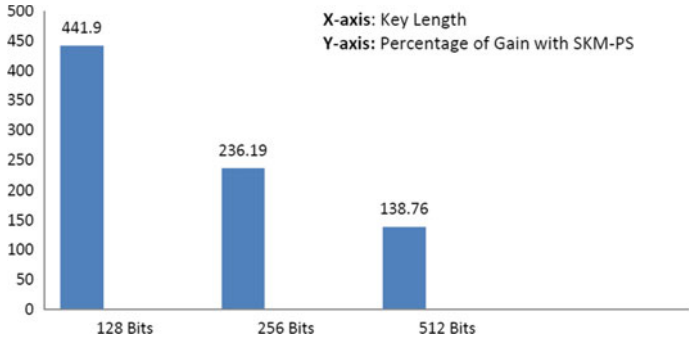


Fig. 13 Performance gain with SKM-PS compared to stored key for keys length 128, 256, 512 bits

- So, for executing single transaction, it requires at least three cryptographic operations and two database transactions.

With SKM-PS

- Proxy generates key from user provided login credentials.
- User data item is encrypted using this key, and proxy sends encrypted data to the database server to store.
- Therefore, SKM-PS requires only two cryptographic operations and one database transaction.

The number of cryptographic operations and database transactions required with respect to CryptDB and SKM-PS is shown in Table 11.

Table 11 Number of cryptographic and database transactions requirement for encryption of a data item comparison

Scheme	No. of cryptography ops	No. of database transactions
Stored key (CryptDB)	3	2
SKM-PS	2	1

5 Security Analysis of Proposed Stateless Key Management

The proposed stateless key management scheme is provable secure for generating the cryptographic keys and their use for preserving the database confidentiality in an untrusted service environment for SQL databases make use of the proxy methodology. Intuitively, security property from the SKM-PS scheme expected is a secure key generation process; i.e., keys generated using the proposed scheme is random keys, and it is not possible to guess or derive keys by any adversary in the proxy for those users who are not logged into the system.

Definition 5.1 (*Secure Key Generation*) The key generation scheme 'KG' is secure such that an adversary '*ADV*' does not able to generate or derive the cryptographic keys 'K' in the proxy without knowing the login credentials of the authentic users in the proxy.

Proof The key generation scheme 'KG' is (q, t, ε)-secure, if for all t-time adversaries A that send at most q queries to the key generation Oracle $O(P)$ it holds that $\Pr[A^{O(P)} \rightarrow K] \leq \varepsilon$.

The probability of an adversary generating/deriving cryptographic key in the proxy using the random login credentials is almost negligible.

The proposed SKM-PS scheme uses PBKDF2 and AES-512 cryptographic algorithms to generate member key and common key in the proxy to access owned and shared data, respectively. The PBKDF2 is used to generate the intermediate key say K_1, and the final member and common key are generated using the AES block cipher. The PBKDF2 uses SHA512 hash function, it is a 'one way' function meaning that it is very hard to 'invert' the function, i.e., to find the original message given only a message digest. It is hard to find two different messages (M, M') such that Hash(M) = Hash(M').

I. **Hash function**:

A hash function is a deterministic function which maps a bit string of an arbitrary length to a hashed value which is a bit string of a fixed length. Let h denote a hash function whose fixed output length is denoted by $|h|$. This h is one way function.

Definition 5.2 A function $h : X \rightarrow Y$ is one way if $h(x)$ can be computed efficiently for all $x \in X$, but $f^{-1}(y)$ cannot be computed efficiently for ${}_{y \in R} Y$.

In this definition, X represents the domain of the function h, Y represents the range, and the expression ${}_{y \in R} Y$ stands for a y that is randomly chosen from Y. Consequently, it must be efficiently compute $h(x)$ for all $x \in X$, whereas it must not or only with a negligible probability be possible to compute $f^{-1}(y)$ for randomly chosen $y \in Y$.

II. **Pseudo Random Permutation (AES Block cipher)**:

Definition (Pseudo Random Permutation) 5.3: A family of permutations $\{f_s : \{0, 1\}^n \rightarrow \{0, 1\}^n\}$ is a strong PRP family (also known as block cipher) if it is:

A. **Efficiently computable**: There is a deterministic polynomial-time algorithm F such that F(s,x)=$f_s(x)$ for all choices of seed s and input $x \in \{0, 1\}^n$.

B. **Pseudo-random**: For every non-uniform probability polynomial time(n.u.p.p.t) A $\mid \Pr_{f \leftarrow \{f_s\}}[A^{f,f^{-1}}(1^n) = 1] - Pr_{F \leftarrow P(\{0,1\}^n}[A^{F,F^{-1}}(1^n) = 1] \mid = \text{negl}(n)$. Here, $P(\{0, 1\}^n)$ is the set of all permutations from $\{0, 1\}^n$ to $\{0, 1\}^n$, and $A^{f,f^{-1}}$ denotes that the algorithm A has oracle access to both the function f and its inverse.

Symmetric Key security definition 5.4: A symmetric encryption scheme (S) with message space M and a cipher text space C is perfectly secrete if for all $m_0, m_1 \in$ M and all $c \in C$, $\Pr[\text{Enc}_k(m_0) = c] = \Pr[\text{Enc}_k(m_1) = c]$. That is, the distributions of $\text{Enc}_k(m_0)$ and $\text{Enc}_k(m_1)$ are identical, over the choice of the key k.

Let us say, an adversary '*ADV*' has compromised the proxy using some trapdoor in it. Now question arise that 'Can *ADV* able to generate or derive the cryptographic key to gain access to the data belonging to application's users?' This question can be answered with two cases. In first case, there is no live users, i.e., no user is logged in application; in this case, proxy does not have any credentials nor it has any users' member key or group key. So, *ADV* will not be able to generate any key as proxy does not have user credentials, and also *ADV* will not be in state of guessing the credentials by any cryptanalysis techniques, since proxy does not store any keys. While in second case, if there are users logged in, *ADV* may have access to keys for those users as long as they are active and not logged out. But again *ADV* does not have access to the keys or credentials of unlogged users as proxy destroys the keys as and when user logs out of the application. The generation of right cryptographic keys depends on right login credentials of the application users in the proxy. Any adversary is unable to generate the keys in the proxy without having the correct login credentials for the application users. The proof of this concept is shown using random oracle model.

Random Oracle Model

A random oracle [53] is an ideal primitive which provides a random output for each new query. Identical input queries are given the same answer. A random permutation is an ideal primitive that contains a random permutation $P : \{0, 1\}^n \rightarrow \{0, 1\}^n$. The ideal primitive provides oracle access to P and P^{-1}. An ideal cipher is an ideal primitive that models a random block cipher $E : \{0, 1\}^k x\{0, 1\}^n \rightarrow \{0, 1\}^n$. Each key $k \in \{0, 1\}^k$ defines a random permutation $E_k = E(k, .)$ on $\{0, 1\}^n$. The ideal primitive provides oracle access to E and E^{-1}; that is, on query $(0, k, m)$, the primitive answers $c = E_k(m)$, and on query $(1, k, c)$, the primitive answers m such that $c = E_k(m)$. These oracles are available for any n and k. The function f is deterministic, so the bit string $f(s_0)$ dependent only on the seed. The generated bit strings from $f(s_0)$ should look like truly random bits, given the seed is chosen at random. If this property holds, then the bit generator is secure.

The two algorithms (PBKDF2 and AES) which are used in the scheme are random oracles, therefore, predicting output of these two algorithms probability is negligible. These algorithms (AES and PBKDF2) produce a unique random output value from a unique input (login credentials) and changes randomly when there is any change in the input (login credentials) and are deterministic algorithms. In addition, these

two algorithms are NIST standard security algorithms, and their security proof is described above. Therefore, any adversary 'ADV' in the proxy cannot able to generate the authentic cryptographic keys to access the sensitive data in the system without having right login credentials. Hence, the key generation scheme proposed in the section is secure as long as long as input parameters such as username, password, and secretID are maintained confidentially.

6 Other Practical Considerations

6.1 Number of Rounds Selection for PBKDF2

The maximum number of rounds needed to opt depends upon the system capability and performance required by application. In PBKDF2, as number of rounds increases performance decreases. Let us consider: The time is required to generate an intermediate key K1 using user login credentials is 'tv' on a normal system where the proxy program is running. This 'tv' can be adjusted with the number of rounds in PBKDF2. Let say, there is a threat scenario where following assumptions are made:

i. A potential attacker has processing power 'ft' times higher CPU speed than the system where proxy program is running.
ii. A user password has n-bits of entropy, which means that an attacker may try to deduct a user password with dictionary of plausible passwords that takes on average of 2^{n-1} tries.
iii. An attacker may try to crack the system to find the password with time less than 'p' where p denotes the attacker's patience.

Therefore, the time required to break a single password is set to exceed the attacker's patience 'p'.

$$\mathrm{tv} \cdots 2^{n-1} > \mathrm{ft} \cdots \mathrm{p}$$

As password entropy bits 'n' increases, it becomes harder for the attacker to crack the password. Hence, it is better to use higher number of rounds to protect password guessing from dictionary attacks.

6.2 Password Change

Change of password only affects the member key (KM) in our proposed scheme. The new member key has to be generated for that user using new password, and any data encrypted with member key generated with old password has to be decrypted and re-encrypted with newly generated member key. Also, secretID encrypted with old member key has to be decrypted and re-encrypted with newly generated member key.

6.3 Forget Password

Passwords and secretIDs used for generation of keys need to securely protected. A password forget mechanism need to setup.

6.4 Adding New Application User

To add new user, the proxy should know OPEN_TO relation with other users for accessing of the common/shared data in the system. Basically, the proxy should know that new user belongs to which group in the system. Accordingly, the proxy maintains the access rights in the system.

6.5 Proxy Deployment Scenarios

The proxy can be deployed (shown in Fig. 14) within the organization premises and also in the cloud. If proxy is setup on the cloud, organization's administrator should manage it not the service provider. Required security settings for sensitive data need to be configured in the proxy by the proxy administrator.

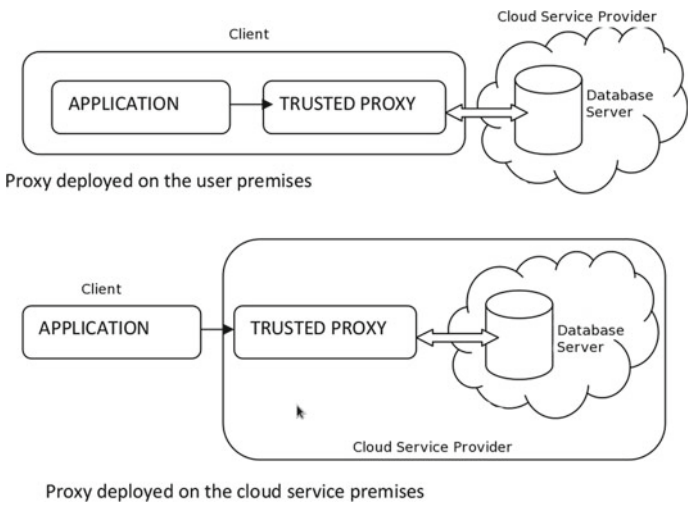


Fig. 14 Proxy deployments

7 Conclusions and Future Scope

Key management has become a crucial security concerns while using the third party services like public cloud databases. Proxy-based security solutions are more prominent way of protecting the confidentiality of sensitive data in databases while in use. In previous proxy-based solutions, which protects confidentiality of sensitive data for relational databases by performing operation directly data which is encrypted in the database, required cryptographic keys to be stored in the proxy. The adversaries may steal the keys by compromising the proxy with help of various cryptanalysis techniques. The adversaries may retrieve the keys of unlogged users. The various issues which are related to key storage, key lost, key rollback, etc., may also arise. A stateless key management scheme is proposed for proxy-based security solutions (SKM-PS) where required cryptographic keys are generated on the fly in the trusted proxy. The scheme presented in this paper generates the required cryptographic keys to be used in the proxy using login credentials along with 'secretID' supplied by user from application dynamically (on the fly). These keys are used to encrypt and decrypt the sensitive data in the proxy. Our proposed key generation scheme eliminates storing of keys in the proxy, hence, avoids cryptanalysis on the stored keys in the proxy (attacks on cipher text) and other key-related issues such as key loss, rollover, backup, recovery, and audit. Required keys are generated on the fly no need to store any keys in the proxy, and all the keys will be deleted in the proxy once user logout from application which is contrary to the cryptDB. Our proposed solution also satisfies many regulatory compliance by not storing the keys anywhere. As a future plan, the possibility of extending the stateless key management scheme in distributed proxy-based protection systems for databases can be explored.

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Exploration of Blockchain Architecture, Applications, and Integrating Challenges

Jigar Mehta, Nikunj Ladvaiya, and Vidhi Pandya

Abstract Internet is the technology that is highly used for communication as well as data transmission in the current scenario. Because of the rapid growth in such technology, the issues related to security are also increasing. Blockchain is emerging as a revolutionizing technology in this field. Basically, blockchain relies on the four components, namely decentralization, anonymity, persistence, and audibility. It focuses more on protecting data from unauthorized parties in performing any modification to the existing data. Blockchain technology is also defined as a digital ledger. It is not only limited to cryptocurrencies but with the potential to be transparent and fair, which opens many doors to various technologies like IoT, big data, and many more. This paper includes blockchain locution, and it will encounter some typical consensus algorithms that are ought to analyze blockchain applications and some technical challenges. The proposed research work will also concentrate more on the recent advances to tackle those challenges.

Keywords Blockchain · IoT · Big data · Consensus algorithms · The architecture of blockchain · Challenges in blockchain · Applications of blockchain

1 Introduction

Day by day, the use of the Internet increases very rapidly; while observing the emerging fields like IoT and big data, it can be said that a massive amount of data is produced every day; wherever data is available, it initiates the need to protect by applying various security measures. These security algorithms will get complicated day by day, and it becomes even harder to implement. This is where blockchain comes into the picture, where it removes any non-trustworthy third party that will solve 2

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purposes: The implementation of the security algorithms is easy, and the transaction takes place directly between the sender and receiver to reduce the complexity. The basic goals or pillars of security are confidentiality, integrity, and availability. Confidentiality means none other than the verified and receiving authority can have access to the information. Integrity means no third party should have the right to change the data, and the last term availability means the information should be available to the verified person present anywhere and anytime. From these three pillars, blockchain focuses more on integrity by maintaining the chain of blocks, where each block contains the hash value of the past block, and thus it creates the chain.

Blockchain was first proposed in 2008 and implemented in 2009 [1]. It is generally considered as a secure digital ledger. It was first recognized by one of its applications that is Bitcoin created by Satoshi Nakamoto by making Bitcoin as one of the first applications of blockchain [2]. Bitcoin was first created to remove a third party such as a bank from a transaction and create a peer-to-peer transaction system. The reason for removing the third party is to solve an age-old human issue called trust. Due to the huge popularity of Bitcoin, more people were interested in blockchain and a vast number of its applications were discovered.

As mentioned earlier, blockchain stores information of all the transactions in the form of a group of blocks. Therefore, the working of blockchain is as follows: The sender broadcasts the new transaction into the network. But yet the transaction is new and is not confirmed. Once the nodes receive the transaction, they will validate it will store a copy of it in their transactional pool. After validation, some special nodes called miners will create a block and then this block goes through several operations which are known as mining. The first block to complete the mining will be added to the chain, thus forming a chain of transactions or blocks known as blockchain [2].

This paper is more focused on the challenges faced in various applications generated from blockchain after its integration with several other fields of technology, namely the Internet of things and big data. Further, this research work will analyze different ways of integration and study the challenges and its potential benefits. The manuscript is separated as follows: Sect. 2 describes blockchain and its architecture, Sect. 3 explains distinctive consensus algorithms, Sect. 4 illustrates different uses of blockchain, Sect. 5 defines difficulties in integration with various technologies and possible solutions, and Sect. 6 gives the conclusion.

2 Blockchain: Overview and Architecture

In 2008, Satoshi Nakamoto distributed a paper containing an inventive electric shared money framework known as Bitcoin by eliminating the outsider along these lines permitting just the two consenting partakers to execute straightforwardly [3]. Bitcoin demonstrated an appropriate case of hashing calculations and unbalanced cryptosystems cooperating. Here, a huge public ledger is created by the volunteer nodes and this public lecture is responsible for tracking every transaction taking place in the network. This public ledger is known as a blockchain. Our typical blockchain algorithms can

Table 1 Comparison between types of blockchain based on participation of no. of nodes

	Public		Consortium		Private	
	All nodes	Selected nodes	All nodes	Selected nodes	All nodes	Selected nodes
Consensus determination	√			√		√
Read permission	√			√		√

Table 2 Comparison between types of blockchain based on performance

	Public		Consortium		Private	
	Low	High	Low	High	Low	High
Integrity		√	√		√	
Efficiency	√			√		√

be categorized into 3 parts, i.e., public blockchain, private blockchain, and consortium blockchain. In public blockchain, all the nodes can take part in the consensus process. In private blockchain, only the nodes from the specific controlling organization are allowed to take part in the consensus process. In consortium blockchain, only some preselected nodes are allowed to take part in the consensus algorithm. Tables 1 and 2 represent a detailed comparison of different types of blockchain.

Blockchain technology is a combination of 6 key features [4] which is explained below.

Decentralized: As discussed earlier, blockchain is said to be decentralized because it does not have any central node or a governing node. Each node has a copy of the chain of transactions.
Unambiguous: All the data blocks are transparent to all the other nodes.
Open Source: Another bit of leeway of blockchain is that it is open source; hence, anybody can utilize blockchain and make their application.
Autonomy: Blockchain can be said autonomy because every node that participates in the chain can transfer or update data securely.
Unchangeable: When a transaction takes place, its records are stored permanently into the chain, and it cannot be changed unless any node takes 51% of the ownership.
Anonymity: As blockchain supports peer-to-peer transaction system, it can also perform anonymous transactions where the information known is the person's blockchain address [4].

Here, some acronyms are defined for convenience:

Ver: Version
PBH: Previous block hash
TS: Timestamp

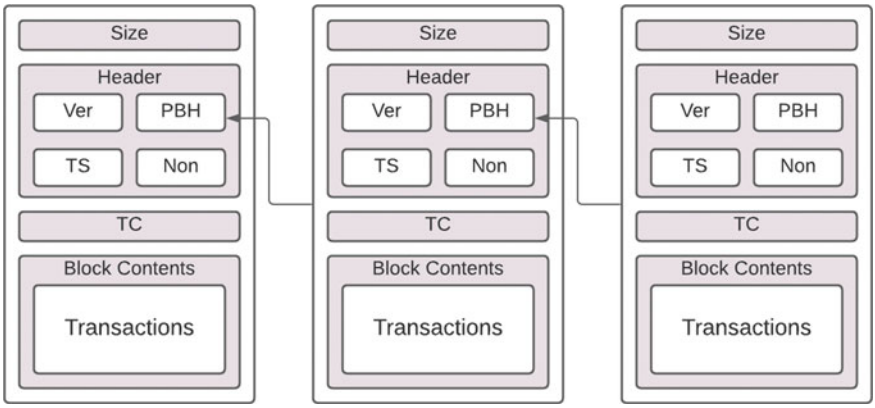

Fig. 1 An illustration of blocks in blockchain architecture

Non: Nonce
TC: Transaction counter.

An architecture of blockchain is shown in Fig. 1. As mentioned earlier that blockchain is a combination of several blocks which is represented for N number of blocks in Fig. 1. Each block contains the complete information of transactions taking place between two entities. You can see from the figure that a typical blockchain block is divided into four subparts, i.e., size, header, transaction counter, and block contents, where the first part constitutes of size of the block, in bytes. Then, the header part constitutes 4 different parts, i.e., version, hash value, timestamp, and nonce. The version represents the version of the protocol; then, the hash value represents the hash of the past block in the chain. For example, as shown in the figure block $N + 1$ has stored the hash value of block N. The timestamp includes the time when the block was created and the nonce is the counter used while calculating the proof of work in the algorithm. The transaction counter gives information regarding the number of transactions that are stored in that particular block. And at last, all the contents of the transactions are stored including sender information, receiver's information, transaction amount/items, etc. Since each node has a copy of the blockchain, there is a possibility of some malicious activity by some of the nodes. To avoid that, some algorithms were introduced such as proof of work (PoW) and proof of stake (PoS) which will be discussed in Sect. 3.

3 Blockchain: Consensus Algorithms

In blockchain, the cycle to arrive at an agreement between deceitful nodes is a change of the Byzantine general issue [4]. In Byzantine problem, a gathering of officers who order a specific aspect of the military circle the city to be captured. But

every general has to attack at the same time or they will not be able to win the war. So how would they reach a consensus of whether to attack or to retreat? Therefore, some of the approaches are mentioned below to reach the consensus. Some of the classical consensus algorithms are proof of work and proof of stake, and some of the other algorithms were later on introduced to overcome challenges faced with the above-mentioned classical algorithms.

3.1 Proof of Work (PoW)

Amongst many of the famous applications, Bitcoin is one of the applications which uses proof of work calculation to distribute a block as it plays out a great deal of computational work to demonstrate that the block is substantial or not. In proof of work, every node calculates the hash value of the given block with the continuously changing nonce value and the consensus decides whether the calculated value is less than or equal to the certain given value. If the calculated value satisfies the requirement criteria, then the given block is broadcast to all the other nodes and is considered valid and other nodes will append the validated block to their blockchains. The node which calculates the hash value is known as miners, and the process of calculating the hash value is known as mining.

In the decentralized network, as all the nodes are calculating the proof of work at the same time there is a possibility that more than one node generates a valid block at the same time, thereby creating a branch/fork as shown in Fig. 2, there is a chain of block-1, block-2, and block-3, and as you can see two valid blocks were generated simultaneously creating a branch or a fork. However, there is less probability that also the next block is calculated simultaneously; therefore, the longer chain will be considered now as a valid chain.

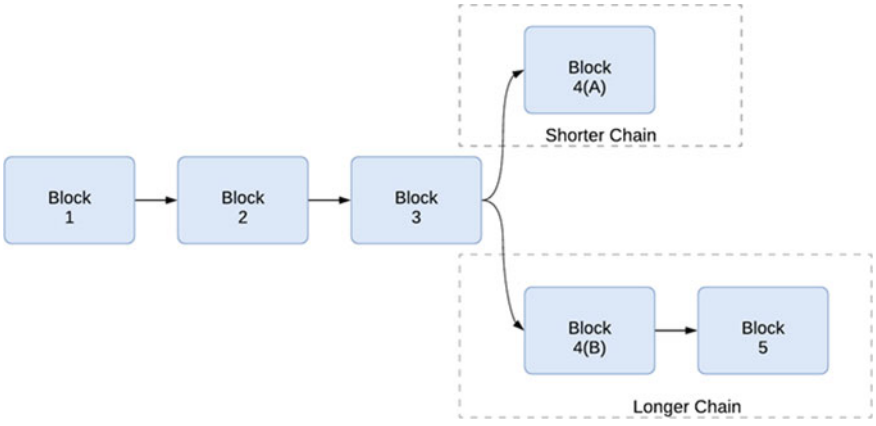

Fig. 2 Fork effect while calculating proof of work

Miners need to go through a ton of PC counts to compute the proof of work; therefore, calculating proof of work results in a large waste of resources. Due to this high consumption of resources, a new cost-efficient consensus algorithm was introduced called proof of stake.

3.2 Proof of Stake (PoS)

This consensus process can be considered equivalent to PoW, but instead of each node calculating the hash value of the changing nonce, here the nodes have to prove the amount of currency that they hold because it is believed that the person with a higher amount of currency is less likely to perform any malicious activity which is injustice. All things considered, the node with the most measure of cash would be ruling the organization. Subsequently, numerous different arrangements were proposed with the blend of proof of stake to choose which node will mine the following block. Some of the famous ones are:

- **BlackCoin**: BlackCoin uses a randomization method to decide which node mines the first block.
- **Peercoin**: Peercoin focuses on the age of the coin that the node with the oldest and a larger amount of coins is more likely to predict the next node.

3.3 Delegated Proof of Stake (DPoS)

The working mechanism of DPoS is the same as PoS. To create the blocks, miners get priority based on their stake [1]. But the main difference between DPoS and PoS is that PoS is direct democratic while DPoS is representative democratic [1]. All the participant nodes select their representative node for the consensus process. With less amount of nodes for the validation process, blocks are confirmed quickly [5].

3.4 Ripple

This algorithm uses a typical client–server architecture. Each node is partitioned into two types. Server for nodes takes interest in the agreement process and client for nodes participating in the exchange of assets. Each server has a unique node list (UNL) [4]. The main role of UNL is to decide where the node will be placed in the chain.

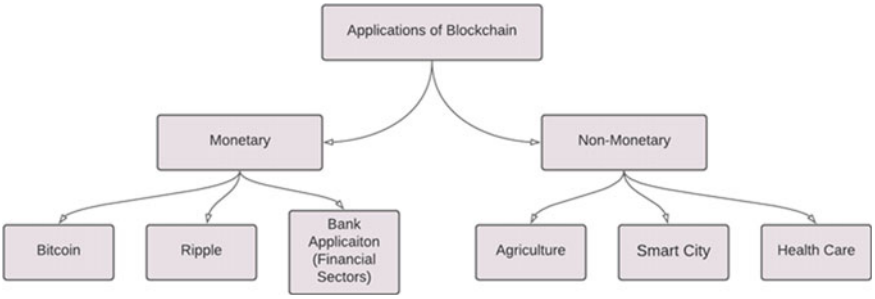

Fig. 3 Classification of blockchain applications

3.5 Tendermint

It is a type of Byzantine consensus algorithm. A random promoter is selected to broadcast the new unconfirmed block. The whole process is divided into 3 steps, i.e., (1) prevote step, (2) pre-commit step, and (3) commit step for validating newly arrived or created block

- **Prevote Step**: During this progression, validators conclude whether to create a prevote message for the new block.
- **Pre-commit Step**: If the proposed branch gets a lion's share vote in favor of the prevote, then it leads the branch to the pre-submit step. In the event that the block gets a lion's share of the decision in favor of pre-commit, therefore promote it to commit step.
- **Commit Step**: Nodes approve the block and broadcast it to all the blocks to accept the block if it receives a majority of votes [4]. This step provides the identity management of the connected object (Fig. 3).

4 Blockchain: Applications

4.1 Bitcoin

Bitcoin is cryptographic cash planned in 2008 by a dark individual or group of people using the name Satoshi Nakamoto and started in 2009 when its execution was conveyed as open-source programming. It is decentralized automated money without a public bank or single chief that can be sent from customer to customer on the common Bitcoin network without the necessity for go-betweens [6]. Trades are checked by network center points through cryptography and recorded in a public circled record called a blockchain. Bitcoins are made as an honor for a cycle known as mining. They can be exchanged for various money-related norms, things, and organizations.

Bitcoin has been applauded and scrutinized. Pundits noticed its utilization in illicit exchanges, the enormous measure of power utilized by excavators, esteem unsteadiness, and robberies from exchanges. A couple of business examiners, including a couple of Nobel laureates, have depicted it as a hypothetical air pocket. Bitcoin has furthermore been used as an endeavor, but a couple of authoritative workplaces have given examiner cautions about Bitcoin.

4.2 Healthcare Sector

Blockchain is currently in a very lead position in the biomedical field [7]. Further, it can be used to merge various fields of medicine such as genomics, telemedicine, neuroscience, and several others. Adaptability is given to the client to perform tasks with the medical services sensors, for example, utilizing a nasal wind stream sensor for perusing pace of wind current or ECG sensor for perusing pulse [8]. Blockchain can also be used in the hospital management system to manage the records of patients. Also, patients' records can be stored in a single database that is controlled or managed by a group of organizations. Blockchain can be also used as a firewall for managerial access to the main healthcare records. Bitcoin which is one of the applications of blockchain already displays the fundamentals of a trusted and auditable computing system used on a distributed system [9].

4.3 Ripple

Ripple majorly focuses on credit networks [10]. It is divided into 6 parts which are listed as follows—server, ledger, last-closed ledger, open ledger, unique node list (UNL), and prosper [11]. It is an application which majorly focuses on banking markets. Ripple is open source; therefore, anybody with the relevant knowledge and skill set can use ripple for their applications [12].

4.4 Smart City

An ideal concept of a smart city focuses on improving the quality of life of its citizens. This can be achieved with the integration of several leading technologies such as blockchain, Internet of things (IoT), and information and communication technology (ICT). Considering blockchain as a branch of ICT offering emerging opportunities ideally used for validating and maintaining cryptocurrency records but several studies later many immersive applications [13]. Thinking about the smart urban communities, it is available to dangers and the chance of dangers is delegated threats on accountability and threats on confidentiality [14].

4.5 Agriculture

The worldwide food supply chain has been maintained by several participants such as farmers, retailers, transportation companies, wholesalers, and several others [15]. Maintenance of this chain is considered a very tedious task. This is where blockchain can be implemented and provide better functionality for the management of the whole food supply system. Agriculture and supply chain have been closely linked since the beginning as the agriculture industry also follows a similar structure. All the processes of the supply chain can be digitalized using various applications such as barcode, QR code, mobile application, and a digital certificate. Also, an advanced level of security can be provided using blockchain.

4.6 Financial Sector

Capital business areas insinuate the coordinating of underwriters with enthusiasm for capital, to monetary masters with the contrasting threat, and bring profiles back. Whether or not the sponsor is business visionaries, new organizations, or colossal affiliations, the route toward raising capital can be trying. Firms face logically serious rules, longer events to get the occasion to grandstand, unusualness from advance expenses, and liquidity peril. Particularly in creating business areas, they ought to investigate the nonattendance of intensive checking, cautious rule, and sufficient market establishment for giving, settlement, clearing, and trading. Blockchain offers various favorable circumstances for a couple of capital market use cases which are recorded beneath:

- Elimination of a lone reason for dissatisfaction by displacing the rights from central utilities.
- Facilitation of capital market practices streamlining cycles, decreasing costs, and reducing time spent on settlements.
- Digitization of cycles and work measures, diminishing operational risks of blackmail, human misstep, and as a rule counterparty peril.
- Digitization or tokenization of favorable circumstances and budgetary instruments, making them programmable and significantly less complex to manage and trade. In the symbolic structure, they increment more broad market access through extended accessibility and the possibility of fractionalized ownership. These result in extended liquidity and reduced cost of capital (Table 3).

5 Blockchain: Challenges and Possible Solutions

There are several challenges faced during the implementation of blockchain technology. This section will discuss some of the general challenges faced during the

Table 3 Recent trends of blockchain in several fields

Paper	Published year	Field	Summary
[34]	2020	Energy sector	In this paper, the author played out a far-reaching audit of how blockchain innovation has been and can be conveyed in energy applications, going from the energy the executives to distributed exchanging to electric vehicle-related applications to carbon discharges exchanging and others
[35]	2020	Supply chain	In this paper, the authors have examined a great deal about the utilization of blockchain in the supply chain industry. Blockchain explicitly does not cover a great deal of this industry. Be that as it may, this paper examined a few practical choices in which blockchain can be utilized in SC applications
[36]	2020	Transport and logistics	This paper zeroes in an extraordinary arrangement on the utilization of blockchain in different applications of the transportation and logistics industry. It likewise examines conceivable future research accessible in this industry as in terms of blockchain
[37]	2020	Internet of things	This paper asserts that still there is a shortage of blockchain-based IoT applications accessible because of a few difficulties. In spite of the fact that the creators of this paper attempt to answer the greater part of these difficulties with practical arrangements
[38]	2020	Power systems	This article plans to propose a wide viewpoint about the use of blockchain innovation in the Power systems area, explaining some specialized perspectives concerning this promising innovation, the highlights, and applications grew up until now while zeroing in on the eventual fate of inventive applications in the electrical energy area

integration of blockchain and later will discuss some of the issues while integrating blockchain with IoT and big data (Fig. 4).

Anonymity The main feature of blockchain is its transparency that each node can be audited at any point of time which causes an inverse effect on user privacy. Various blockchain applications lack this level of privacy [16]. Some of the attempts

Fig. 4 Challenges faced by blockchain technology

to solve this issue were Zerocash [17] and Zerocoin [18] which provide a facility of a completely anonymous transaction system by encrypting the sender and receiver addresses [16]. Monero [19] uses a chain of signatures which makes transactions nearly impossible to trace back. As discussed earlier, there are various other applications such as Bitcoin fog [20], CoinJoin [21], Dark Wallet [22], and Dash [23] which was the first cryptocurrency that took anonymity and privacy into consideration.

Security Threats Fifty-one percentage of attack is the most common threat to blockchain [24]. Whenever any node gains control over the majority of the network, the node will now have the power to control the consensus process. Along with this, another major concern of malpractice is bribery [25]. Blockchain terminals or endpoints are where the clients communicate with the blockchain and it is likewise the weakest piece of the blockchain because of all the trading of information.

Storage Capacity and Scalability A large amount of storage is required in order to store the chain because a new block of sizes varying from various MBs is generated every few minutes. The increase in the size of the chain increases the number of resources needed to store the chain. There were various advancements taken into consideration, and some of them are Bitcoin-NG [26] and Litecoin [27] which is quite similar to Bitcoin but it provides improved confirmation time for transactions and also provides optimized storage.

Smart Contracts Basically, when the computer automatically does the work of a contract with the help of certain code it is known as smart contracts. It can be better understood as a smart contract code is implemented on the blockchain network which identifies each of the nodes/users of the transaction and helps the network in time efficiency cost reduction, precision, and transparency. This led to a newer version

of blockchain that is Blockchain 2.0. As it is a computer code, it is vulnerable to attacks such as hacking, viruses, and Trojans which harm the integrity of the software which in turn compromises the system. One of the examples of an application that has adopted this technology is Ethereum.

Consensus Any consensus algorithm is a backbone of the blockchain network as it performs a crucial task of whether to append the new block or not. The classic algorithm of consensus was proof of work (PoW) which was implemented in the first application of blockchain that is Bitcoin. Energy/resource consumption was one of the major limitations of PoW. Still, some of the cryptocurrencies such as Namecoin, Litecoin, Ethereum, and Bitcoin have still adopted this PoW as their consensus algorithms. There were several approaches to solve these limitations such as proof of stake (PoS), proof of burn (PoB) [28], proof of importance (PoI), proof of capacity (PoC), Paxos, and RAFT.

5.1 Challenges in IoT and Blockchain Integration

Internet of things plays a vital role in building a modern environment around us by offering various smart solutions that are increasing our quality of living. IoT is the integration of software and hardware focused to make our everyday tasks easy. With all the recent advancements in this technology and providing a cloud platform for sharing a massive amount of data to and from it lacks some basics of data security. That is, the blockchain integrated with IoT can provide a better platform for the betterment of these technologies by providing the proper security, traceability, transparency, and reliability to the data. Integration of blockchain is IoT is not that hard but it also comes with its flaws which will be further discussed in this section:

Storage Capacity and Scalability As we have discussed earlier, the issue of storage is quite alarming but when integrated with IoT it becomes more complex as a typical IoT device can generate gigabytes and terabytes of data in a limited amount of time. Blockchain is not made for handling a large amount of data which could be an issue while implementing it with IoT applications.

Security Most of the IoT networks are prone to security attacks as they work on a wireless system. The main challenge with the integration of blockchain with IoT is the integrity of the data. If any corrupted data enters the blockchain, then it stays corrupted as the data once stored in the blockchain is immutable [16]. Some parts of the IoT network contain various physical devices that sometimes stop working properly or send malicious data which leads to security attacks on the network. Some of the programs such as GUITAR [29] and RemoWare [30] were introduced for run-time network updates which helped in keeping the smooth integration of blockchain and IoT.

Anonymity and Data Privacy Some of the IoT applications such as user health management, smart house, and various others generate very sensitive data that needs to be confidential. Securing this data, blockchain is quite tricky because one of the characteristics of blockchain is to be transparent. In order to make this integration more secure, several cryptographic algorithms should be implemented on the system to restrict unregistered access to the data in the system which is quite tricky.

Smart Contracts As discussed earlier, smart contract is one of the best applications of blockchain. But when it comes to the integration of blockchain and IoT, it gets a little trickier. A contract can be divided into two parts, one of which is code and another is data [16]. As IoT works on real-time data generation, accessing data from various sources would be complex for the contracts.

Consensus As IoT contains a greater number of physical devices that were designed to perform only the designated task, it would be very challenging to implement any consensus algorithm even as easy as proof of work or other algorithms. Keeping these challenges in mind, there were certain attempts to create an algorithm for consensus but still, the mining of the block would still be an issue. Proof of understanding (PoU) was an advanced version of PoW generated for this specific purpose of blockchain–IoT integration.

5.2 Challenges in Big Data and Blockchain Integration

Big data is a field that focuses on the extraction of important data from a large data source such as a data warehouse or a large database. These data warehouses are filled with all the kinds of data collected from our smart devices, some of which are very sensitive such as user location and user information which if fallen into wrong hands is very disastrous. Blockchain can be integrated to this kind of application in order to monitor the flow of sensitive data and to protect the data from data breaches. In any such applications, blockchain acts as the mediator in order to restrict the access of service providers from gaining sensitive information from users. Let us take an example of a user-controlled medium that is Ushare [31] which gives users the rights to grant permission to the service provider for the access of its sensitive data as well as he/she can revoke those rights anytime they want. The ownership of data on the Internet is really flawed. Any data shared on the Internet is prone to be copied. The safety of these documents and artworks uploaded online is a very crucial task to do. But with blockchain technology, a digital registry can be generated for maintaining the content produced by the rightful owners and to find all the copies of any given document existing on the Internet and compare it to the original using various machine learning algorithms. One of the better examples of this technology is Ascribe [32] which was generated to carry out Internet document licensing. Ascribe uses its own protocol for blockchain implementation known as SPOOL which stands for Secure Public Online Ownership Ledger [33]. Several

artists face issues regarding their artworks being forged; for that reason, monograph was generated with the implementation of blockchain to provide a proper platform for buying and selling of artworks.

6 Conclusion

Blockchain holds the true potential to bring revolutionary changes to the field of technology. However, a portion of the impediments of blockchain is additionally talked about ensuing as (1) blockchain itself requires a great deal of time to measure and arrive at an agreement. In any case, when utilized with IoT, it is viewed as a weakness as time-taking applications are not proficient. (2) Blockchain utilizes an exorbitant measure of energy. (3) Scalability is a significant issue for blockchain applications. Likewise, examining future prospects or upgrades for blockchain as there are significant odds of the presence of cross-country acknowledged cryptographic forms of money or cryptocurrency. A few nations have proposed this thought. More integration with IoT will occur later on as a large portion of the leading organizations is looking for advances to this incorporated innovation. This paper has discussed the architecture of blockchain along with its types, several consensus algorithms, and some of the challenges faced by blockchain when integrated with several leading technological fields such as the Internet of things and big data for future development. Some of the existing solutions for the problems were also discussed.

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Filter Bank Multicarrier Systems Using Gaussian Pulse-Based Filter Design for 5G Technologies

Deepak Singh and Mukesh Yadav

Abstract FBMC has arisen the most multicarrier (MC) procedure since it satisfies the need of the next-generation 5G standards. Optimized generalized Gaussian pulse (OGGP) filter of the FBMC systems have been proposed in this paper. A PTF strategy based on optimized generalized Gaussian pulse is proposed along with the lowest time domain side lobe levels and tail energy. The proposed system has been used to OQAM modulation and different Tx and Rx antenna. From the numerical perspective, the transmission execution can be improved by considering the greatest signal-to-noise ratio and reduced ISI. The proposed system is simulated by using MATLAB software and also by using the BER and magnitude response.

Keyword Filter bank multicarrier (FBMC) · OGGP · MIMO system · 5G technology

1 Introduction

The flow research interest on mobile communication system is going through a change in a perspective from the generally settled third and fourth era advancements, to a much adaptable future 5G networks [1]. 5G networks, which are required to be sent in 2020, target giving its clients with giga-bit information rate insight under expanding information traffic-request and high portability, high throughput alongside low inactivity, productive use of accessible range, and so forth, at decreased expense and with low force utilization. In any case, customary OFDM experiences different disadvantages, which settle on it a restricted decision to meet the assorted and testing necessities of the future cell frameworks. To battle time scattering and to encourage per sub-transporter balance, OFDM utilizes an excess time stretch called cyclic prefix, between two images [2].

The presence of cyclic prefix prompts wasteful utilization of the accessible transmission time, there by upsetting the low idleness prerequisite, prompting low ghostly

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productivity, and at last, diminished throughput. The communicated and get channel utilized in OFDM is time-restricted rectangular heartbeat, which has high side-projections in the recurrence area that makes phantom spillage neighboring sub-transporters. These out-of-band emanations eventually lead to ICI. The presence of huge side-projections additionally restricts its application to intellectual radio situation. The symmetry among the sub-transporters is misshaped under quick blurring versatile channels which likewise incites ICI. Under doubly dispersive channels including both time and recurrence spreading, OFDM experiences both ISI and ICI, which requests rigid synchronization procedures, which builds the force utilization.

In FBMC, the out-of-band emanations are diminished by utilizing adaptable heartbeat molding channels which are all around confined in time and recurrence spaces, thereby giving vigor against time-recurrence scatterings brought about by doubly dispersive channels [3, 4]. FBMC frameworks, particularly OFDM-OQAM, can accomplish upgraded ghostly productivity and decreased ISI/ICI without the presence of cyclic prefix. In FBMC, a bunch of information images, which should be communicated at a specific sub-transporter, is gone through a communicate channel adjusted at that relating sub-transporter. The information adjusted at various sub-transporters are totaled and also sent through the channel.

At the collector, the information images are isolated out by an examination channel bank. In OFDM-OQAM, not at all like the cyclic prefix-OFDM, the complex information images are sent as genuine images, for example, the in-stage and quadrature-stage segments are communicated at each time moments that are products of half of the image span, thereby keeping up great ghastly effectiveness, even with no cyclic prefix. The usage parts of the various variations of FBMC frameworks through productive equipment models and polyphase structures are concentrated [5]. It is significant that the model heartbeat forming channel utilized at the examination and amalgamation channel banks assumes a critical function in defeating the restrictions of OFDM.

2 FBMC Technique

The Tx/Rx block outline for an overall symmetrical multicarrier balance framework is introduced in Fig. 1. Despite the fact that Fig. 1 can be relevant to both FBMC and OFDM, the rectangular channel is the model channel utilized in OFDM, whereas different strong channels serve the capacity of model channel in the last case. In the event that the information image to be sent at the n-th time moment and k-th subcarrier is indicated as $d_k(n)$, the communicate signal is created as

$$s(t) = \sum_{n} \sum_{k=0}^{N-1} d_k(n) h(t - nT) \mathrm{e}^{j2\pi(t-nT)kF} \tag{1}$$

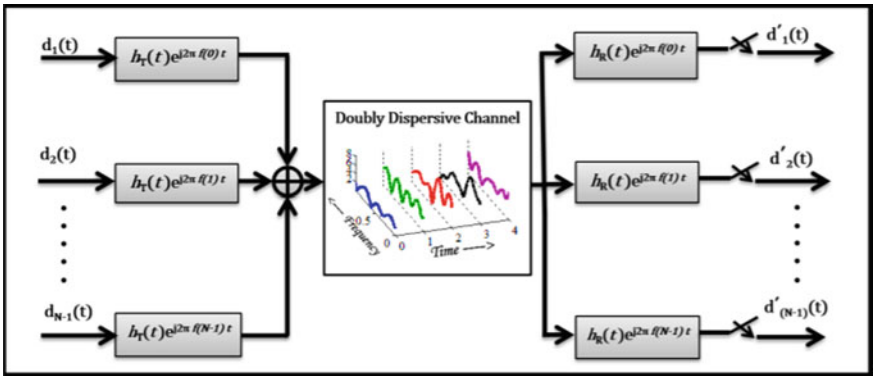

Fig. 1 Block diagram for a multicarrier modulation system

Here, T and F mean the time separating between progressive images and the sub-transporter separating individually. N means the quantity of sub-transporters, and $h(t)$ speaks to the motivation reaction of the communicate model channel utilized in FBMC framework. The information images $d_k(n)$ are spread over the time-recurrence lattice as clarified [6–10].

In OFDM-OQAM frameworks, the in-stage and quadrature-stage parts of the perplexing images $d_k(n)$ are stumbled in time space by a factor $T/2$, so that it can be considered as two heartbeat adequacy balanced symbols sent with a timing balance of $T/2$ [11–15].

Let $d_k(n)$ be written as

$$d_k(n) = d_k^I(n) + jd_k^Q(n) \tag{2}$$

At the collector, the got signal is passed through a coordinated channel bank and is examined at the image time dispersing, T, so that the sent images can be demodulated. Under ideal channel conditions, the sent information images are recoverable at the recipient if the model channel fulfills certain conditions which are summed up. Let k and I indicate the sub-transporter lists at the transmitter and collector individually and the comparing image testing time files be m and n.

3 OGGP Based Filter

The conventional filter issues were focused on planning filter that are isotropic and with better recurrence reaction attributes to decrease the out-of-band radiation. The proposed OGGP based filter is dissected and contrasted and the regular filter utilizing shape plots of equivocalness capacity, time and recurrence space side-projections and tail energy, and so on. The proposed filters have lower side-flaps and quicker rot in

the time area contrasted with the other existing filters. A broader plan technique for the plan of OGGP channel is likewise proposed which prepares to improve the time-space qualities of the channel by fluctuating only one plan boundary. The equation of OGGP based filter is given by:

$$g_{\alpha,T}(t) = \frac{1}{1-\alpha}\left(e^{-4\pi\left(\frac{t}{t}\right)^2}\right) - \alpha\left(e^{-4\pi\left(\frac{\alpha t}{t}\right)^2}\right) \tag{3}$$

α is the scaling boundary which chooses the recurrence confinement, and T is the ordinary term. The GGP will have a zero intersection in time area as indicated by estimations of α and T. Thus, a channel symmetrical in time area that fulfills Nyquist standard can be developed if the plan boundaries α and T are fittingly picked, so that the vagueness capacity will have zero intersection at the ideal focuses.

4 Proposed Methodology

The articulation for summed up OGGP based filter is yielded (4). Here, α is a scaling boundary, and T speaks to the ostensible span of the OGGP. In OGGP plan issue, the boundary T is gotten by fixing α and discovering the zero intersection of the beat by likening the (4) to zero. In OGGP plan, a connection between the zero intersection of the beat and the equivocalness work as expected space is assessed by bend fitting, and the estimation of T is gotten for the given α esteem. This methodology is heuristic since the proportionality consistent relies upon the α worth and it changes for various α values. Henceforth, an overall methodology to discover the ideal T should be planned. The uncertainty work along time hub is same as the autocorrelation of the beat. Consequently as opposed to discovering T from the equivocalness work, the autocorrelation of the GGP channel can be utilized. The autocorrelation of $h_{\alpha,T}(t)$ is gotten as

$$x(t) = \int_{-\infty}^{\infty} h_{\alpha,T}(\rho) h_{\alpha,T}(t+\rho) d\rho \tag{4}$$

It could be seen that the SIR amplifying condition relies upon the proportion of defer spread and Doppler spread of the doubly dispersive channel instead of the specific estimations of the spread which is shown in Fig. 2.

It could be seen that the SIR amplifying condition relies upon the proportion of defer spread and Doppler spread of the doubly dispersive channel instead of the specific estimations of the spread as shown in Fig. 2. The underlying loads are admirably picked by the standardized postponement and Doppler spreads with the goal that the equivocalness work spreads across time and recurrence tomahawks with the end goal that the SIR is augmented. The extended inclination calculation

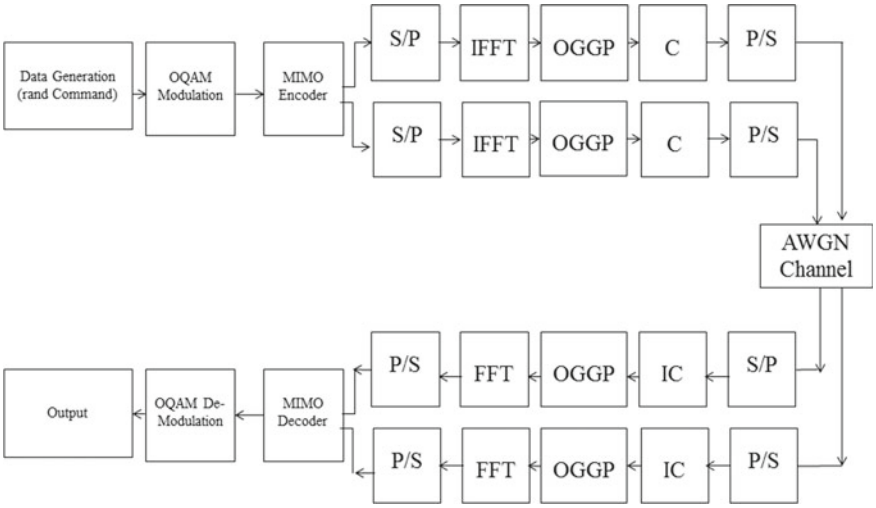

Fig. 2 FBMC transceiver using OGGP

is applied with these loads as starting worth, so that the vagueness work spread is kept up. In the interim, the extent of vagueness work at those focuses, where a base worth is required, is pulled down to zero. Consequently, for a specific deferral and Doppler spread, the vagueness capacity of the planned heartbeat has a shape which amplifies SIR and simultaneously fulfills the Nyquist rules as expected and recurrence domains. The key thought of the part is to adaptively shift the plentifulness scaling boundary, so the beat accomplishes a shape which amplifies the SIR. The numerical articulation for the time-space and recurrence area side-flap energy is likewise inferred in the current investigation. In light of the greatest reasonable side-projection energy as expected and recurrence spaces, the upper and lower cutoff points of the adequacy scaling boundary can be fixed. The connection between the time-recurrence scattering of the beat and the adequacy scaling boundary is too set up. A shut structure articulation for the last heartbeat shape is additionally inferred in the present commitment utilizing Jacobian theta work. The adjustment fits as a fiddle of the channel, and furthermore, its vagueness work for various estimations of the scaling boundary and the precision of the detailing of the shut structure articulation for the model heartbeat are broke down through reenactments. The SIR execution of the proposed strategy under doubly dispersive channels is dissected and contrasted, and the traditional isotropic model channel plans.

5 Simulation Results

The OGGP channel is intended for various estimations of α as clarified is area. The standardized image timing span and subcarrier transmission capacity are taken as $\sqrt{2}$. The various estimations of α and the comparing T esteems got utilizing the proposed strategy are organized. The assembly plots of T versus number of emphases are shown in Figs. 3, 4, and 5.

The size of mistake versus emphasis number for different α values is appeared in Fig. 4. It very well might be noticed that the plots meet inside eight emphases. There is a slight expansion in the quantity of cycles for expanding α be that as it may, which is unimportant.

The various channels and their uncertainty capacities utilized for creating the ideal heartbeat are delineated. Figure 5 speaks to the rectangular, square root raised cosine, and Gaussian heartbeats individually. The form plots of their uncertainty capacities are shown in Fig. 6 individually. The shape plot of the DAF of rectangular channel is delineated.

In the shape plots, the sizes at different network focuses are shown by various tones. The planning between the greatness esteems and the shading can be acquired from the shading bar close to the form in Fig. 7.

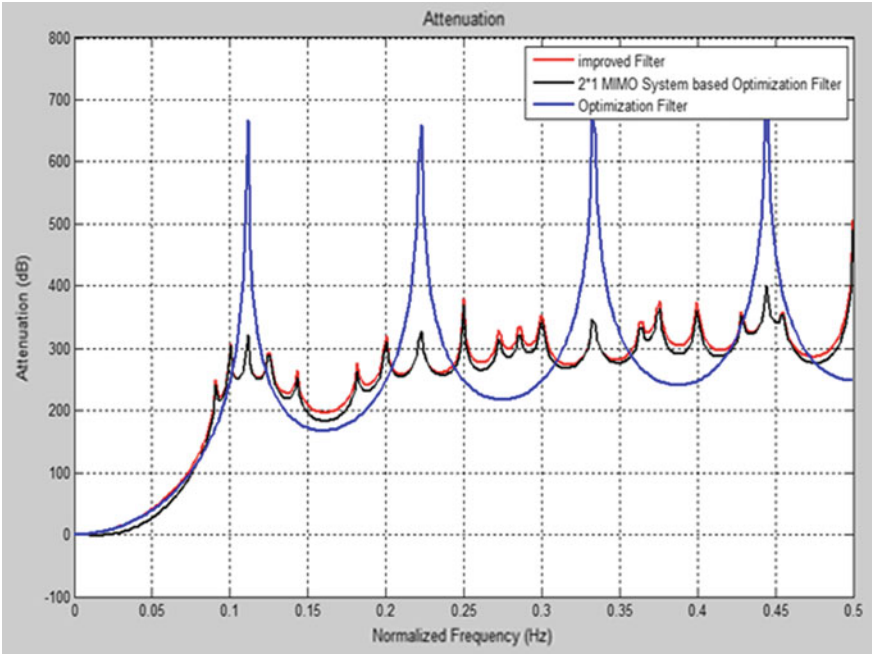

Fig. 3 Attenuation of 2 × 1 system-based OGGP based filter

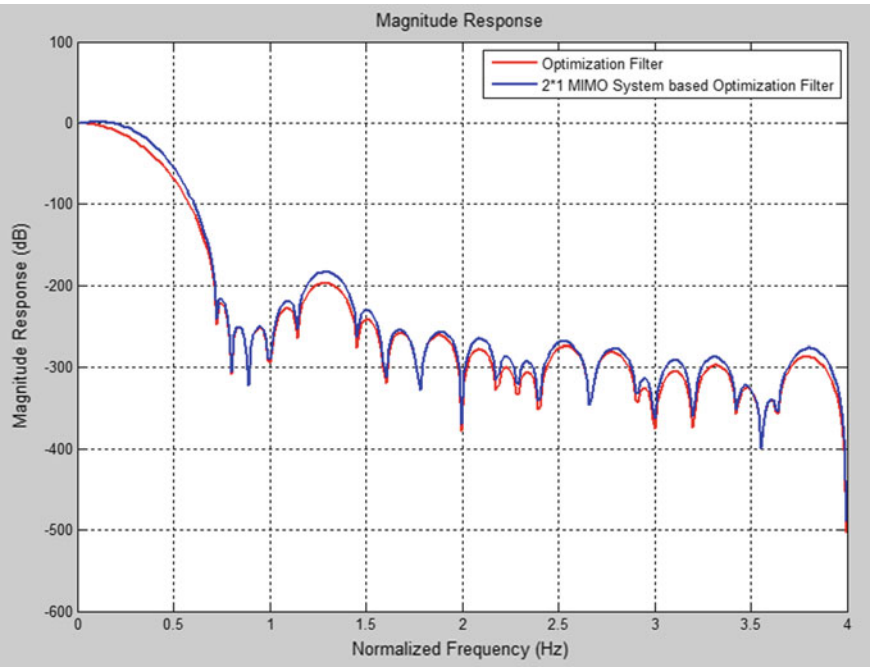

Fig. 4 Magnitude response of 2 × 1 system-based OGGP based filter

White regions speak to an extent more modest than the base worth showed in the shading bar. The DAF of rectangular channel is spread along the vertical hub since the beat is not band restricted. Since the rectangular heartbeat becomes beat in the phantom area shown in Fig. 8, the side-flap sizes fall in the range of −20 to −13 dB along the recurrence hub.

6 Conclusion

PTF plan strategies for FBMC frameworks and visually impaired assessment techniques with OFDM were proposed in this postulation. Two filters, which have fixed time/frequency area attributes and two versatile channels, whose time/frequency area attributes differs as per channel varieties, are planned. The planned channels are fundamentally obtained from the ideally restricted Gaussian channel and have subsequently shown great time/frequency space restriction. The plan method of the channels has guaranteed that they will fulfill Nyquist models in both time and frequency spaces, so that the images sent are entirely reproduced without the channel.

The OGGP filter displays the most reduced time-space side-flap levels among the different traditional and proposed fixed channels.

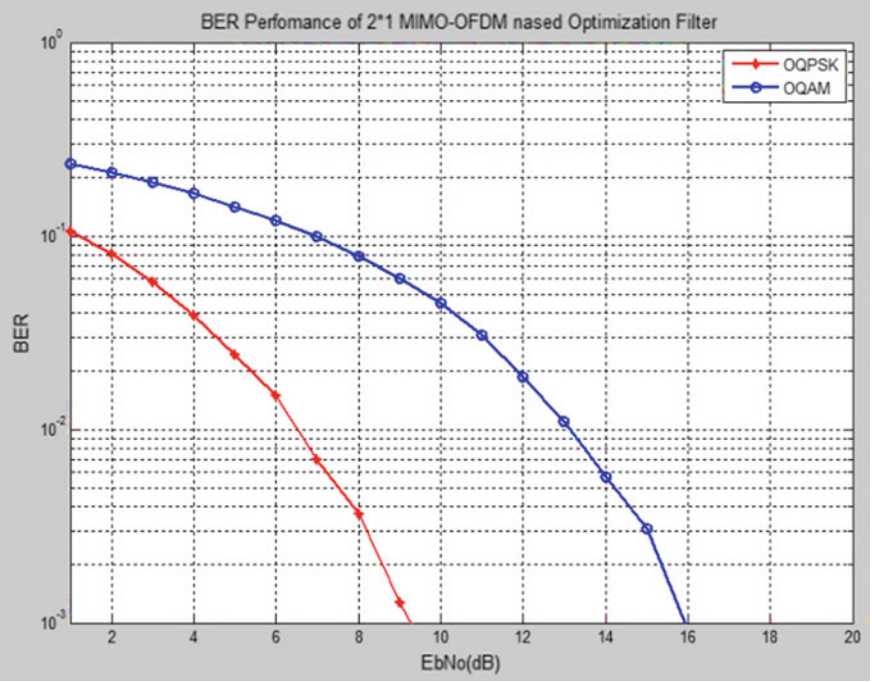

Fig. 5 BER of 2 × 1 system-based OGGP based filter

The proposed work has the state of a sinusoid and henceforth assessed utilizing just three preliminary qualities. The presentation improvement of the proposed strategy is appeared under doubly dispersive channels with huge defer spreads and also Doppler spreads.

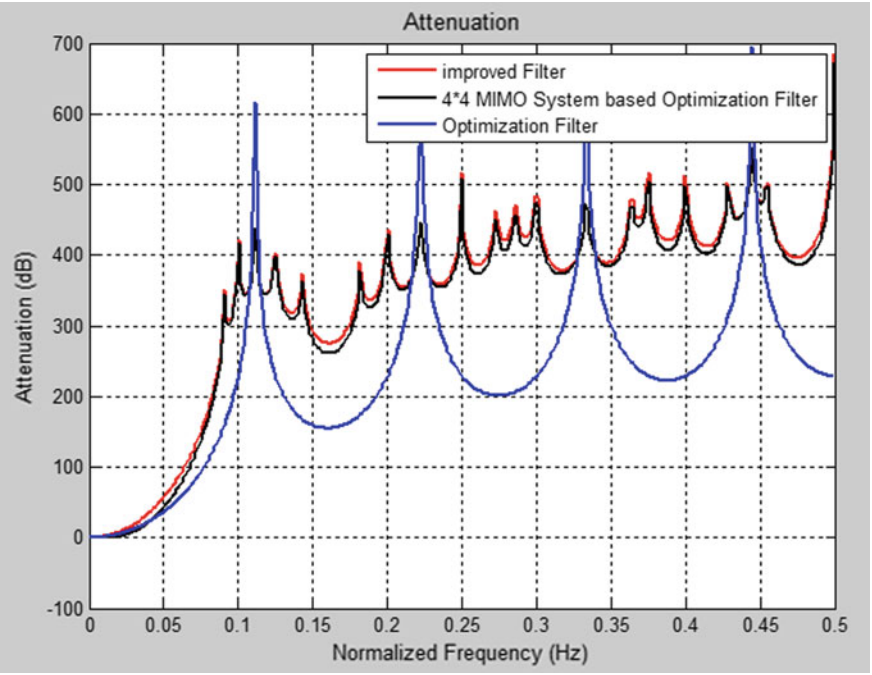

Fig. 6 Attenuation of 4 × 4 system-based OGGP based filter

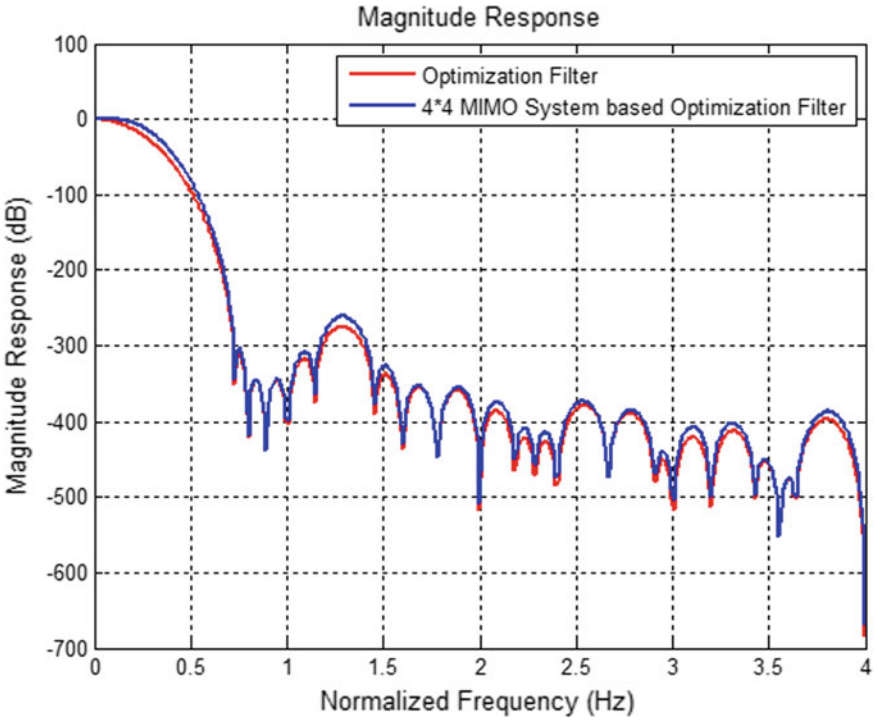

Fig. 7 Magnitude response of 4 × 4 system-based OGGP based filter

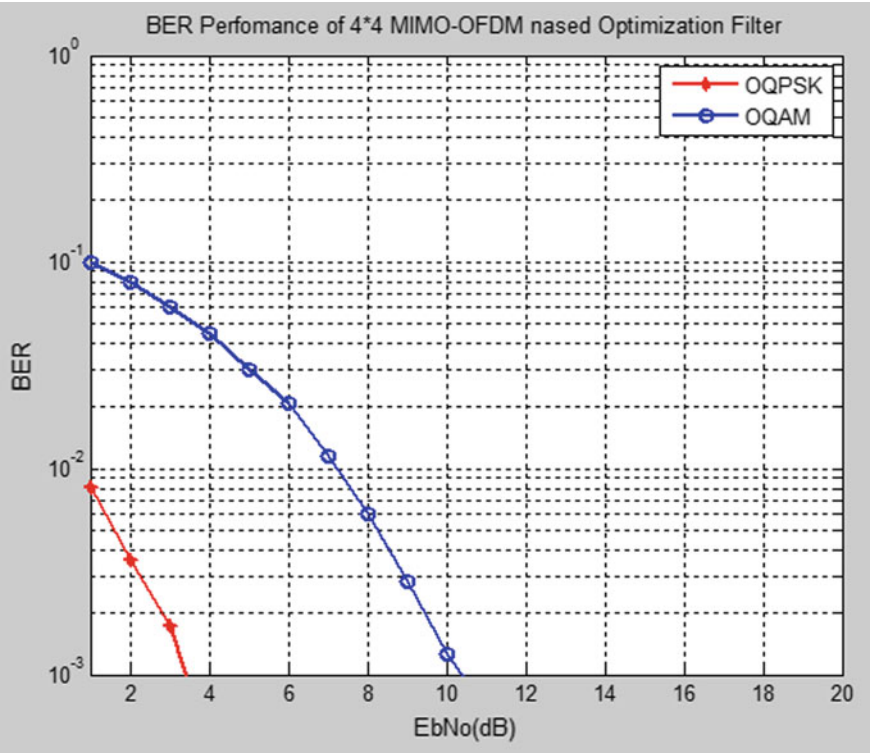

Fig. 8 BER of 2 × 1 system-based OGGP based filter

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LIMES: Logic Locking on Interleaved Memory for Enhanced Security

A. Sai Prasanna, J. Tejeswini, and N. Mohankumar

Abstract Globalization and increasing distribution of IC supply chain have resulted in various third parties having a key to precious intellectual property or the physical integrated circuit and therefore information can be exploited. Information security is the practice of safeguarding information by minimizing information risks. It is required to scale down the danger of unauthorized information disclosure, modification, and destruction. Hardware security threats have been observed at several levels of the IC supply chain. To protect the hardware from potential attacks, there are various design-for-security (DFS) techniques. Interleaved memory with logic locking techniques for information security is proposed in this paper. Interleaved memory is a solution for random arrangement and logic locking is needed to interrupt the chain and to protect the data by restricting its access to authorized users. It is a versatile and easy-to-integrate solution that needs only trusted designers. The approach proposed in this paper compares the Hamming distance (HD) and Levenshtein distance (LD) and BER obtained for random logic locking (RLL) and weighted logic locking (WLL) on the interleaved memory. From the results obtained, it can be concluded that weighted logic locking on interleaved memory provides better security.

Keywords Hardware security · Interleaved memory · Logic locking · Design for security · Information security

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1 Introduction

Information security is the use of physical and technical controls in an endeavor to shield the confidentiality, integrity, and availability of data. It is needed to cut back the danger of unauthorized information leaks, modification, and deletion. Since the advent of the Internet, cybersecurity has been a significant research and business focus. Since an attack can occur on any of the layers of the cyberenvironment (e.g., operating system, network, and application software), there are several strategies to tackle different cybersecurity threats, including malware, ransomware, denial of service, etc. Usually, a hardware attack results in more serious and hard-to-recover damage. Also, low-cost attacks based on hardware may be devastating. Hence, this paper investigates issues related to hardware security. Hardware used for various applications from customer electronics to defense systems requires a secured access, as there emerges various threats in the integrated circuit (IC) design flow [1]. A hardware-based attack occurs as a result of an attacker having the ability to take advantage of hardware vulnerabilities to cause a trade-off in the system security [2]. Outsourcing of the fabless IC manufacturing companies to the untrusted foundries leads the major cause of these threats [1]. The different threats are reverse engineering [3, 4], IP piracy [4, 5], overbuilding [6, 7], hardware Trojans [8, 9], and counterfeiting [10, 11]. Solely due to the intellectual property right violations, the semiconductor industry losses about $4 billion per annum [6, 11]. Information or data is stored in the memory based on the memory address assigned to it. The address assigned can be either in order or randomly arranged. Generally, the orderly arrangement of address takes place. But orderly arrangement of data makes it easily accessible whereas random arrangement like in interleaved memory is a little tricky. To protect this data, design-for-security techniques are to be used such as watermarking [8, 10], fingerprinting [11], IC metering [12], split manufacturing [5, 13], and logic locking (LL) [1, 14], but logic locking is one technique that has proved to be resilient to maximum attacks and is easy to incorporate in applications.

Logic locking hides features of the structure and can be opened with a secret key. Owing to its simplicity, logic locking has gained notable recognition from the research community [6].

The remainder of this paper is organized as follows. Section 2 talks about interleaved memory for information security. Section 3 discusses the threats faced to keep information secure, sheds light on various designs-for-trust (security) approaches and how logical locking is more efficient than the other methods. Section 4 deals with logic locking and different ways to implement logic locking and threats faced by it. Section 5 describes the proposed method. Section 6 performs analysis of the methods discussed. Concluding remark is given in Sect. 7.

2 Interleaved Memory

Interleaving is the method of reorganizing the positioning of a data sequence to form a rearranged version of its initial self and is carried out at the transmitter side and the converse of this operation is deinterleaving which restores the obtained sequence to the initial order observed at the receiver side [2].

Error correction coding is believed to be a fruitful way to cope with various types of error in data communication. Interleaving is conventionally suggested to minimize bit error rate (BER) of digital transmission over a channel with data transmitted as bursts of information. The interleaving architecture enhances the performance at the expense of complexity, memory requirement, and time delay [13].

There are two conventional methods of interleaving, namely the block interleaver and convolutional interleaver. In the block interleaver, the input data is noted rowwise into a memory that is established as a matrix and retrieved columnwise. In the convolutional interleaver structure, the information is multiplexed through and from a fixed amount of shift registers [2].

Generally, the orderly arrangement of address takes place. But orderly arrangement of data makes it easily accessible whereas random arrangement like in interleaved memory is a little tricky. Therefore, the interleaved memory approach to storing data is better at securing information, yet this memory is not completely fool proof and is vulnerable to attacks.

3 Threats and Design for Security

To avoid any inside or outside danger such as criminals or any person who aims to impede or undermine the organization's sustainable state, security measures are taken. The protection measures taken against the damages that may happen are known as the safety [15]. Hardware used for various applications from customer electronics to defense system requires a secured locking, as there emerges various threats in the integrated circuit (IC) design flow [1]. The various threats are (i) reverse engineering [3, 12]. (ii) IP piracy [12]. (iii) Overbuilding [12]. (iv) Hardware Trojans [9]. (v) Counterfeit ICs [10, 12].

3.1 Design for Security

Passive (watermarking, finger printing, etc.) and active (logic locking) techniques are the different types of classification of hardware security techniques [16].

- Watermarking—unnoticeably modifying a part of information. Helps in the detection of piracy/theft after its occurrence but no prevention.

- Fingerprinting—signatures of designer and end users are embedded together. Similar to watermarking only detection.
- IC metering—unique ID assigned to ICs being manufactured to track them.
- IC camouflaging—masking chosen gates. Protection against unreliable end users only [12].
- Split manufacturing—splitting the process of manufacturing and then combining together. Protection against unreliable foundries alone [5].
- P. kumar et al. proposed a toggle count-based node selection for module placement to enhance security [17].
- Logic locking—introducing an additional hardware segment into a design to lock/secure the design [12].

3.2 Choice of Logic Locking

The most sought out design-for-trust (DfTr) technique is logic locking. Without knowing the correct key, even if an adversary manages to lay their hands on the encrypted netlist, it will not be of any use as the correct functional design cannot be obtained [6]. With logic locking in place, overbuilding by the foundry is minimized as the excess ICs cannot be activated [6]. Trojan insertion is prevented as the attacker finds it difficult to find suitable location to place them [12].

4 Logic Locking

In this technique, additional logic is inserted into a circuit and the primary design is locked with a secret or confidential key. The correct output is produced only when correct key values are applied [7, 18]. Logic locking can be implemented in two ways: *sequential logic locking* [5, 8, 11] and *combinational logic locking* [4, 7, 11]. The two logic locking techniques and different types of combinational logic locking are as shown in Fig. 1.

- Random logic locking (RLL) or EPIC—instituted by Roy et al. [14] in 2008. XOR key gates are placed at arbitrary locations in the netlist [6]. Suffers from low HD. Prone to key-sensitization attack.
- Fault analysis LL—nodes with high fault impact are identified and key gates are introduced at these nodes [1]. Provides 50% HD but results in longer implementation time. Prone to key-sensitization attack [16].
- Strong LL—Key gates with maximum mutual interference are incorporated [11]. Resistant to key-sensitization attack. But it provides low HD rates [16] and insertion of pairwise secure key gates depends highly on the circuit topology [11].
- Weighted LL—It controls the design with multiple key inputs and offers:

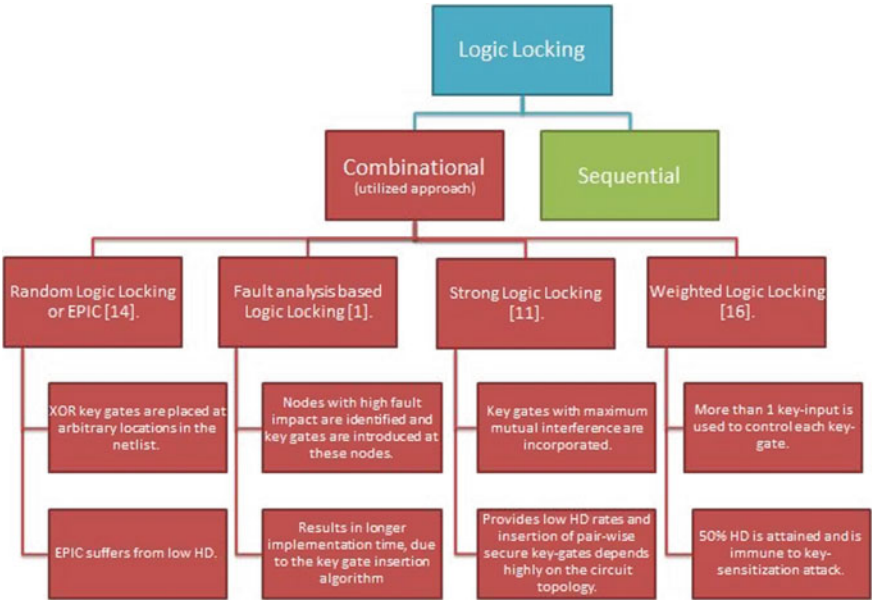

Fig. 1 Block diagram depicting different logic locking techniques

- Immune to key—sensitization attack
- 50% HD due to an efficient key gate insertion metric, and
- Notably refined output corruption efficiency of the key gates resulting in a much shorter execution time [16].

5 Proposed Method

This paper proposes the idea of protection of data that is first stored in an interleaved memory and further uses logic locking technique to enhance security. Block diagram representing the proposed method is shown in Fig. 2.

In an interleaved memory organization, the data is either evenly arranged in consecutive address blocks or can be arranged randomly using linked lists or hash table data structure. This random arrangement of data provides a layer of security than the serially arranged data. This interleaved data is protected using logic locking techniques. Here, it has been proposed to use both RLL and WLL and compare their efficiencies. As shown in Fig. 3, the input data is sent to an interleaver which scrambles the data and either RLL or WLL is implemented on this data. The HD%, LD and BER calculation are performed and these responses' values are checked. If the values are not close to the optimal result, then the design is modified to add more logic gates to increase security and the output is taken as the final output.

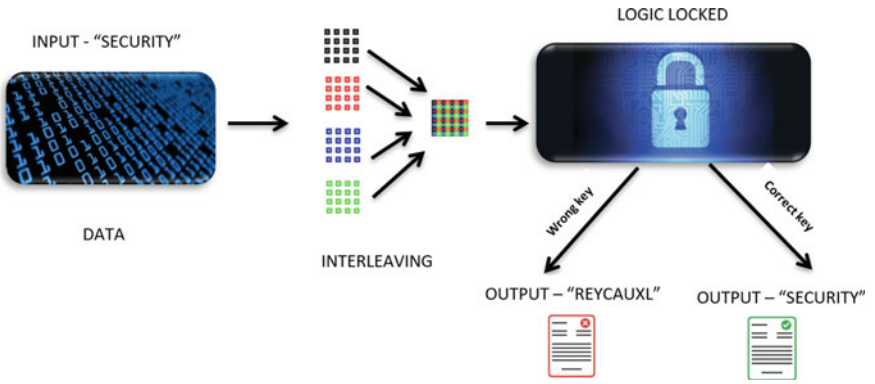

Fig. 2 Block diagram representation of proposed method

Without knowing the correct key, even if an adversary manages to lay their hands on the encrypted netlist, it will not be of any use as the correct functional design cannot be obtained [6]. It hides some part of the functionality in the secret key bits; the structural information obtained from hardware implementation reveals only the remaining part of the functionality [9]. LL protects the system from IC piracy and reverse engineering. Overbuilding by the foundry is minimized as the excess ICs produced cannot be activated. Trojan insertion is prevented as the attacker finds it difficult to find suitable location to place the Trojans because the transition probability of the signals that are being altered by the key gates is unknown to the attacker [12]. Extracting the secret key of the logically locked design has become an extensive effort and it is commonly known as key guessing attacks.

Thus, the main objective of the proposed technique is to build a secured hardware against attacks like brute-force attack, hill climbing attack, and path sensitization attacks.

RLL inserts key gates such as XOR/XNOR gates at arbitrary locations in a circuit. These gates can be configured as buffers or inverters by using the key inputs. If the key gates are left with no further modification in the circuit, then the key bits can be retrieved by inspecting the key gates [11]. Due to fault masking, random insertion of key gates will not propagate the excited faults toward the primary output [1]. RLL is not efficient enough to corrupt a sufficient number of outputs. It also suffers from low Hamming distance and is susceptible to key guessing attacks.

On the other hand, weighted logic locking is inherently immune to the key-sensitization attack. This is because the key inputs are integrated in control gates initially and are not driven directly. The likelihood of any key gate corrupting the design's output is higher in WLL; therefore, fewer key gates can be used to achieve 50% HD, which thereby reduces the execution time drastically.

WLL is also fairly generic which implies that, in order to improve security, it can be combined with other techniques.

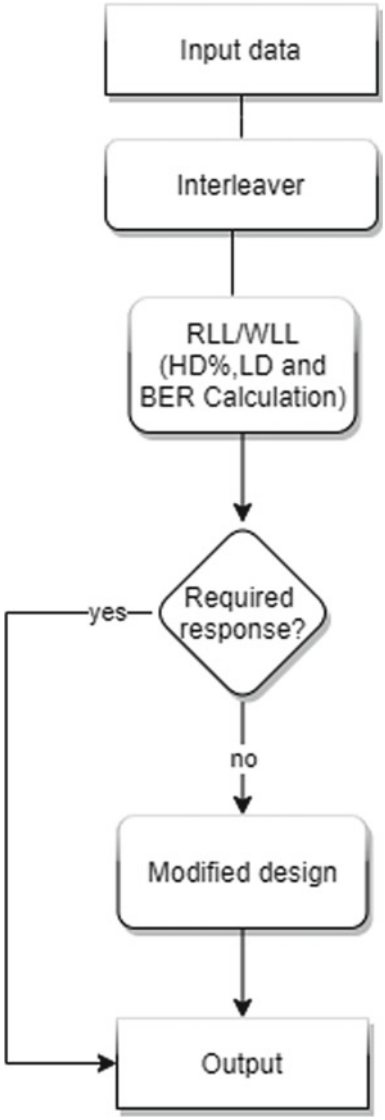

Fig. 3 Flowchart representation of proposed method

A single key input controlled key gate can be actuated by a random key with a probability of 0.5 (Pact) as the corresponding key bit has a probability of 0.5 to be set as a correct or wrong value. This implies that when a random false key is applied, roughly fifty percent of the key gates have an impact on the circuit. Increasing the Pact of each key gate will result in furthermore actuated key gates when invalid keys are applied, implying that only few of them are needed to achieve the desired HD value.

The Pact can be increased when more than one key input controls the key gate. The key gate is unactuated when right values are given to all key inputs controlling it else, even one wrong key input will actuate the key gate. This can be achieved by using a NAND or AND gate along with the key gates that are XNOR/XOR [16].

Key generation modules need to be embedded into the actual circuit and possess the following:

- Lower area overhead
- Not much increase in power consumption
- Authentication keys to be encoded, to enhance security, which will complicate their true origins and curb logical reverse engineering [9].

In XOR-based LL, functional buffers or inverters are replaced by key gates which introduce uncertainty in retracing the circuit design and the knowing the key values become significant [6].

6 Result

In this paper, when logic locking is implemented to secure an interleaved memory, the correct key will give us the correct output as in Fig. 4a and in case of wrong key the wrong output is displayed as in Fig. 4b. The input is loaded after one clock cycle and the output is displayed after 4 clock cycles.

Valid out can be assigned as per the need of the application. The initial clock cycle is used to load the data and hence the output for that cycle remains undefined. Two codes, i.e., two different arrangements of logic locks have been implemented to strengthen the security provided by the logic locking system against external threat.

From the results obtained in case 1 (Fig. 5), it is observed that WLL has much better values (in terms of Hamming distance (HD) and Levenshtein distance (LD) than RLL. But this still did not provide results in the required range of values (50% HD as expected) and this was also confirmed with the calculated BER values. The vagueness of an attacker to the output values, on application of random keys, can be maximized on achieving a 50% HD. Although any percentage change provides ambiguity, 50% or close to 50% is considered desirable.

This prompted for development of the second code (Fig. 6a, b) in which a number of logic locks were increased in general and that increased the overall performance as expected. As shown here, the HD%, BER and LD values obtained are closer to ideal in the case of weighted logic locking (WLL) than compared to that of random logic locking (RLL) for the codes.

So, one thing is observed in common in both the test cases, WLL performs considerably better than RLL and this is seen because in the case of RLL the logic lock is controlled by only 1 key value. In this case, the impact of the wrong key is only 50% (that is because the key can be either 1 or 0 and the probability of any of that being guessed correctly is 0.5). This is why WLL was chosen, in this case the logic lock depends on more than one input, effectively increasing the chances of getting

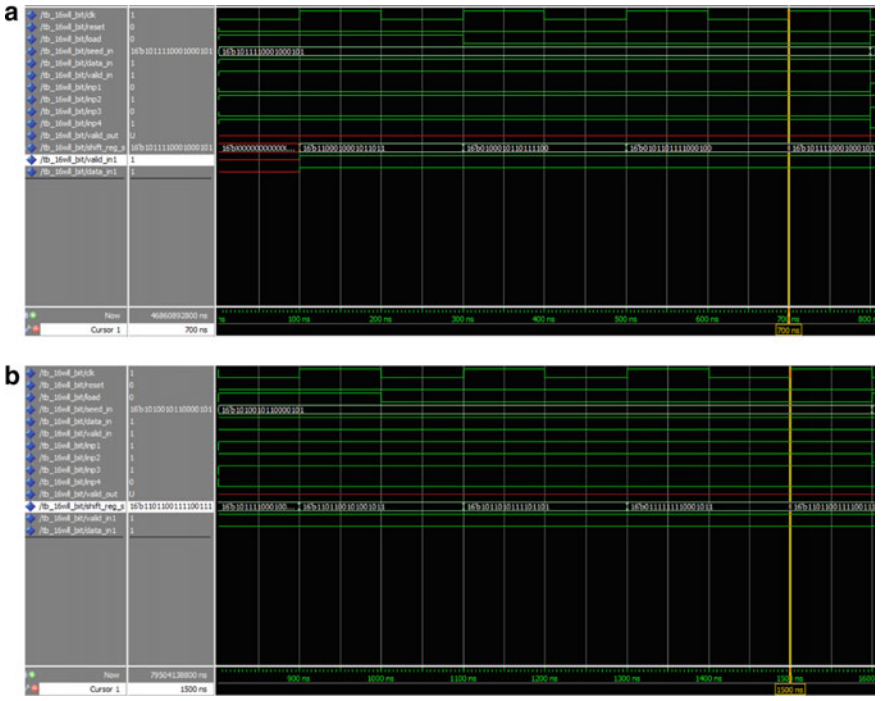

Fig. 4 **a** Waveform for correct key input for 16-bit data. **b** Waveform for wrong key input for 16-bit data

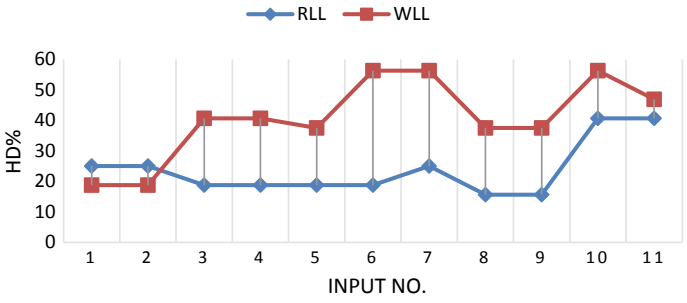

Fig. 5 Comparison between RLL and WLL HD% obtained for 32-bit data

a wrong result when the wrong key value was entered. Take the case of two keys controlling a logic lock, the chance of the correct key is only ¼ that is 25% but that of the wrong key is ¾ that is 75% which is clearly better than 50% odds. In case of WLL, two or more inputs (apparent key values) are passed as inputs to what is called a control gate. The control gate can be any gate (Fig. 7), (for analysis in this paper, only AND and OR gates are used). The output of the control gate is taken as one of

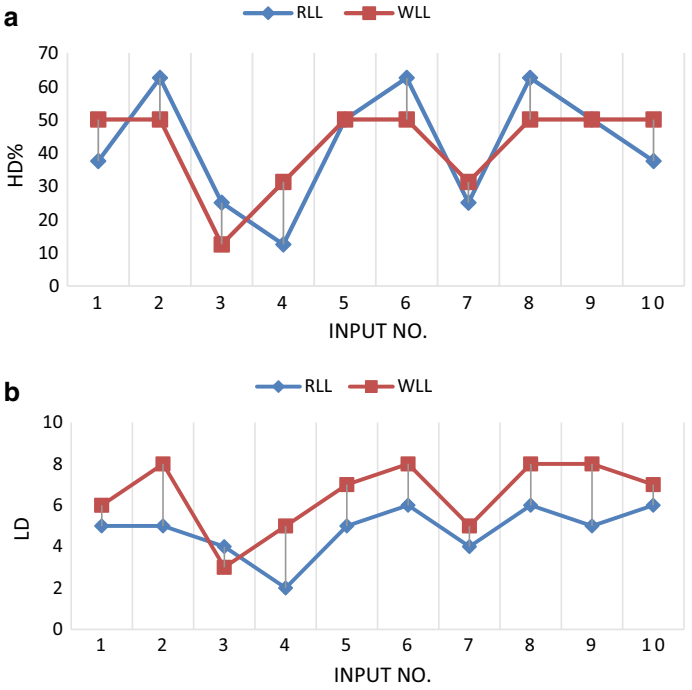

Fig. 6 **a** HD% calculated for 16-bit data, around 50% for WLL, **b** LD values for both RLL and WLL

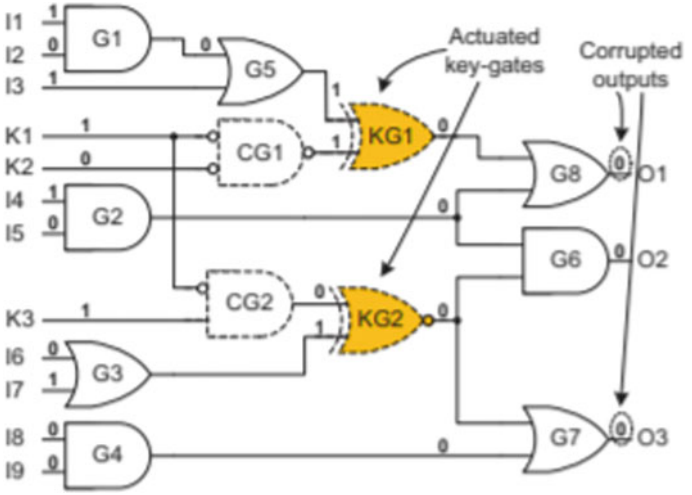

Fig. 7 An example for the control gate that can be used [16]

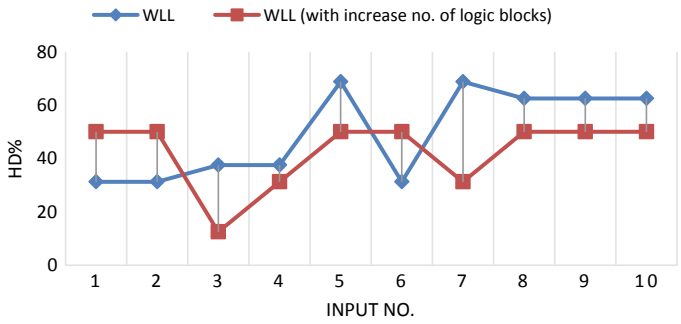

Fig. 8 Change in the HD% due to addition of more logic locks in the new code

the inputs to the logic lock (either a XOR gate or a XNOR gate), where the other input to the logic lock will be from the circuit the lock is being attached to.

As shown in the graph (Fig. 8), the values obtained can be made by adding logic locks, changing the number of inputs the lock is dependent on, etc. The efficiency of WLL can be further amplified by using increased number of controlling key inputs per key gate; three key inputs shoot up the Pact to 0.88 (7/8), with 4 it extends to 0.94 (15/16), while with 5 it goes up to 0.97 (31/32) [16].

The difference between the two cases obtained has already been explained briefly but to give more insight, in case 1, a section of the circuit was dependent on a set of keys and another section was dependent on another section of keys but this caused a form of discontinuity or reduced the impact of wrong keys on all parts of the circuit so in the second case, the issue was countered by having no particular condition like in case 1. Any wrong key input would impact any part of the circuit thus causing more ambiguity and more anonymity. This makes it more secure from key-sensitization attacks. Figure 9a–c represents the schematic diagram for different bit inputs for the proposed methodology.

7 Conclusion

This paper proposes an efficient method for securing data using interleaved memory and logic locking. Two types of combinational logic locking approaches namely random logic locking and weighted logic locking were implemented and the results were compared. Two different codes with varying number of logic locking blocks were simulated for RLL as well as WLL. From the HD and LD values obtained, it was observed that a twofold security method involving WLL on an interleaved memory is an efficient way to establish information security. Interleaved memory accounts for arbitrary arrangement of input data. This memory when further secured by weighted logic locking provides resistance against key-sensitization attacks and promises shorter execution time. WLL provided an optimum 50% HD and acceptable

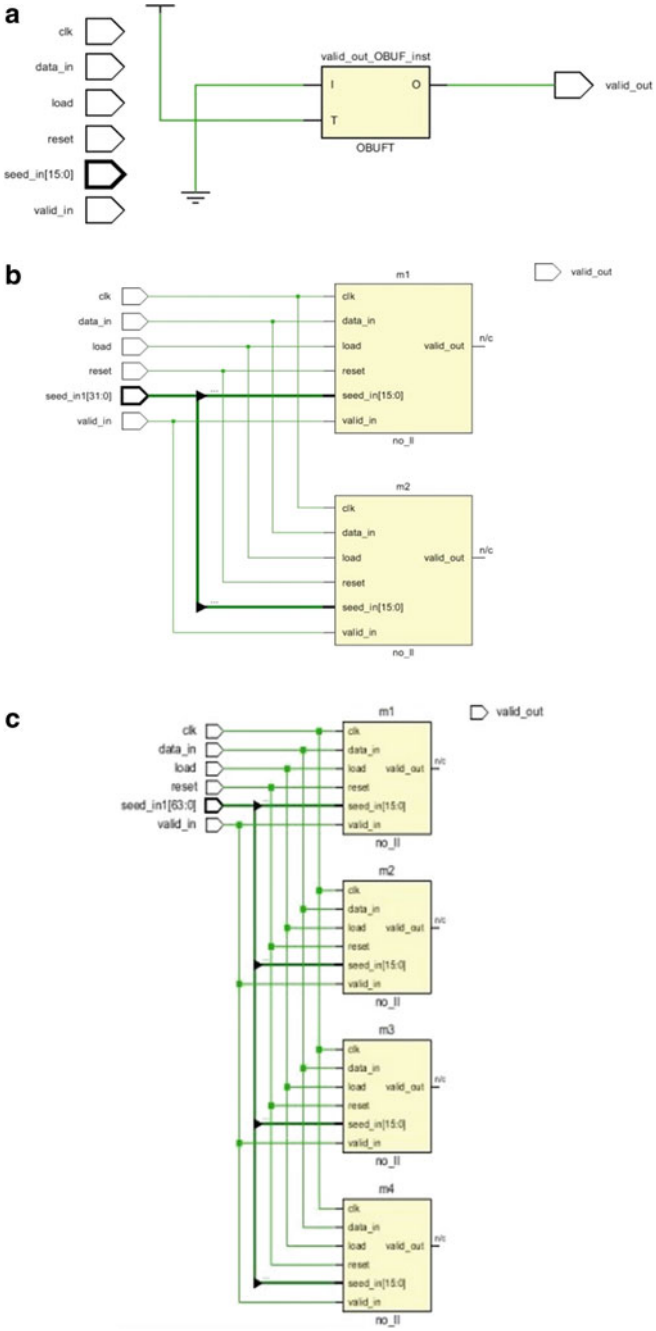

Fig. 9 **a** Schematic diagram for 16-bit input. **b** Schematic diagram for 32-bit input. **c** Schematic diagram for 64-bit input

LD value for around 50% inputs whereas RLL provides 50% HD to comparatively low number of inputs. Further improvement by adding more logic locking blocks showed an increase in the percentage of inputs giving optimum HD% and LD. Future works can enhance the placement of the logic locking blocks and compare results obtained for each arrangement.

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A Novel IoT Device for Optimizing "Content Personalization Strategy"

Vijay A. Kanade

Abstract The research paper discloses a theoretical model of a "content personalization device" that functions over an operating system (OS) of any mobile handheld device. The device is in the form of a thin-layered transparent film that fits on the screen of the mobile device. The device operates as a layer over the OS as all the content mediated or allowed by the OS on the device passes through this personalization layer, where it gets filtered. This layer analyzes user interactions with the device and provides filtered content based on the user's response to the content. The externally integrated device tracks the user's device usage pattern and adapts to changing user choices and preferences over time for filtering and displaying relevant content to the user of the mobile device.

Keywords Content personalization · Content filtering · User preferences · Feedback loop · User's real-time response

1 Introduction

Content personalization refers to rendering Web-based or app-related content to a user based on user's choice or preferences. Web site visitor history is used to provide relevant content to the user in a manner that promotes end-user satisfaction and in most cases helps in lead conversion [1].

Content personalization is generally opted by e-commerce players to double their e-commerce sale. Such personalization is termed as one-to-one marketing as the organization's Web site specifically targets individual customers. Personalization also leads to meeting consumer needs effectively and in an efficient manner, thereby motivating the customer to revisit the Web page in future [2, 3].

However, with the current personalization strategy, one-to-one marketing has reached a point where it has become more burdensome for the consumers rather than of any help. As the customers visit any Web page, they are overloaded with

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personalized ads, social media feeds that are essentially taxing. These ads are sometimes not just irrelevant for the user, but they also tend to gulp a lot of Internet data unnecessarily [4].

Further, personalization is needed in situations where apps tend to send out irrelevant notifications that the user may not be interested in at a particular time. Here again, these notifications are more disturbing similar to the above ads, rather than of any value. Hence, there seems to be a long pressing need to identify a solution for content personalization that is not just specific to the user but takes into consideration user behavior, device usage pattern, and user context before delivering any content. The research paper provides a theoretical model of a novel IoT device that addresses this problem of content personalization. The IoT device also puts a break on excessive personalization opted by most marketing agencies [5].

2 Content Filtering Techniques

Content filtering is employed strategically by various business verticals. Some of these techniques are as listed below [3]:

1. Collaborative content filtering

Here, data from different Web sites is collaborated and filtered to provide user-relevant data that may give better user experience (e.g., e-commerce) to the user.

2. User-specific profiling

Creating personalized Web page for a user based on user-specific data collected from various sites.

3. Analytic tools

Data analysis tools are used to predict likely future interactions of the user based on the user's activity on the site.

2.1 Real-Life Examples of Content Personalization

Amazon, Netflix, and YouTube are some of the common platforms that disclose content personalization for better user experience [6, 7].

1. Amazon generates product recommendations based on page views, user purchase history, and user behavioral data.
2. Netflix recommendation engine uses user's viewing history, interactions, content title info (i.e., genre, cast, etc.), duration of sessions, device type, and time of the day.

3. YouTube provides recommendations based on the user's past history, interaction patterns, and from demographic data where content consumed by various users with similar personas is recommended.

However, these recommendations do not take into consideration the user context or the content type that is being consumed in real time. This leads to user distraction many a times. For example, consider YouTube recommendation engine having one-to-one marketing ads. YouTube ads are difficult to bare for consumers, as they seem to pop-up after every "n minutes." Now, when the user is amidst a serious video content, such interruption by ads becomes disturbing and forces the consumer to view the ad. Although personalization enhances customer experiences, however, its biggest challenge today is that it should not act as a source of distraction to its customers [8].

3 Novel IoT Device

3.1 Hardware

The proposed novel IoT device is a thin transparent sheet that fits on the top screen of the mobile device. The arrangement of the device is similar to that of a screen guard that is adopted by most mobile phone users for protection against screen damage. The device is provided with a micro-USB cable that is used to plug-in and integrate it with the mobile device (Fig. 1).

3.2 Architecture

The IoT device consists of a secure file system that sits on top of the original OS of the electronic device. On integration of the IoT device with the mobile device (i.e., by plugging-in the micro-USB cable), it synchronizes with all the repositories of operating system(s). This may include AppStore for MacOS for Iphone-based system, Google Play Store for Android-based system, Windows for Microsoft. The secure file system is provided with a monitoring module through which the data flow of the device takes place. This module monitors and tracks the inter-application data traffic occurring within the device as well as the data communicated by the device via servers when using the Internet data. Therefore, user interaction with the device is closely monitored by the secure file system of the IoT device.

The architecture of the IoT device is shown in Fig. 2.

Description

In Fig. 2, the secure file system acts an independent layer above the OS. Such an arrangement ensures that the device data exchange between various apps (AppN) or Web sites (WebsiteN) is closely tracked leading to a better understanding of the user

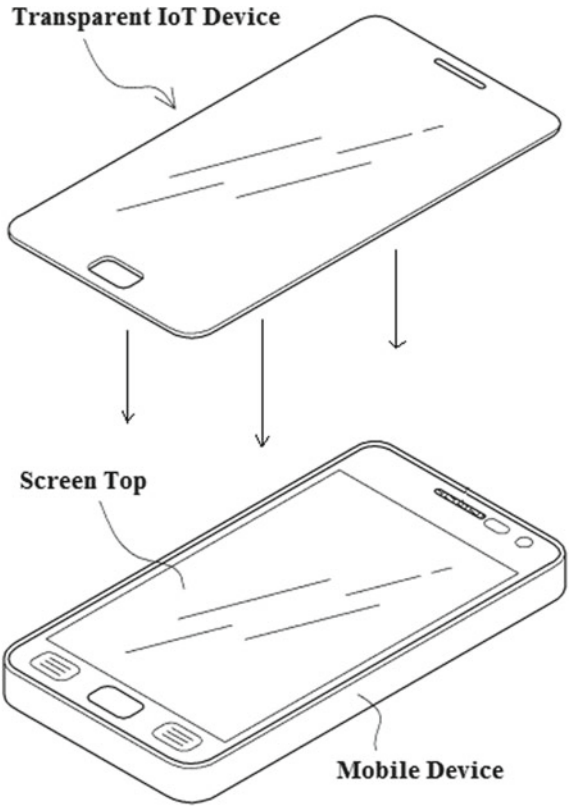

Fig. 1 Theoretical model of transparent IoT device. (Micro-USB cable not shown)

interactions with time. The secure file system helps to gauge user context based on the feedback (i.e., user response) that the user provides for the live content that is currently being played on the mobile device. This allows better content filtering as it takes into account the changing user's taste over time as content is being delivered to the user.

3.3 Data Flow

The general data flow of proposed theoretical model is shown in the below flowchart (Fig. 3).

The steps involved in the operation of the novel IoT device are summarized below:

Step 1: Monitoring data exchange
Step 2: Verify user context [interaction pattern, behavioral data]
Feedback loop; [user response on live content]
Step 3: Allow content delivery or block content

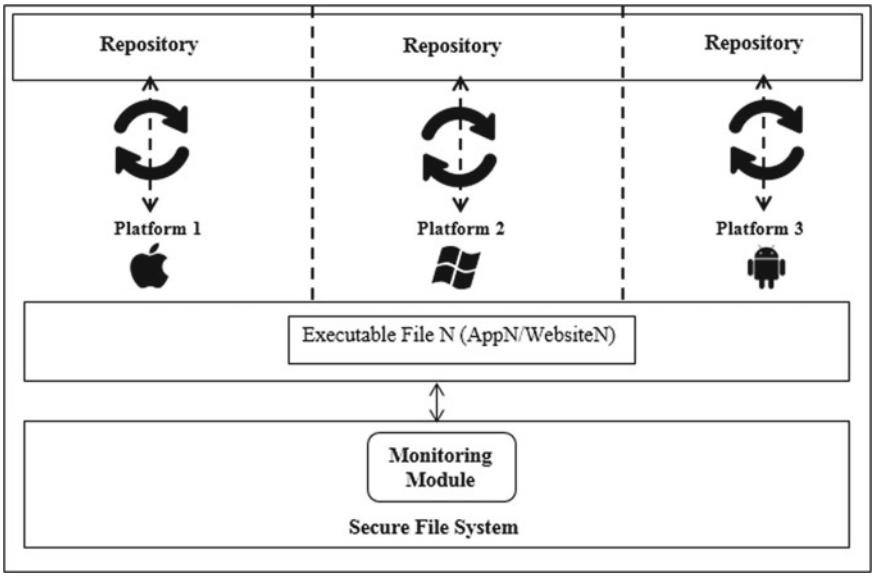

Fig. 2 Theoretical architecture of IoT device

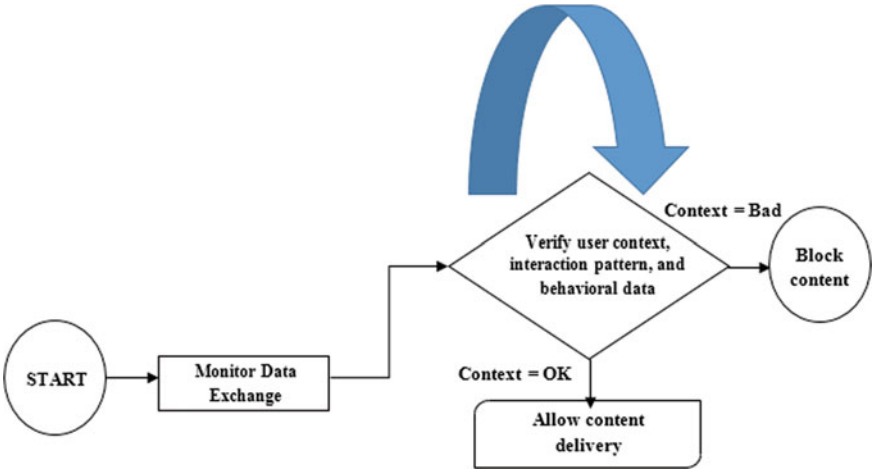

Fig. 3 Data flow during content personalization

Context value; [good or bad]
Repeat; [loop-in > Step 1].

4 Preliminary Research Observations

Currently, the end users are bombarded with excess personalized information, where the marketer is missing on the actionable content that would derive insights needed to drive user engagement and earn substantial revenue.

A study was recently conducted to discover thoughts and feelings of the college students regarding the annoying marketing tactics adopted by most marketers today [9]. About 273 students from a large public university located in the southern USA participated in the study. The insights derived from the study are as tabulated in Table 1.

Hence, the proposed theoretical model of the IoT device is designed to lower this impact of excessive personalization on customers by controlling the type of content being delivered to the end users based on user's real-time response to the provided content, i.e., feedback.

5 Applications

The proposed research is specifically useful in following scenarios:

1. Notifications and ads are delivered to the user by tracking user feedback for certain content type that is already being delivered.
2. Consider a scenario, where the calendar shows meeting scheduled at 12–1 pm. In such cases, notifications are not provided to the user, as the phone can be put on DND mode. However, if something very critical pops-up while the DND mode is on, then the proposed IoT device will monitor this content and flag it, so that the content is delivered to the user irrespective of the DND mode. This can happen for SOS emergency calls, urgent meeting emails, or in cases when someone sends a serious text message over WhatsApp or any social media.
3. Another case can be considered of Apple IPhone, where at night the phone enables DND, so that all the notifications are automatically silenced until user's wake-up time. However, some important texts, updates, or notifications can be missed due to this facility. Hence, the disclosed IoT device checks the semantics of the data being communicated to the mobile device and thereby decides if the content should get through the DND mode. An example of this could be, allowing phone calls from contacts saved as Mom, Dad, Family, etc., to get through, but denying access to rarely communicated contacts.
4. Consider another scenario where the user is continuously skipping ads on YouTube. In such a scenario, as the user usage pattern is already being tracked by the IoT device, next time YouTube decides to play an ad, that content will be automatically skipped or filtered, thereby avoiding its delivery to the user. Further, the discussed marketing ads also consume excess Internet data, which can be avoided by using the disclosed IoT device.

Table 1 Study responses [9]

Annoying marketing tactics	Subcategories	Marketing quotes	Percent
Aggressive tactics		"Marketing that keeps trying to influence a customer to buy a certain product even when they already turned the product down"	41
Repetition		"When companies use the same commercials over and over"	23
Obnoxious tactics			15
	Garish/loud ads	"Any marketing that is loud, persistent, or vulgar, or things that are spelled incorrectly"	8
	Irritating	"Marketing that is irritating to any of the 5 senses of a target customer"	4
	Distracting	"Ads before YouTube videos, Pandora, etc. Any ad that keeps you from doing what you are trying to do"	1
	Low quality	"Marketing that does not meet today's standards"	~1
Irrelevant content			7.3
	Nonsensical	"Ads that seem to have no plan"	4
	Uninformative	"Marketing that tells nothing about the product. It just tries to be funny or flashy to sell me something"	2
	Product focused	"Only concentrating on selling the product, not caring about the customer"	1
Tactics which cause avoidance		"Bugging a customer to the point that they want nothing to do with your product"	5
Consumer discomfort			32
Violates social norms			14
Out of the ordinary tactics (creates weird feeling)		"Marketing that uses techniques that we think are odd or unusual to get our attention"	13

6 Conclusion

The proposed research discloses a theoretical model of a novel IoT device to fine-tune and optimize the content personalization strategy. The personalization mechanism takes into consideration user context, user behavioral data, and user interaction for filtering the content. The proposed research removes unwanted content delivered via a modern one-to-one marketing strategy and recommendation engine. This gives the

user better control over the Internet data as only user-relevant content is allowed to pass through the IoT device.

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IoT Based Self-Navigation Assistance for Visually Impaired

Nilesh Dubey, Gaurang Patel, Amit Nayak, and Amit Ganatra

Abstract One of the major challenges faced by visually challenged people is self-navigation in unknown environments. They often tend to get hurt by objects that they cannot feel using their hands or a walking cane, as certain objects are hard for a blind person to detect by just using tapping their walking cane. To avoid obstacles and navigate through a new environment, a smart belt for the visually impaired is performed in which he/she can continuously detect the obstacles around the user with its sensors that span the entire 360° of his/her field of view. Whenever an obstacle is in a nearby range, sufficiently enough to cause a hindrance, the device will give sensory cues to the user about the location of the obstacle and family members are also tracked them using GSM and GPRM system.

Keywords GSM · Obstacle detection · Visually impaired · HC-05 sensor system

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1 Introduction

Unlike us, blind or visually challenged people are not blessed with the same gifts, and consequently, they cannot perform the same tasks with the same parity as what a normal individual could do. In an entirely novel place, they might be able to dodge the obstacles coming in their way with the help of the walking cane but knowing where to go seems like an uphill climb without any external help as they are unfamiliar with the layout. This could lead to getting lost sometimes, which would be a difficult situation to get out of. The current solution also renders them with only one usable hand while walking, which in some cases may be a minor inconvenience. Countless other problems are not mentioned here but affect them daily.

The project aims to mitigate the most common problems of their struggle and make their lives comparable to ours. It takes advantage of a simple wearable belt that everyone can adorn. On the belt, there would be ultrasonic SR-04 sensors fitted, about six of them which handle their own respective direction. Four sensors are entirely dedicated to the X-Y plane, i.e., the horizontal plane located at about the waist height of the wearer. They continuously pulse in the four major directions, i.e., North, East, West, and South. This way, the entire 360° field of view of the blind person is covered by the sensors. The extra two sensors cover the vertical plane, and they check for any obstacles on the floor which may come in the way of the person. Hindrances at the head height of the person should also be taken care of, which is done by the sensor aligned at the pre-decided angle with the horizontal plane. For the additional features, the distress alert feature helps them to stay connected wherever they are. In any event of trouble, this feature will notify all the people which were set earlier when setting up the device. Additionally, with the help of an Android app, connected to the device via Bluetooth, it can help in navigating walking distances by giving turn by turn directions to the user via the handset connected by the auxiliary port with the Android phone. Through this app, blind people walk safely outdoors or in traffic areas.

2 Existing Work

2.1 Smart Mobility Aid for the Visually Impaired Society

Electronics is a domain that is constantly growing and developing [1–4]. There are approximately 15 million people who are blind in India. Major developments square measure worn out a sensible for seeking a well and smarter life and welfare toward the blind society. This paper [4–6] recommends and pursues a thought of removing the stick and mounts these sensors on the visually handicapped individual body itself.

2.2 Real-time Dangling Objects Sensing

The initial style of mobile ancillary device for pictorial impaired [7–10] was discussed. This analysis planned a mobile real-time dangling objects sensing (RDOS) model that is mounted on a front of a cap for obstacle detection. This device uses relatively low-cost audible sensing parts which provide balance sense for blinds to know the anterior projected things. The RDOS gadget can the executives the sensor's front point that is at the client's body stature and upgrades the detecting precision. The RDOS gadget can manage the sensor's front angle that is at the user's body height and enhances the sensing exactness [11]. Two major required algorithms are to live the height-angle activity and un-hearable detector alignment and planned unit space. The analysis team to boot combined the RDOS device with mobile automation devices by act and Bluetooth to record the walking route.

2.3 Assistive Infrared Sensor-Based Smart Stick for Blind People

In this article, the authors proposed a lightweight smart stick that is relatively inexpensive, very user-friendly, and easy to use [12–14]. The smart stick gives a quick response to the user about the obstacles ahead and helps them with better mobility and uses low power consumption. The stick utilizes infrared technology; a cluster of infrared sensors can observe stair-cases and totally different obstacles presence at intervals the user path. As a stick could be an acquainted object to a blind man thus employing a good stick for higher quality and obtaining the device would be terribly straightforward [15, 16]. The experimental results provide smart accuracy and thus the stick is prepared to watch all of the obstacles [17].

3 System Components

3.1 Arduino Uno

The ATmega328 AVR microcontroller is the core of the Arduino Uno R3 microcontroller board. It consists of 20 digital input and output pins which comprise six PWM outputs and six analog inputs. A computer program named Arduino Uno IDE is used to load the code from the computer to the Arduino. The Arduino has widely used in the world which makes it an extremely simple approach to begin working with embedded electronics.

3.2 Ultrasonic Sensor SR-04

The ultrasonic sensor SR-04 is used to measure the distance between the sensor and some object. The way distance is measured by the sensor is that it emits a sound, usually about 40 kHz which falls in the inaudible range for humans, but the sensor is capable of picking it up. After emitting the sound, the sensor waits for the sound to bounce back from the object, and it measures the time taken. With the help of time taken, it gets conceivable to calculate the distance between the object and the sensor. The general formula speed is equal to distance divided by time is used here. It is rearranged to be distance which is equal to speed multiplied by time. The next step is to simply plug in the values for the speed of sound and the time measured by the sensors in the previous step and obtains the distance. Here, the distance calculated would be the round-trip time, which means the distance from the sensor to the object and the distance between the object and the sensor. To solve this, just divide the distance by two.

$$\text{distance} = \frac{\text{speed of sound} * \text{time taken by sound}}{2} \tag{1}$$

3.3 Bluetooth Module

HC-05 module is an unbelievably essential Bluetooth SPP (Serial Port Protocol) module, proposed for direct far off successive affiliation plan. The HC-05 Bluetooth module can be used in a master or slave design, making it a viable answer for remote correspondence. This sequential port Bluetooth module is a totally qualified Bluetooth V2.0+EDR (enhanced data rate) 3Mbps modulation, and it contains an absolute 2.4 GHz radio handset and baseband. It uses CSR Blue center 04-External single-chip Bluetooth structure with CMOS development and with adaptive frequency hopping feature (AFH). Bluetooth, a ton of explicitly Bluetooth low energy (BLE), has become the overwhelming innovation for associating Internet of Things (IoT). The innovation is also ready to keep up the quality correspondence range all through the trade. This low energy form of Bluetooth may totally affect IoT innovation, by giving gadgets the adaptability to existing and with progress perform during a huge decision of use situations. Bluetooth empowers low force correspondence between gadgets that are in the closed closeness of each other existing instrument.

4 System Design

This is the basic format of how the sensors are placed around the belt and what field of views will they cover. The lines *a* and *b* work on the XY plane, toward the front

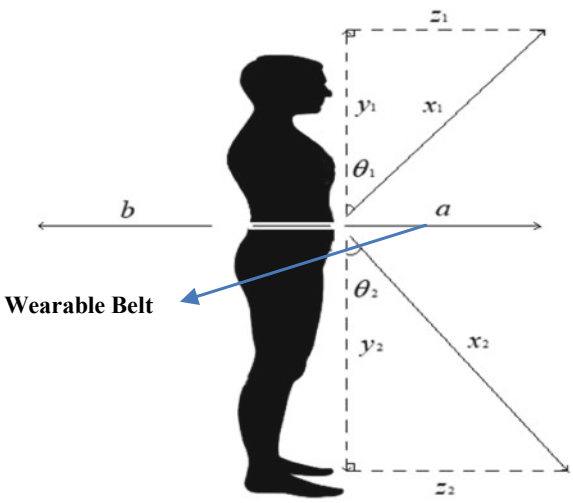

Fig. 1 Representation of the proposed system with wearable belt

and rear of the wearer, respectively. Both sensors are not person dependent, and they will have the same configuration regardless of the wearer because they work in a straight line perpendicular to the user. The height of the wearer will not affect their function in any way (Fig. 1).

The next two sensors sit at a little distance from the sensor with the line of sight *a*. The problem with fitting all the sensors equidistant to one another is that two sensors will fall on either side of the torso which is the normal resting position for both the arms. Hence, putting them on the sides will give erroneous results as hands constantly interfere with the reading of the sensors. The remaining two sensors have a slightly tricky implementation. Their implementation depends on the height of the wearer as well as the waist height of the wearer concerning the ground. The sensors are placed at an angle over and below the front sensor. The bottom sensor, with the line of sight x_2 detects the steps or little obstacles along the way of the user. The problem with placing the sensor pointing straight down is that due to the walking it is impossible to detect the distance accurately. Also, it is pointless to do that as the detection of the obstacles takes longer time. Hence, the angle θ_2 is placed concerning the vertical plane. The distance x_2 will depend on the height y_2 at which the user wears the belt on his waist as the Pythagoras theorem will be applied here.

$$x_1^2 = y_1^2 + z_1^2 \tag{2}$$

Also, to calculate without the distance, the formula is very useful.

$$\cos\theta_1 = \frac{y_1}{x_1} \tag{3}$$

The sensor which detects above the head of the user works in a very similar way with a slight difference. The distance x_1 is decided on y_1, but y_1 is not the height

Table 1 Values are taken for the respective variable and generated values of θ

Parameters	x_1	y_1	z_1	θ_1	x_2	y_2	z_2	θ_2
Data	128.6	91	91	45°	142.8	101	101	45°

of the wearer; it represents a distance that is slightly above the height of the wearer from the waist. This is done because objects near the head of the user can pose a significant threat while walking. The code is designed in such a way that it will trigger the buzzer if anything is detected closer than 20 cm to the height of the head of the user.

With the current tested data, the following table is prepared using the device (Table 1).

4.1 Design Requirements

(1) It has one input because of having one degree of freedom.
(2) It is a coplanar mechanism with at least four links.
(3) It has at least one combine pair to form a non-uniform output speed.
(4) It has at least one gear pair to vary the uniform resultant speed.
(5) It has a ground link to support or constrain other links.
(6) It has one output link.

4.2 Design Constraints

(1) The number of links should be four or five links.
(2) The frame must be a link with three joints or more to have a firm support.
(3) At least one cam pair must be incident to the frame.
(4) The input link must be adjacent to the frame with a revolute joint.
(5) The input link, the output link, and also the frame should be appointed on completely different links.

5 Experimental Results

After rigorous testing, it can be concluded that six sensors are the optimal solution required for this device to work efficiently. It creates a good balance between the working and affordability of the device, and it provides enough sensory cues for the visually impaired person. Anymore several sensors will confuse the user and exacerbate the problem instead of alleviating it. To implement the sensors in many different combinations of wearables, environments found that a belt can be used in

Table 2 Classification of hurdle based on sensor readings

Type of hurdle	Type of alert
Non-uniform path	Voice alert Beep 1
Small object	Voice alert Beep 2
Large object	Voice alert Beep 3

all kinds of weather and can be worn by almost everyone. Also using the HC-05 sensor instead of the SIM9000 sensor proves to be a wise choice as the recipient of the SIM9000 sensor can be poor at times which prevents the distress feature from working. With the connection of an Android phone via a Bluetooth sensor to the device, accurate latitude and longitude can be sent with precision (Table 2).

6 Conclusion

The project work aims to solve an underlying problem that has been overlooked for years. The technology for the masses has seen an exponential growth, while it has been stagnant for a certain demographic. This device will replace a tried and tested practice used by blind people, i.e., walking and navigating with the help of canes. The benefits that this product will provide to the users are subtle yet revolutionary. The simple convenience of having both hands-free while still being able to walk freely in a known or unknown location should be available to everyone. This device helps in making blind people more independent with the use of SOS features and more familiar with technology in general. Thus, the obstacles were detected using the SR-04 sensors via measuring their latency of the 40 kHz sound signal and processing using the algorithm used by the Arduino Uno.

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An Overview of Cyber-Security Issues in Smart Grid

Mayank Srivastava

Abstract A smart grid is an updated version of the traditional electrical grid that uses Information and Communication Technology (ICT) in an automated fashion for the production and distribution of electricity. Several attributes like efficiency, sustainability, and reliability are improved in the smart grid as compared to the traditional grid. Smart grid gives significant benefits for the entire community, but their dependence on computer networks make them vulnerable to various kinds of malicious attacks. This article focuses on identifying the various cyber-security issues of different areas of the smart grid which are prone to vulnerabilities. Finally, the possible solutions for resolving the cyber-security issues in the identified areas for making the smart grid more secure were analyzed.

Keywords Smart grid · ICT · Smart devices · Cyber-security · Vulnerability

1 Introduction

Smart grid technology offers many benefits to the entire society [1]. However, the integration of computer networks into the smart grid makes society vulnerable to different types of malicious attacks. Also, such integration makes the way for the privacy issues of the customer. The ICT is the basis of the underlying smart grid infrastructure, which is required for the successful operation of the smart grid. Henceforth, it becomes necessary to address the security issues of ICT in this domain. Finally, one can say that it is important to address the cybersecurity issues in various phases of the smart grid [2].

Besides this, the unintentional compromises of the network infrastructure due to user-oriented errors, apparatus failures, and natural blows also need to be considered. Securing the entire facility of the smart grid is a daunting task [3]. The vulnerabilities of the existing technology infrastructure must first be identified and analyzed, before applying the management process to mitigating them. But there are certain barriers

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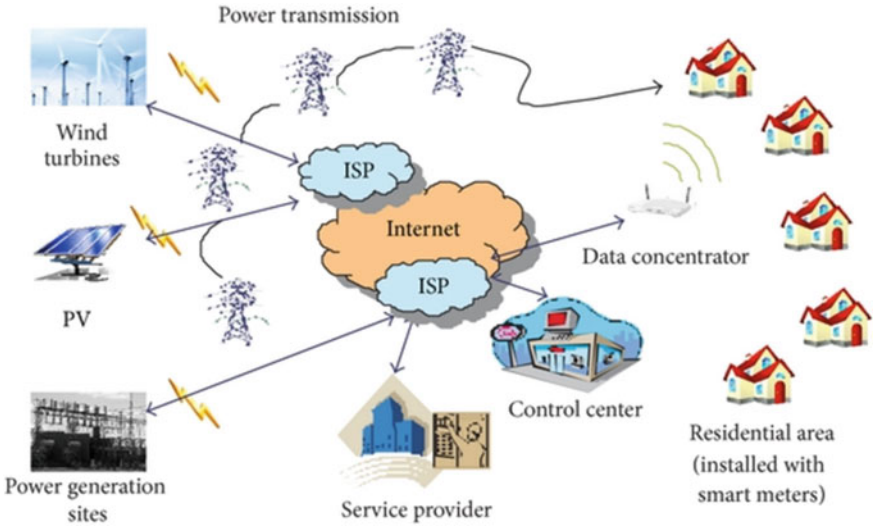

Fig. 1 Smart grid architecture [5]

such as organizational issues, lack of technical skills, and awareness concerns that prevent us to achieve this objective. [4].

A smart grid basically incorporates a computer network with the existing grid infrastructure to analyze and distribute data related to energy consumption. In the smart grid, the energy producers and energy consumers interact intelligently which eventually serves the purpose of saving a lot of energy. In Fig. 1, the different forms of energy generation schemes like wind turbines, photo-voltaic (PV), and power generation sites are used for power generation. The generated power is distributed to various categories of customers. The figure also shows the interconnection of various nodes across the entire transmission network of the smart grid. The various network components used in the infrastructure are data concentrator, control center, Internet Service Provider (ISP), and various sensors. The sensors are used to give accurate information about different aspects of smart grid architecture.

2 Review of Literature

Different researchers are working on various domains of the smart grid. Some of the major contributions of the research done in this area are as follows.

Chebbo [3] focuses on the importance of smart technologies, smart vision, smart processes, and finally smart stakeholders for energy innovation. Tuballa et al. [4] present an outline of the associated technologies of the smart grid. The paper also mentions the importance of the latest technologies in influencing the existing grid. Mrabet et al. [5] provide a deep understanding of the security vulnerabilities and their

possible solutions. The paper gives a cyber-security strategy to deal with various kinds of cyber-attacks. Wang et al. [6] put a thought on the hybrid structure of the computer networks that connect the energy providers and consumers in a smart grid. The author then emphasizes the challenging problems of network reliability and security. Bigerna et al. [7] perform the literature review about the social costs affecting the development of the smart grid. The paper finally presents the opportunities and challenges in the business, applications, policy, and security issues of the smart grid.

Kappagantu et al. [8] specify that the three main objectives of cybersecurity that need to be addressed are availability, integrity, and confidentiality. It also emphasized on multilayer structure of the smart grid, where each layer is having specific security concerns. Finally, it states that the use of advanced techniques is essential to tackle sophisticated cyber threats. Baumeister [9] proposes a study that is divided into five different smart grid security categories namely process control, communication protocol, smart meter, simulation for security analysis, and power system state estimation for achieving smart grid security. Wang et al. [10] present a comprehensive review of different cybersecurity issues for the smart grid which focuses on various vulnerabilities and solutions concerning the smart grid.

Yang et al. [11] discuss the various cyber-attacks and their possible solutions which are crucial for the expected operation of the smart grid. The paper also presented its insight on the critical aspects related to cyber-security of smart grid-like interdependency, vulnerability, etc. Pearson [12] presented a study on the use of ICT in Europe's electricity sector. The article highlights that increased reliance on ICT in the electricity sector will open up new vulnerabilities that will undermine the advantage of the smart grid. It also explains that the European Union (EU) has to mitigate these challenges to avoid a possibly expensive technical lock-in. Yan et al. [13] summarize the different cybersecurity issues and vulnerabilities related to the smart grid. It also presents a survey that focuses on the current solutions to different cybersecurity issues of smart grids.

Aillerie et al. [14] present the report which identifies significant issues in cybersecurity policy design for the International Smart Grid Action Network (ISGAN) membership. The paper discusses the smart grid architecture along with fast-changing cyber threats. The paper also proposes certain hardware designs for improving the security of the smart grid. Berthier et al. [15] focus on using secure protocols to prevent the network from being exploited. It also emphasizes the importance of intrusion detection system (IDS). Sou et al. [16] explore the smart grid cybersecurity problem by analyzing the false data attacks-based vulnerabilities of electric power networks. Here, the analysis of the problem is based on the constraint cardinality minimization problem. It was shown in the paper that a relaxation technique provides an exact optimal solution to the cardinality minimization problem.

3 State Estimation of Smart Grid

Figure 2 shows another basic infrastructure of the smart grid. It can be seen from the given figure that it includes cloud-based servers, power transmission lines, smart grid operators, and transmission lines to the industrial, commercial, and residential customers. The whole smart grid infrastructure is based on smarter networks, which are mainly used for transmission and distribution purposes [17]. The smart grid makes use of mostly new technologies to improve the transmission as compared to the traditional system. Advanced distribution automation (ADA) technologies along with advanced metering infrastructures (AMI) provides the required intelligence to the power grid infrastructure to meet out its defined expectations.

The smart grid acts intelligently to integrate distributed energy generation from different energy sources. A smart grid helps mainly in conserving energy, increasing reliability and transparency, reducing cost, and making the entire process of energy generation and distribution more efficient [18]. In a smart grid, the data between consumers and the grid operator is exchanged by using secure communication channels based on encryption. Here, the homomorphic data encryption techniques are used to provide data privacy over the cloud.

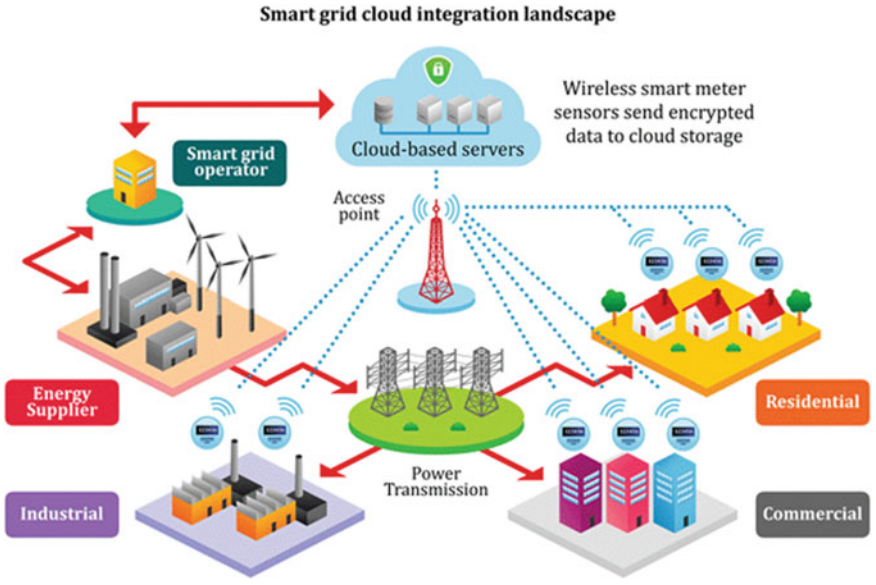

Fig. 2 The smart grid architecture [17]

4 Cyber-Security Issues in Smart Grid

Smart grid infrastructure dominantly uses smart devices that are prone to vulnerabilities. As the smart grid makes heavy use of ICT, this gave the attackers a possibility to exploit the different vulnerabilities of ICT to disrupt the normal operation of the grid. A smart grid is an interconnection of heterogeneous systems, where each system may be having its own set of technologies and communication equipment. This heterogeneity, diversity, and complexity make the security of the smart grid highly difficult. The objective of this section is to highlight the major cyber-security issues of different areas of the smart grid, which is having vulnerabilities and can be exploited by the attackers to do malicious activity [19]. The various cyber-security issues in different areas are as follows:

1. **Architecture**: The weakness of the smart grid architecture can be exploited by the intruder for a possible attack. For example, vulnerabilities related to the operating system, server, etc. can be exploited to perform malfunctioning of the system.
2. **Communication protocols**: Devices can be compromised if they are communicating over an insecure line. Some of the widely used wireless protocols like Zigbee, Wimax, Wifi are also having vulnerabilities.
3. **Interfaces**: Web-based smart grid applications are subject to several vulnerabilities. The vulnerabilities related to the application can be exploited to make the system error-prone.
4. **Home area networks (HAN)**: Vulnerability can also exist in smart equipments within HAN. Network parameters of HAN can be identified to launch various network attacks.
5. **Human factor**: Social engineering techniques can be adopted by the attacker to access customer accounts and to change their settings. For example, by using phishing attacks, the attacker can get the basic details related to the customer and exploit the system.
6. **Physical security**: Physical exposure of the network components and smart devices are vulnerable to intrusion. If devices are not properly physically secured, anyone can connect to them to change the network settings or may perform any malicious activity.

There are several ICT-based smart grid components that also suffer from different cyber-security issues.

1. **Operational systems**: Meter Data Management System (MDMS), Supervisory control and data acquisition (SCADA) Systems, Utility system, etc. For example, the system may have several open ports that can be exploited by the attacker.
2. **Standard IT systems**: PCs, servers, mainframes, application server, database server, web server, etc. For example, there is a possibility that apart from port numbers generated by specific applications other port numbers can be open, which can be exploited by the attacker.

3. **Terminating devices**: Smartphones, electric vehicles, smart meters, and other mobile devices. For example, smart meters can be hacked to increase or decrease power demand.

5 Possible Solutions of the Cyber-Security Issues

It is evident from the previous section that the smart grid is vulnerable to different types of cyber-security issues. To deal with these vulnerabilities, prevention is considered to be the most effective strategy as compared to elimination. This section provides a possible solution to deal with various cyber-security issues mentioned in different areas of the previous section [5, 9, 13].

1. **Architecture**: It must be designed so that they can be able to handle malicious attacks like denial-of-service (DOS). The network must also be able to cope-up with the network failures oriented attacks by maintaining the automation service locally.
2. **Communication protocols**: To make communication secure, end-to-end encryption must be used. Secure wireless protocols like WPA2 can be used for securing data in wireless networks.
3. **Interfaces**: Web interfaces can be secured by following one or many of the given means: context output encoding, secure password storage, multi-factor authentication, etc. Context output encoding is a programming technique that can prevent cross-site scripting flaws.
4. **Home area networks**: Wireless communications between smart appliances and central systems should be secured by using encryption. Also, there is a need to eliminate rogue access devices to protect against interception or manipulation.
5. **Human factors**: The devices should be capable to use encryption for achieving authentication and authorization to prevent sniffing password attacks. The process of creating user-id and password should be complex to thwart any dictionary-based attacks.
6. **Physical Security**: Providing physical security of the entire network including connected devices is majorly a daunting task. However, infrastructure at the grid, sub-station, and (if possible) at the customer level must be protected by some means of physical guarding and surveillance guarding for physical security.

The smart grid's ICT components are also needed to be resolved for vulnerability so that the cyber-security issues related to them can also be prevented.

1. **Operational Systems**: The operational systems may include one or many of the components like wireless communication, data collection and management, and utility system. The means of securing each one of them is already given in the discussion above.
2. **Classic IT systems**: The IT systems especially web servers, application servers, the database server can be made more secure by resolving the vulnerabilities related to their operating systems, applications, protocols, and network. The

found vulnerabilities can be resolved by updating them through the required patch given by the solution provider.

3. **Terminating devices**: The terminating devices must be purchased from the authorized center, and their operating system and applications must be updated regularly for achieving security.

6 Conclusion

Smart grid technology is a recent research area in which issues of existing grid infrastructure are addressed. The smart grid is basically used to monitor various grid-oriented activities, load side preferences, and to perform real-time actions. The smart grid consists of various distributed and heterogeneous computer systems, required to integrate the various forms of energy and to deliver electricity more easily to the consumers. Despite the various advantages of the smart grid, there are multiple challenges in its implementation which include coordination and adoption of the new technology. This article focuses on identifying different cyber-security issues about the current state of a smart grid. These important issues need to be addressed to make the smart grid implementation successful. More specifically, the paper highlights the cyber-security issues in key areas of architecture, communication protocol, interfaces, home area networks, human factors, physical security, and different ICT components. The study finally gives the state of the art solutions to deal with the mentioned cyber-security issues for improving smart grid security.

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Data Streaming Architecture for Visualizing Cryptocurrency Temporal Data

Ajay Bandi

Abstract The utilization of data streaming is becoming essential in mobile computing applications to reduce latency and increase bandwidth. Vast amounts of data are generated continuously from the Web sites of stock markets and financial institutions. The data's meta-analysis is critical for investors and needs to analyze in a short time. Traditionally, it requires several heterogeneous resources with high storage capacity to process and compute the data. Data streaming helps to capture, pipeline, and compute the data without storing it. This research aims to visualize the continuous updates to the cryptocurrency temporal data using aggregations and simple response functions. The cryptocurrency data is collected from multiple data sources. A macro-enabled Excel external live data from Web feature, `C3.js`, and Tableau tools are used to capture and pipeline the streamed data in real time to make better decisions. The results show that the visualizations are dynamically updating in the events of trades in cryptocurrencies over time. Data streaming researchers and practitioners benefit from extending the streaming architecture methodology and dataflow to other domains.

Keywords Mobile edge computing · Data streaming · Cryptocurrency · Visualization · Architecture · Big data

1 Introduction

In the context of big data, "data streaming" means a continuous generation of data from various data sources. It is also referred to or interchangeably used as streaming data [13]. In various domains, it is essential to observe and react to events in real time. Events such as analyzing the trends for investing in stock markets, identifying unauthorized transactions in bank accounts, detecting cyber-attacks, analyzing social media posts for privacy and intelligence purposes, and monitoring sensor data to detect wear out parts in machinery are a few examples.

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The streaming solutions are necessary for high-speed and voluminous data. Data streaming is essential for mobile edge computing (MEC), an alternative to centralized cloud computing, to reduce latency [10]. In MEC, the storage and computation happen on the Internet's edge of mobile devices to overcome network communication challenges such as latency and bandwidth. The leading global market intelligence of communications and technology, International Data Corporation (IDC), forecasts that there will be 42 billion IoT devices, and the estimated data generated from these devices is 80 zettabytes ($8x10^{22}$) by the year 2025 [14]. Storing and computing such voluminous real-time data are highly challenging. Data streaming benefits the capturing, process, and bringing insights into massive data without storing it to improve MEC latency. The data stream processing requires latency in milliseconds to seconds using simple response functions and aggregation techniques. In contrast to traditional data warehousing, data streaming uses non-relational data to capture, pipeline, and then to compute the results using simple functions.

The continuous data generated from mobile applications [1] such as IoT apps, sensors, and vehicular systems makes it hard to capture, process, analyze, and get insights from real-time data without storing it. In some instances of data streaming, responding to the events can be done automatically. However, there is a need for human intervention to detect the changes, especially in the temporal data, when there is a continuous generation of vast amounts of data. To overcome this, there is a need to visualize the data in real time to monitor trends. In this paper, the proposed method is to visualize the real-time temporal data of changes in different cryptocurrencies' prices using macro-enabled Excel and visualization tools. The rest of this manuscript is organized as follows: Sect. 2 presents the related work. Section 3 describes the methodology and the implementation of the visualization of the streaming data. Section 4 presents the results, and Sect. 5 concludes with future work.

2 Related Work

Data streaming has wide variety of applications in various domains. Ehrlinger et al. [6] discussed industrial streaming data. They conducted a case study in a production plant that generates huge amounts of data. Their study dealt the stability of the production process using machine learning algorithms to handle semantic shift of streaming data. The literature of the data streaming architectures concentrated on reducing latency, accuracy, efficiency, and resource allocation. Henning and Hasselbring [7] focused on reliability and scalability. They proposed a data stream aggregation-based architecture to protect the scalability and reliability of the streaming process. The authors defined these quality attributes' requirements that can be considered for the multilayer and multi-hierarchical systems. The suggested architecture is applied to an industrial case study and observed a linear relationship with the sensor data and reliability.

Tiburtino et al. [12] presented a new method called Xtreaming. This method aims to update the visualizations without visiting multidimensional data exactly once continuously. Yang et al. [15] and Ben-Elizer et al. [5] addressed the robust streaming algorithms in the insertion-only model. Ragan, Stamps, and Goodall [13] proposed a focus and context awareness to visualize the streaming data with visual aggregation technique. However, the data resolution was diminished to represent the context for a longer time. Their results show a negative impact for the contextual awareness in visualization of streaming data. With the emergence of cloud [11] and edge computing [4] applications, there is a need for data processing and visualizing without storing it. The data streaming aggregation and append-only techniques are used to visualize the cryptocurrency temporal data.

3 Methodology

The data processing lambda architecture is used to visualize the real-time change in cryptocurrency values [8]. The three main components of a lambda architecture [9] are the batch layer, speed layer, and service layer, as shown in Fig. 1. The new data is fed to both the batch and speeding layers simultaneously from multiple data sources. These sources include but are not limited to IoT applications, mobile apps, vehicle communication with moving parts of traffic, satellites, sensors, and other devices. This speed component includes the inbuilt external streaming data function of the macro-enabled Excel. The batch layer has the complete data that is immutable, append-only and serves as the historical data.

The speed layer contains the most newly added data not yet thoroughly recorded and classified by the serving layer. This layer holds the data that the service layer is currently recording and new data that arrived after the current indexing. It is common to notice the delay in the latest data added to the system and the same data queried by the service layer—technologies such as Apache Spark, Flink, and Amazon Kinesis are used to reduce the latency between the speed and service layers. The service layer contains the regular additions of indexed data and is queriable for the end users to visualize and perform predictive analytics. The standard queries' results are also updated to the complete data in the batch layer and direct usage to end users.

The research goal is to visualize the streaming data. This research proposed the dataflow diagram, as shown in Fig. 2, to visualize the continuous real-time data using lambda architecture. The horizontal cylinders represent the streamed data. The next subsections describe the steps involved in the proposed dataflow diagram.

3.1 Tools Used

To implement a visualizing streaming data project, the following tools are used.

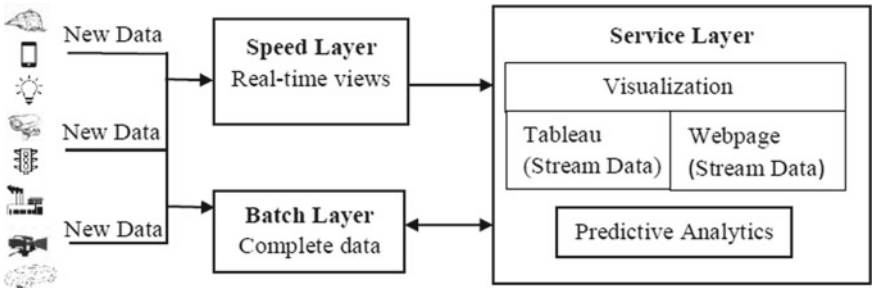

Fig. 1 Lambda architecture for data streaming

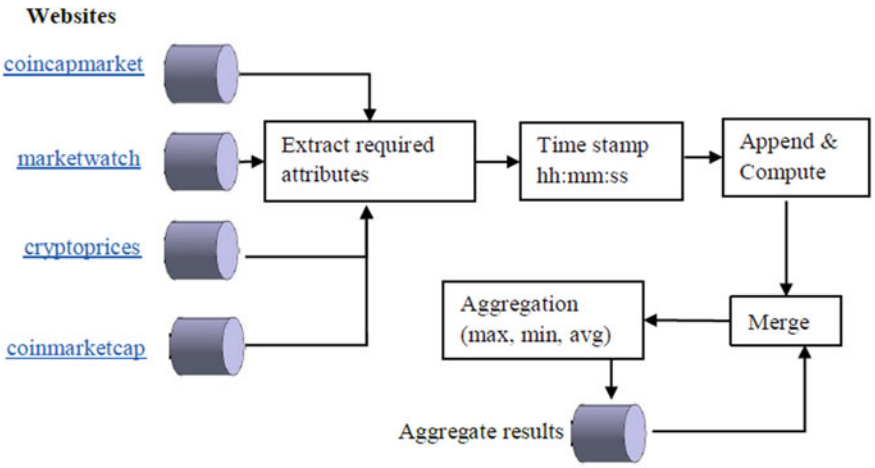

Fig. 2 Dataflow diagram of data streaming and computation

- Macro-enabled Excel—To extract live data from the Web sites—VBA and live data extraction. Visual basic for applications (VBA) Script is used to curate data, perform aggregation operations, conservation of Excel to `.csv` file, and connect it with web pages for visualizations.
- Papa Parse—It is a fast and powerful CSV parser for the browser that supports Web developers and streaming large files.
- `C3.js`—D3-based reusable chart library for customized visualization purpose on the web pages
- Tableau—A business intelligence and visualization tool to visualize the temporal data using line and multiline charts.

3.2 Data

The different cryptocurrencies such as Bitcoin, Ethereum, Tether, XRP, Chain Link, Bitcoin Cash, Binance Coin, and Cardano, Litecoin, Polkadot, Wrapped Bitcoin, USD coin, and DOW Jones industrial average's stock price are considered in this research. Also, the change in the percentage of the current price of these currencies is used for computations.

3.3 Data Sources

The cryptocurrencies and the stock price are colletecd from multiple data sources. The data is scraped from multiple Web sites (coincapmarket.com, marketwatch.com, coinmarketcap.com, cryptoprices.com). These Web sites are chosen to collect similar attributes related to the goal of this research project. The extracted data is cryptocurrencies and the stock price that changes in real time whenever there is a change in the market price.

3.4 Data Extraction

A macro-enabled spreadsheet (Microsoft Excel) is used to extract the data. The price of Bitcoin, Ethereum, Tether, XRP, Chain Link, Bitcoin, Bitcoin Cash, Binance Coin, Cardano, Litecoin, and Polkadot is extracted from the coincapmarket.com Web site. The Dow Jones industrial average's stock price is from marketwatch.com Web site. The USD coin currency value is from the coinmarketcap.com Web site. The Wrapped Bitcoin's value obtains from the cryptoprices.com Web site. The data from the four different Web sites is extracted into the four different Excel sheets in one Excel workbook. Also, the change in percentage of the current price is extracted and compared to the price before 24 h. This attribute is used to perform the calculations on the streamed data.

To collect the real-time data, embed the Web site URL by clicking the Data tab under the "Get External Data" group, select "From Web." Provide the Web site URL in the "New Web Query" window to import the Web site's raw data. Similarly, import the raw data from other Web sites in separate sheets. Identify the selected cryptocurrency values and stock prices from the raw datasheets. The new sheet extracts the selected values from the four sheets using Excel formulae (Example: Sheet1!D155). The data in the new sheet is the cleaned data and is later used for the visualization. Then, set up the connection properties for live reloading for every one minute.

3.5 Insert Time stamp

Since the cryptocurrencies change dynamically in real time according to the market trend, the time stamp is included by using the visual basic for applications (VBA) script within the Excel using the shortcut (Alt+F11). The time is represented in the hh:mm:ss format in a 24 h clock. The time stamp is an essential attribute for the temporal data to represent the changes. The significance of the time stamp in this research is to identify the unique record of the data and the corresponding cryptocurrency price.

3.6 Append and Compute

After executing the above steps, the initial values of cryptocurrencies and stock prices are recorded in the respective columns' first row. The initial values are the values extracted from the Web site for the first time after execution. Then, append the values in the new row for every one minute. The new row may have two possible values. (1) The new price of the cryptocurrency or the stock is based on the market. (2) If the value is not changed, the previous value will be recorded at a new time stamp. In this way, the live stream data is recorded and appended in the Excel for further computations and analysis. In other words, the first column is filled with the initial values of all the cryptocurrencies. The second column is the time stamp. From the third column onward, consider the transpose of the first column cryptocurrencies to stream the given time stamp's respective values. For example, if the first column has ten cryptocurrency values, there will be ten respective columns from column #3 to #13. The pseudocode for appending streaming data is given in Algorithm 1.

Algorithm 1: Pseudo code for appending streaming data

```
Declare and initialize int LastFilledCell ← address of last filled cell in a
column
    ▷ N is total number of different crypto currencies or the number of values in
    the column one
for int i=0; i<=N.size; i++ do
    if LastFilledCell.value != N[i] then
        Append to LastFilledCell+1.value = N[i].value;
End
```

The change in the value of the cryptocurrency price is calculated based on the change in percentage value. The result is the value of the cryptocurrency before 24 h. The change in percentage value is streamed on the Web site and extracted during the data extraction phase. The calculated change in the value of the price will help the investor for better decision making. For example, the value of the Bitcoin at 14:20:00 is $20,000, and the percentage change is +2% compared to the previous day at the same time. The change in value is $400.

3.7 Merge and Aggregation

While capturing the Web sites' streaming data, aggregation functions are used and calculated the average, maximum and minimum values of the Bitcoin and the time stamp. In the VBA script, average, max, min functions of the `WorksheetFunction` class are used to calculate aggregation values. The computed values are merged in the original data and compared with newly added data to calculate the final results for streamed data.

3.8 Aggregation Results

The results derived from the aggregation step are compared with the newly streamed data to calculate the new maximum and minimum values. Consider the overall past data to recalculate the new average of the streamed data entry. The VBA pseudocode for aggregation results is given Algorithm 2.

Algorithm 2: Pseudo code for calculating aggregations on streaming data

```
Create a column named max in Excel
Declare and initialize int MaxColLastFilledCell ← address of last cell in max column
                                                  ▷ N is total number of different crypto currencies
                                                  ▷ column is size of a respective column
for (int i=0; i<=N.size; i++) do
    for (int j=0; j<=column.size; j++) do
        if MaxColLastFilledCell.value < N[i] then
            Append MaxColLastFilledCell.value = Max(column)
            Get timestamp and append

                                                  ▷ to find min
int MinValue ← 9999.
                                                  ▷ this will be declared in excel in min column cell 1
Declare and initialize int MinLastFilledCell ← address of last cell in min column
                                                  ▷ N is total number of different crypto currencies
                                                  ▷ column is size of a respective column
]for (int i=0; i<=N.size; i++) do
    for (int j=0; j<=column.size; j++) do
        if MinLastFilledCell.value > N[i] then
            Append MinLastFilledCell.value = min(column);
            Get timestamp and append

        ▷ To find Average Declare and initialize int AvgLastFilledCell ← address of last cell in average column
Append AvgLastFilledCell.value = Average(column)
                                                  ▷ column is size of a respective column
```

4 Results and Discussion

The cleaned data set is used in the speed layer for real-time views and then pipelined to the service layer. Visualizations and prediction analytics are performed in the service layer. For the real-time visualization of the cryptocurrencies' temporal data, the first

step is converting the macro-enabled Excel sheet into `.csv` files. The pseudocode for the conversion in VBA script is given in Algorithm 3. Then, the cleaned data in the .csv file is used to visualize on the web page. Papa Parse is used to parse the `.csv` files and `C3.js` to visualize. Papa Parse library is a fast and powerful CSV parser for the browser that supports Web workers and streaming large files. It is easy to use and parse `CSV` files directly to local or over the network. C3 is a JavaScript library that builds on top of D3. C3 makes it easy to generate D3-based charts by wrapping the code required to construct the entire chart. The pseudocode for visualizing streaming data using Papa Parse and `C3.js` is given in Algorithm 4.

Algorithm 3: This is a pseudo code for converting .xlsm to .csv file

```
Start:
Declare Excel.Worksheet ws;
Declare String SaveToDirectory;
Initialize SaveToDirectory as "Streaming-Visualization \ Web Visualization \data"
foreach ws in ThisWorkbook.Worksheets do
    ws.SaveAs SaveToDirectory & ws.Name, xlCSV
end
End
```

Algorithm 4: This is a pseudocode for visualizing streaming data.

```
Start:
functionparseData(createGraph)
Read the CleanedDataset.csv using Papa Parse library
Call createGraph (CleanedDataset.data)
End Function
functioncreateGraph(data)
                                        ▷ data is excel data from CleanedDataset.csv
Initialize time of an array type.
Initialize array variables for all the cryptocurrencies in CleanedDataset.csv
for var i = 1; i < data.length-1; i++ do
    Add the time stamp from the CleanedDataset.csv to time array
    Add cryptocurrencies data into its respective arrays
end
Generate multiline chart using c3 library taking time on X-axis and cryptocurrencies on Y-axis
functiontimedRefresh(timeoutPeriod)
                ▷ timeoutPeriod is the period of time in milliseconds for refreshing the webpage
                                ▷ Web page will reload for every 60 seconds i.e. 6000ms
End Function
End
```

The visualizations of the streaming data are shown in Figs. 3 and 4. These charts are dynamic, and the visualizations update every one minute. The web page is developed to automatically refresh every minute to update the data dynamically in the visualizations. The change in the cryptocurrency prices is temporal data as it changes according to the market trend. The resulted visualizations compare various cryptocurrencies in a multiline chart, and the Bitcoin's price change is presented in the line chart. The user can filter whatever the cryptocurrency they want to view. Figure 4 shows the line chart of Bitcoin's trend after filtering it from other cryptocurrencies. The real-time visualization can be viewed in the video [2], and the project artifacts can found in the GitHub repository [3].

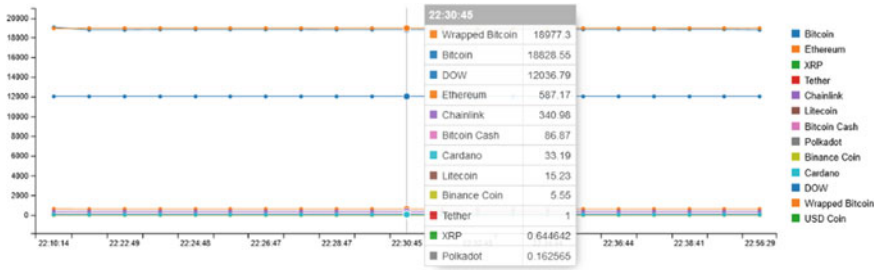

Fig. 3 Multiline chart for streamed data on a web page

Fig. 4 Line chart for Bitcoin streamed data on a web page

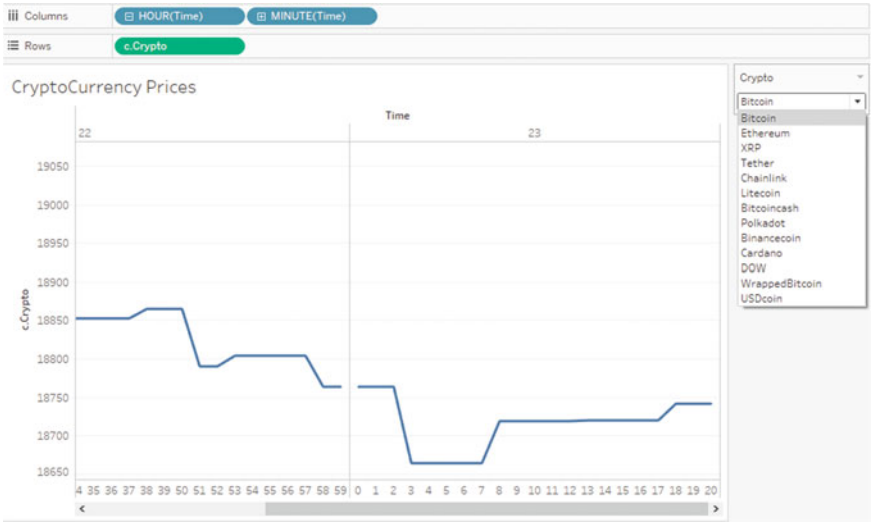

Fig. 5 Line chart for Bitcoin streamed data in tableau

On the C3 chats, the Y-axis represents the dynamic increment of the time stamp, and it changes as the new data arrived for every minute. The *X*-axis represents the cryptocurrency value that automatically adjusts based on the change in the prices. The tool tip in Figs. 3 and 4 shows the time stamp and the corresponding cryptocurrency

values at that instance. In tableau visualizations, the X-axis represents the time for every minute (0–59) for every hour. The Y-axis represents the cryptocurrency value. In Fig. 5 the line chart shows from 22:35 to 23:20. After 22:59, the new hour 23 started and continued to represent the data for every minute to visualize the streaming data's dynamic changes.

5 Conclusions and Future Work

Software systems that analyze the continuously generated data, also called streaming data, need to visualize in real time to make better decisions. This research presented a method to visualize cryptocurrencies in that lambda architecture for data streaming. The implementation method uses aggregations, append-only and simple response functions of data streaming for temporal data. The results show that the visualizations are updating for every minute dynamically. The implementation of the architecture and the artifacts are provided in the GitHub repository. In the future, this research will be extended to measure and reduce the latency along with the security aspects of the data streaming.

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An Overview of Layer 4 and Layer 7 Load Balancing

S. Rajagopalan

Abstract Load Balancing is a significant process to dispense the numerous types of traffic into various servers and clients. The key aim of load balancing is every single server must not be overloaded with tasks. Disseminate the network traffic through various routes would reduce the congestion in the network and it would reduce the latency of the servers. Actually, load balancing ensures the server's well-being. There is a high possibility of a server fall through when there is no load balancers assigned to servers. Load balancers enhance the overall proficiency of the servers and minimizing the load of the server by efficient traffic management. The OSI reference model characterizes four types of load balancing namely application, transport, network, and channel. This review article intends to analyze the pros and cons of layer 4 and layer 7 load balancing in the OSI reference model.

Keywords TCP (Transmission control Protocol) · UDP (User datagram Protocol) · HTTP (HyperText transfer Protocol) · HTTPS (Hypertext transfer protocol Secure) · OSI (Open systems Interconnection) · SMTP (Simple mail transfer Protocol) · ADC (Application delivery Controller) · Offloading

1 Introduction

In the present network scenario, websites are forced to handle numerous requests from clients. When a data center nears or reaches or exceeds the threshold level then it is considered a congested network [1]. A pool of servers must send back the proper images, audios and videos for these client requests. Mobile users receive a variety of services from clouds [2]. In order to satisfy the customer needs, more servers must be added. Load balancers behave like a traffic regulator just before the server to route all the client's requests [3]. The application delivery controller distributes the network traffic optimally across over used servers to less-used servers [4]. The vital function of ADC is load balancing. Load balancing can be done in different

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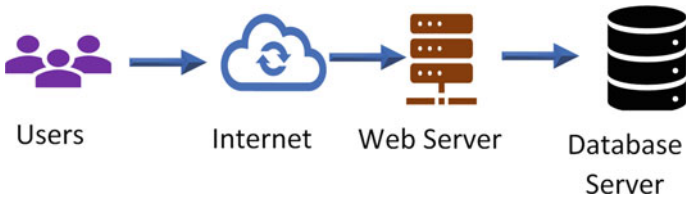

Fig. 1 User—web server connection without load balancing. *Source* https://www.esds.co.in/blog/types-of-load-balancing/

ways at layer 4 as well as layer 7 [5]. This layer 4 and layer 7 load balancing is based on the OSI reference model. Layer 4 uses TCP and UDP protocols and uses simple load balancing algorithms to balance the traffic among networks in order to avoid congestion [6]. It uses basic information like server connections and response time. Layer 7 load balancer works at the topmost layer of OSI reference model, i.e., it works on the application layer. Enhanced information known as header, content, cookies, URLs, and HTTP allows it to make the correct routing decision. Network services are utilized to manage network traffic and also provide data storage, manipulation, and communication services. Cloud provides a lot of storage area in a secured way [7]. Let us see the differences between Layer 4 and Layer 7 in forthcoming sessions.

1.1 Need for Load Balancing

Figure 1 shows the client-server connection without load balancing. Scalability is the principal problem in load balancing, despite many load balancers are introduced at several levels. Sometimes, sites may not be accessible due to imbalance load distribution. So obtaining optimal load and distribute it by using routing algorithms to achieve optimal functioning is still a challenge. Cloud bursting is one of the techniques to resolve load balancing issues in the cloud environment [8].

1.2 Variances of L7 and L4 Load Balancing

Layer 4 load balancing optimizes the traffic at the transport lever. It uses information such as ports and protocols to manage the traffic without checking the actual content of the messages. For simple packet-level load balancing this layer 4 load balancing is enough. Poor utilization of the resources may lead to congestion, so load balancing must be done properly [9]. It uses simple algorithms such as round-robin. It doesn't have the visibility of the content. Layer 4 never inspect the content or decrypt them to forward quickly as well as in a secure manner. So routing will not be based on media type, localization rules, etc.

It operates at the application layer. L7 load balancer uses protocols such as HTTP, HTTPS and SMTP. L7 finalizes the routing with respect to the message's subject. Layer 7 load balancer inspects messages and the routing decision is taken based on the content of the message. It can terminate traffic, perform decryption and provide end-to-end security. L7 load balancer creates new TCP connection to the upstream server. TCP may have issues in high-speed networks due to packet loss [10].

The need for encryption reduces the performance at Layer 7. But this can be almost neutralized by the user of SSL offload functionality. L7 load balancing enables context sensible networking. It increases server efficiency by sending all client request to the same server. The visibility at the packet level allows content caching. L7 load balancer provides intelligence to handle piggyback or multiplex requests onto a single connection. This reduces the overhead and optimizes the traffic.

On the whole, layer 4 load balancing is meant for applications that do not access HTTP and layer 7 load balancing is a request/reply service [11].

1.3 ADC Load Balancing

Layer 7 load balancers offer intelligent routing decisions with more functionality. Its visibility and application awareness enable intelligent routing, optimizations, and performance enhancement. For example, The user can access the correct content version according to the language indicated in the browser header. This gives best experience for any user, device, and site. ADC load balancing from L4 to L7 addresses a variety of client needs for diverse applications.

ADCs provide advanced layer 4 to layer 7 load balancing and provide high availability and business continuity. It enables fast response time with optimal and intelligent traffic distribution by customizing traffic such as blue/green traffic. The SSL/TLS offloading techniques further optimize application performance.

At layer 4 the load balancer delivers the traffic by knowing the limited network information like ports and protocols and uses simple algorithms like round robin. It delivers the traffic by calculating the best destination path.

In layer 7, load balancer having awareness about applications. It can make complex and informed load balancing decisions with this additional information. By knowing the protocol such as HTTP, it can easily identify client sessions based on cookies.

Layer 7 load balancer can balance the traffic based on the content. For e.g. If any request from the client and requesting for images, that request can be diverted to the server having images. This will reduce the load on application server. The load balancing in OSI and TCP reference models are depicted in Fig. 2.

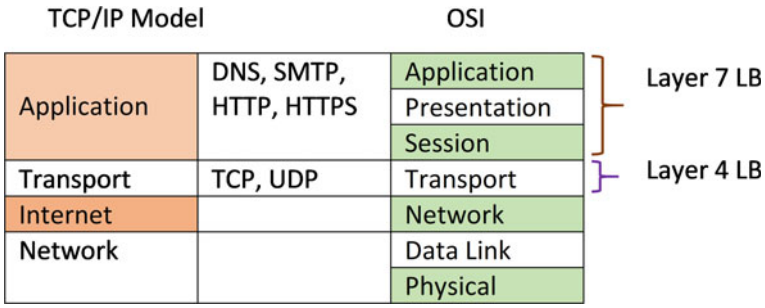

Fig. 2 Load balancing in OSI and TCP models. *Source* https://freeloadbalancer.com/load-balancing-layer-4-and-layer-7/

2 L4 Load Balancing Architectures

In layer 4 load balancer uses TCP and UDP protocols at transport level. Layer 4 load balancer decides the route based on IPs and TCP or UDP protocols. It can view the traffic between client and server as packet. It will take the routing decision for each packet.

In layer 4 connections are established between the client and the server using simple load balancing algorithms. It is fast but it can't do anything on the protocol above layer 4. The fastest layer 4 load balancer uses an ASIC for routing decisions.

List of possible architectures for L4 load balancing are Network Address Translation (NAT), IP Tunnel and Direct Server Return.

2.1 Network Address Translation (NAT)

Client and server packet transmission routing will be done by the load balancer in Network Address Translation (NAT) mode. In this client-server network, a TCP connection is created to forward the network load to the intended server. A server is selected after a group of servers, then it will send the packet to the newly identified server with an altered address. The TCP connection and Dataflow are shown in Fig. 3.

Employment of NAT In a transmission NAT can be implemented, when a response time needs to be intensified when there is no necessity for response time, where there won't be any bottleneck in the future, and where there is a need for a default gateway of the servers to be changed.

Strengths Load balancing will be done in a faster manner. The deployment is very straightforward and simple.

Weaknesses For reverse NAT procedures, server entry points need to use load balancers. According to the load balancer output capacity, the output bandwidth is limited [12].

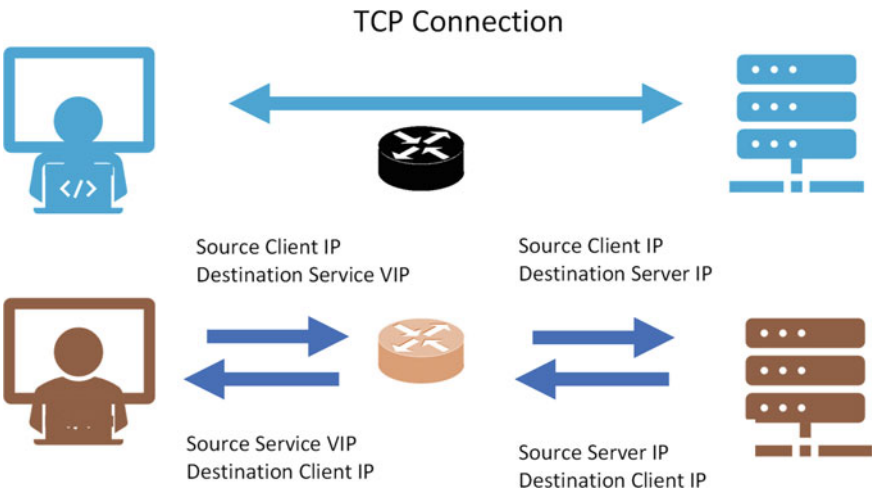

Fig. 3 NAT: TCP connection and data flow. *Source* https://www.haproxy.com/blog/layer-4-load-balancing-nat-mode/

2.2 Direct Server Return (DSR)

In Direct Server Return (DSR), the MAC address will be changed by the load balancer. It won't change anything except MAC. After this point, client and server will have direct contacts and there is no need for any load balancer. The TCP connection and Dataflow are shown in Fig. 4.

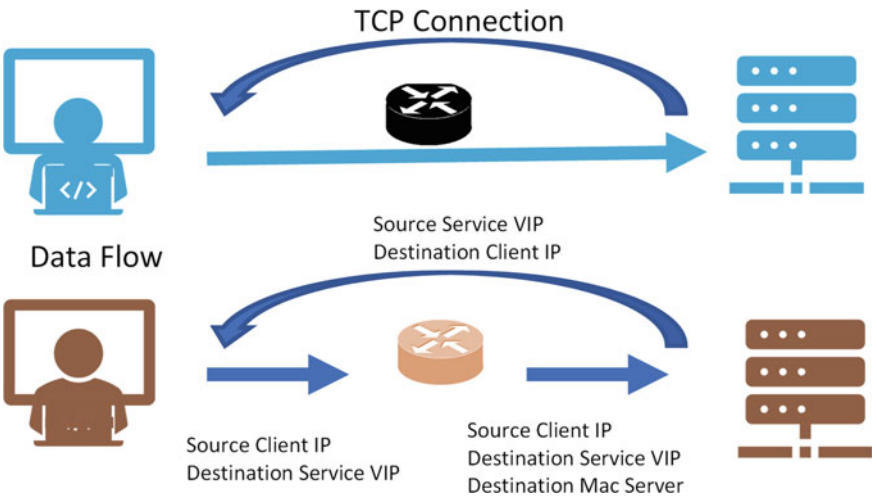

Fig. 4 DSR: TCP connection and data flow. *Source* https://www.haproxy.com/blog/layer-4-load-balancing-direct-server-return-mode/

In layer 4 load balancing, the TCP connection is established at the backend. But the request passes through the load balancers. The requests by clients are seen by the load balancers and the destination address will be changed.

Employment of DSR DSR implementation is also similar to the NAT.

Strengths Load balancing is performed in the fastest mode. The Sum of each backend bandwidth is the total output bandwidth. Bottleneck will not be created due to the bandwidth of the load balancer. Less intrusive as compared to the layer 4 load balancing.

Weaknesses Service VIP must be configured on each system looping boundary. It should not answer ARP requests. There are no layer 7 advanced characteristics [13].

2.3 IP Tunnel Mode

IP Tunnel mode and DSR mode are somewhat similar up to a certain extent. The users' requests are processed by the master when it receives from the load balancer. Afterward, the clients will receive a reply straight away from the servers. In IP tunnelling, the load balancer compresses a demand and sends it to the master. IP tunnelling helps to direct the traffic between the service user and the server. The TCP connection and Dataflow are shown in Fig. 5.

Employment of IP Tunnel mode Routing is the only way to access the backend servers. The rest of the scenarios is similar to NAT and DSR.

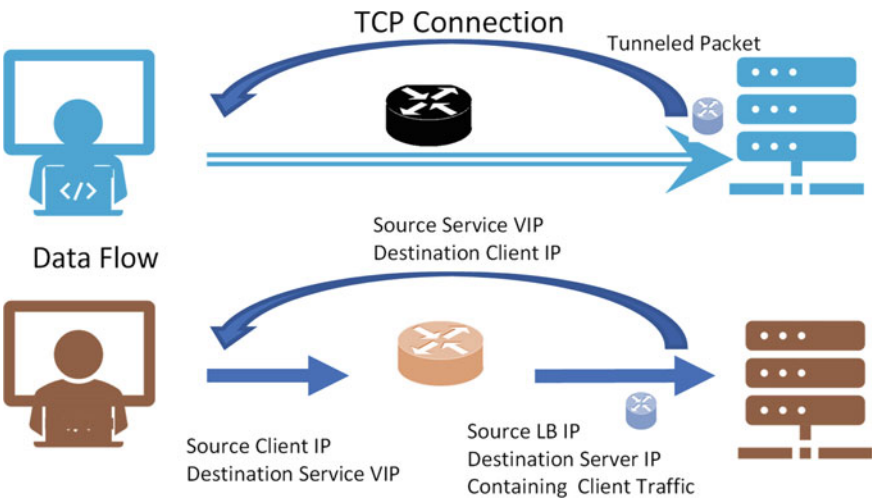

Fig. 5 IP tunnel mode: TCP connection and data flow. *Source* https://www.haproxy.com/blog/layer-4-load-balancing-tunnel-mode/

Strengths Multiple datacenters' backends could be utilized. The other strengths are alike DSR.

Weaknesses It requires a patched backend so that it will be able to tunnel the IP traffic. There are no layer 7 advanced features available [14].

3 L7 Load Balancing Architectures

Layer 7 is related to the 7th layer of the OSI model, i.e, application level. Example HTTP, FTP, SMTP, DNS protocols. Layer 7 load balancer makes the routing decisions based on IPs, TCP, or UDP ports. It can get any other information from the application protocol (mainly HTTP) and takes the routing decision. Even this kind of process seems to be slow, but actually, it took less than a millisecond.

Proxy mode is the only architecture with two main flavours, namely Proxy Mode and Transparent Proxy Mode.

3.1 Proxy Mode

This is also called as reverse-proxy. All transactions between the user and the server are passing through the load balancer. If a TCP connection is meant for user, here load balancer behaves like a master. So request-reply will be done properly by the load balancers to the clients. If a TCP connection is meant for the server, load balancer behaves like a service user from the master server. Without any modifications, the client-server technology works well. The TCP connection and Dataflow are shown in Fig. 6.

Load balancer upholds two TCP connections as shown in the diagram.

Employment of Proxy mode This method can be realized when the app does not bother about client's IP address, when the application layer needs to work smartly, and to secure an application.

Strengths There is no direct server access mode, so it will be secured. This method allows protocol authentication and verification. Load balance is possible even in the case of client and server are in the same subnet.

Weaknesses Comparatively slow load balancing done in this method than layer 4. Only IP address can be seen by the backend servers [15].

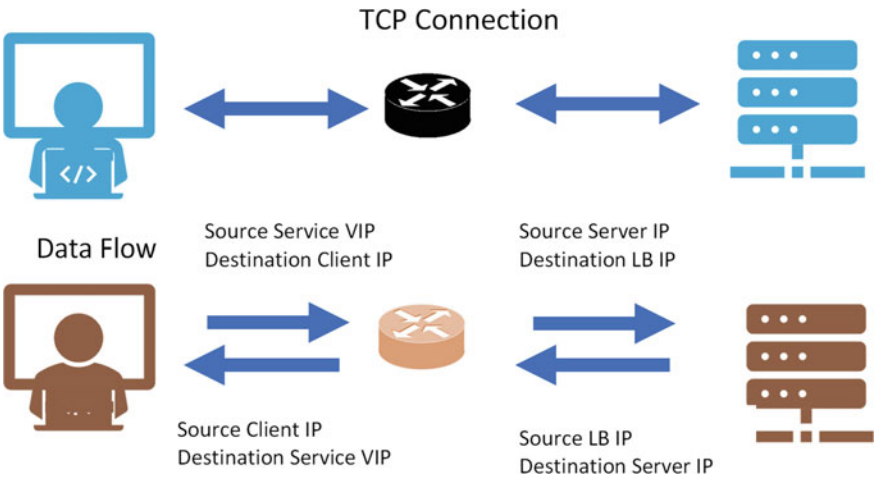

Fig. 6 Proxy mode: TCP connection and data flow. *Source* https://www.haproxy.com/blog/layer-7-load-balancing-proxy-mode/

3.2 Transparent Proxy Mode

It is almost like the proxy mode, but it differs in a way that the load balancer uses request machine's IP as request origin machine's IP.

A load balancer and two TCP connections are shown in the above figure. Here, server happens to use the load balancer as a default gateway because load balancer commences TCP connection with server by IP address of a client. Or else the server would reply to a client straightaway but client will decline it. The TCP connection and Dataflow are shown in Fig. 7.

Employment of Transparent Proxy mode This method can be utilized whenever a network layer level load balancing facility is required for a client IP, when content switching desirable, and to safeguard an application.

Strengths Client IP will be notified by server in network layer. The rest are similar to the Proxy Mode.

Weaknesses It is a very intrusive method because there must be a variation in gateway of the default server and slower than the layer 4 load balancing. The clients and servers should not be in the same subnet and it must be indifferent subnets [16].

4 Conclusion

Layer 4 and Layer 7 load balancing methods, advantages and disadvantages are discussed in this article. Load balancing will improve server uptime. Layer 4 and

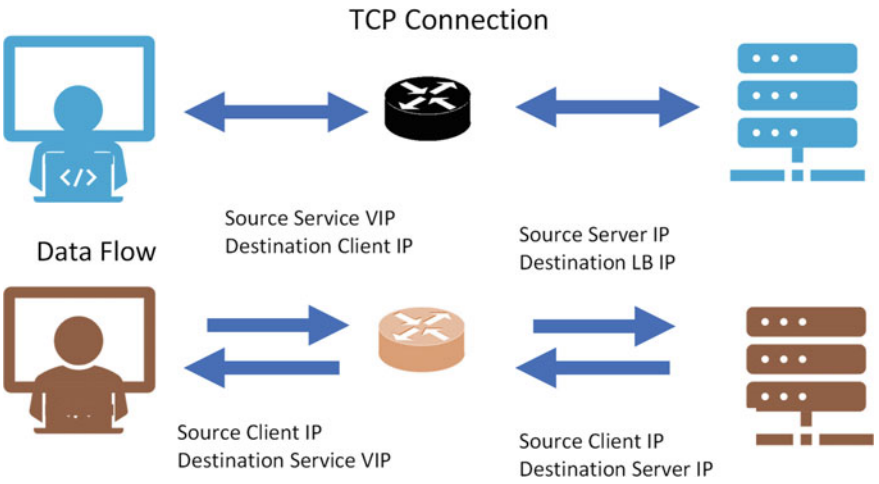

Fig. 7 Transparent Proxy mode: TCP connection and data flow. *Source* https://www.haproxy.com/blog/layer-7-load-balancing-transparent-proxy-mode/

Layer 7 load balancing are provided by ADC to ensure fast, reliable, and secured communication without any discontinuity. Even a one connection failure may lead to multiple logical connections failure [17]. The primary goal of this load balancing method is to achieve ideal traffic dispersal or personalized traffic dispersal. SSL/TSL computation offloading method impacts positively to obtain the optimal distribution of the network traffic. It's very difficult to ascertain which balancing method is the best to be practiced. It can be decided according to the unique demand of the network traffic and it will resolve the security issues.

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Integration of IoT and SDN to Mitigate DDoS with RYU Controller

Mimi Cherian and Satishkumar Verma

Abstract Internet of Things is an upcoming technology, where IoT devices are interacting with cloud over Internet. Large number of IoT devices generate exponential amount of data that creates a huge impact on storage, network elements and specifically on the security and analysis of data. Recent research indicates that there should be a change in the networking paradigm to inculcate the dynamic demands of IoT environment. The network security issue like distributed denial of service [DDoS] attacks are of major concern, and its mitigation at the earliest remains vital. In IoT-related environment, the security issues of traditional network have major impact in IoT application domain. The IoT-related data that are depending on domain of application can be time sensitive or highly confidential, and hence, it arises the need to change the paradigm of traditional network. The expectant network should be more secure and flexible to detect and mitigate the network attacks. IoT environment with software-defined network seems to be promising enough to reduce many security issues with respect to IoT in traditional network environment. The proposed research work has created a test bed that collects IoT live data and sends it through secure SDN into the cloud platform.

Keywords SDN · IoT · Security · DDoS · Network

1 Introduction

Internet of Things as already known it is an evolving technology, which is having an increasing impact in domains like manufacturing and automation industries, health care, transportation and many more fields. The true potential of IoT can be achieved when existing traditional network paradigm evolves to meet the dynamic requirements of IoT environment. In traditional network, many security issues were

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found like sidechannel attack, denial of service, distribute denial of service, Sybil, blackhole, code injection and many more. The solution for each of these attacks is different and needs to be mitigated separately as traditional network is not flexible enough to adapt to these changes. Hence, improving the existing countermeasures would not be sufficient to resolve security issues in IoT. Recent research suggests to change the approach of resolving IoT network-related issues by implementing proactive measures to resolve network security issues. Many of the security issues in IoT can be reduced if traditional network was more flexible, dynamic and proactive in nature with respect to security and scalability of network [1]. Software-defined network allows IoT network to be managed dynamically also provides flexibility to enhance security in IoT networks by creating applications to prevent, detect and react to threats. SDN decouples the data planes and control plane in a network. Decision-making in SDN is done by control plane, and data forwarding is handled by switches. SDN allows centralized programming of networking and can be managed more easily.

1.1 Structuring of Paper

Section 2 will be the briefing of work done by different researchers that promise the SDN, and IoT integration is new direction of research to change existing network framework for meeting the upcoming demands of IoT applications. The related work has motivated to create an experimental architecture for SDN and IoT integration.

Section 3 will be briefing of work done in DDoS detection and mitigation in SDN environment thus leading to development of a secure SDN framework for IoT.

Section 4 will have architecture of SDN and IoT integration. The subsequent sub-sections are the technical aspects for implementation of IoT test bed, implementation of SDN test bed and setting up cloud platform ThingsBoard is briefed.

Section 5 is simulation of DDoS attack and its mitigation using sFlow-RT to detect DDoS attack, and this flow is given to RYU Controller's Northbound API for mitigation.

2 Related Work in SDN and IoT Integration

The related work section will be considering the research papers that are assuring that IoT and SDN integration is promising paradigm for future of IoT. Many researchers have suggested that integration of software-defined network with Internet of Things has great potential [1–3]. The advantages of SDN and IoT integration are recognized in many domains like smart grid settings, smart homes or smart transportation. SDN-IoT integration is also provides security in IoT, because security mechanisms can be implemented easily and network can be more scalable by implementing SDN-IoT integration [4–8].

Jararweh et al. [5] proposed a SDIoT software-defined-based framework model to address the challenges in the traditional IoT architecture to secure and store the data from IoT objects by sending through software-defined network.

The authors in [6] proposed an architecture that applies SDN technology into the IoT such that it improves the security of the IoT. The simulation experiment was provided with the architecture model that can effectively improve the security of the IoT.

The authors in [5] proposed a framework to provide flexible and scalable IoT network that are benefits of SDN. The framework focused on the machine to machine (M2M) transactions.

The work in [7] shows that software-defined techniques can have better network control, especially in IoT networks, such that it can provide better robust and vigorous solutions.

The work in [8] shows the performance difference between SDN-enabled network and traditional networking architecture. This paper helps in designing and implementing SDN test bed for the current research. The literature survey in related work provided research and scope in this domain that has influenced to create a potential experimental test bed for the current research.

3 Related Work of DDoS Attack Detection and Mitigation

Distributed denial of service attack can occur in different forms but they all try to flood the network. DDoS can even saturate the network and disrupt from further functioning of network. The attack takes place by flooding of ICMP, UDP and TCP SYN packets. The compromised host attacker will try sending packets to victim host through switch. The controller update the flow table based on request. Once the request is granted, the network is immediately brought down as the attacked host motive was to flood the network toward victim. There are many techniques to mitigate DDOS attack researched and few will be discussed in this section.

In paper [12], authors have discussed emulation of SDN network and in real-time detection and mitigation of DDoS attack using sFlow and Mininet.

In paper [13], authors have used algorithm for measuring entropy that is randomness in network using Shannon's entropy equation. The entropy values change based on DDoS attack. The setup is done using POX controller, Raspberry pi and OpenVSwitch.

The authors of paper [14] have proposed defence mechanisms used are ingress, egress and pushback to validate the legitimacy of packets in DDOS attack. Attacker is identified by applying ingress filtering in same domain and pushback for another domain.

The authors of paper [16] use the concept of entropy and detect whether the network flow is abnormal. BiLSTM-RNN neural network algorithm is used to train dataset thus identifying real-time DDoS attack and reduces overhead on controller.

The authors of paper [17] proposed a secure SDN-based IoT framework. This framework is called SoftThings, and it is used to detect abnormal activities and attacks at the earliest and mitigate it. SDN controller uses concepts of machine learning to monitor the network behaviour. The testing environment is created on mininet emulator.

The authors of paper [6] have utilized the combination of the neural network and the support vector machine. These concepts are used to detect and the classification method for the DDOS attacks in the telecommunication network. NS-2 is used for implementation of the project.

4 IoT-SDN Test bed Architecture and Setup

Many research papers in related work section suggest that SDN and IoT integration seems to be promising environment due to flexible and programmable network providing a centralized view of network. The implementation of a experimental test bed for these two unique domains is done in three sections. First section will be creating IoT test bed, second section will be creating SDN test bed, and third section will be integrating both the domains with cloud platform.

The architecture of IoT-SDN test bed is shown in Fig. 1 that has end-to-end connectivity. Starts from collecting the real-time sensor data from live IoT environment and sending the data through SDN network to IoT dashboard on cloud platform Thingsboard.

The Iot test bed will be executed with necessary hardware components. The SDN environment can be executed based on the topology required that consists of RYU controller and respective IoT gateways and hosts.

4.1 IoT-Test bed Setup

The motive of IoT test bed is to capture live sensor data and send it through IoT gateway. IoT test bed can be created using Arduino or Raspberry pi based on scope of the project. The micro-controller is then connected with different sensors as per the project requirement, and currently, it is required to collect the temperature and humidity data; hence, in Fig. 1, the DHT11 sensor is used. The coding for circuit is executed in Fig. 2. These data collected from DHT11 can be used to create .csv file with required amount of live data for dataset.

4.2 SDN-Test bed Setup

The SDN setup is done in an Ubuntu 18 operating system that is installed in a virtual machine. Flat tree topology is created in SDN network which currently consists of IoT gateway, host and controller. The switches used will be OpenFlow-enabled switches that will be connected with RYU controller. The topology is created in mininet. Mininet has better features for simulation of topology as discussed by researchers in related work section. Mininet is integrated with sFlow as sFlow can provide network data statistics. Mininet enables us to create multiple hosts and Web servers that can interact through RYU controller. IoT gateways will have IoT protocols like CoAP or MQTT so that it can transfer data from IoT test bed to IoT cloud platform through SDN network. The IoT gateway and hosts are built in mininet topology. An add on of mininet dashboard is used in sFlow-RT so they can communicate with each other and provide the network flow statistics. In further sub-sections, the installation and working of mininet, sFlow-RT and RYU controller will be done.

Mininet Mininet is installed as it is the most utilized platform for SDN topology building. In mininet, the desired topology with multiple hosts and controllers can be created. Currently, in this scenario, four hosts and three switches are considered for flat tree topology. As per further requirements, these switches and hosts count can be increased as mininet is scalable and easy to configure. In Fig. 3, the topology setup is shown with four hosts and three Openflow-enabled switches. One host will be used as IoT gateway that has either MQTT or CoAP protocol based on application domain of IoT. These protocols are currently used in research [9] to send data to ThingsBoard.

sFlow-RT The sFlow-RT setup is done, and an add on of mininet dashboard is done in it. Integration of sFlow with mininet such that topology created in mininet can be viewed and monitored in sFlow-RT. sFlow-RT provides GUI port statistics which helps in analysing the flow traffics within the topology created in mininet showed in Fig. 4.

sFlow is an open-source platform for network-related statistical and real-time-based traffic sampling technology for monitoring traffic. It has better GUI to see traffic pattern and network performance. sFlow will be needed in Fig. 1 test bed as later in the project, DDoS attack detection is required for which sFlow would be helpful.

4.2.1 RYU Controller

Ryu controller is most widely used controller by researchers to design SDN network [10]. RYU controller is used in this test bed as it is an open-source SDN controller. The script for controller written in Python code supports Openflow switches and many other protocols. It also supports compatibility in creation of well-defined API.

As RYU controller is compatible with OpenFlow switches, Hewlett Packard, IBM and NEC are tested and certified with Ryu controller. It also supports the OpenFlow

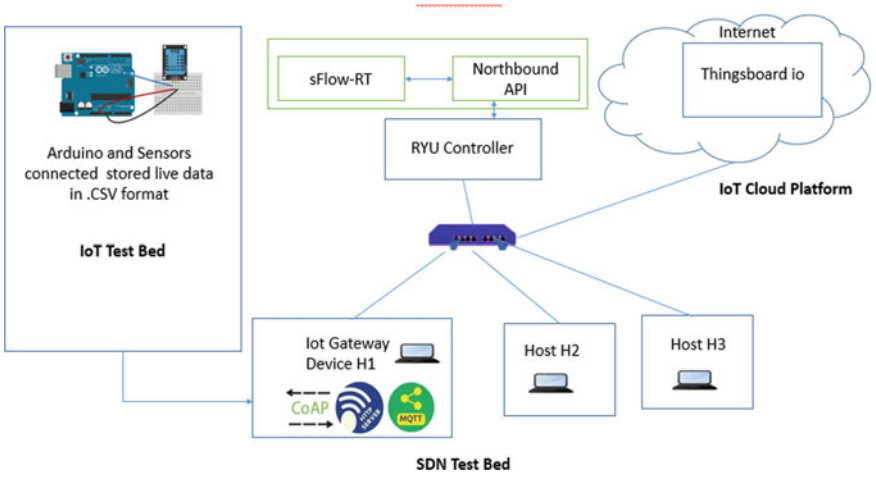

Fig. 1 IoT-SDN test bed

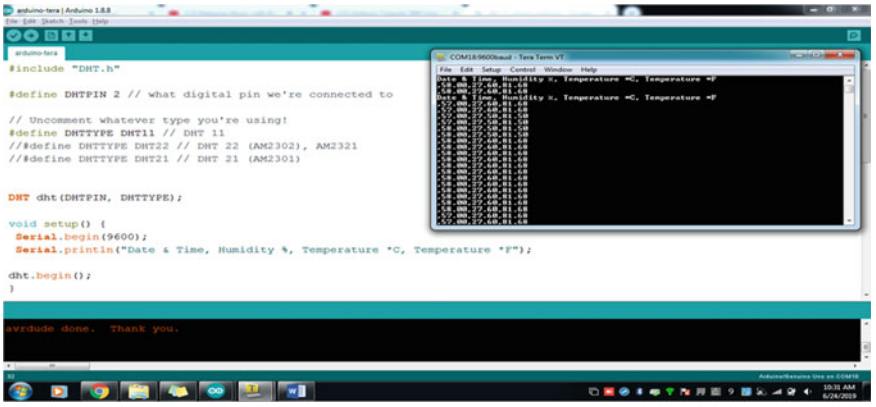

Fig. 2 Arduino code execution

protocol up to the latest version 1.5 [2]. Ryu controller keeps track of all new and old flow in the network thus monitors the switches connected to it. The Ryu controller is installed and initiated in Fig. 5.

4.3 Thingsboard Cloud Platform

ThingsBoard is based on the Java eight platform. It provides the user with a interface to register and manage devices connected. The credentials can be user-defined strings

```
Connecting to remote controller at 127.0.0.1:6653
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3 h4
*** Adding switches:
s1 s2 s3
*** Adding links:
(h1, s2) (h2, s2) (h3, s3) (h4, s3) (s1, s2) (s1, s3)
*** Configuring hosts
h1 h2 h3 h4
*** Starting controller
c1
*** Starting 3 switches
s1 s2 s3 ...
*** Enabling sFlow:
s1 s2 s3
*** Sending topology
*** Starting CLI:
```

Fig. 3 Mininet topology

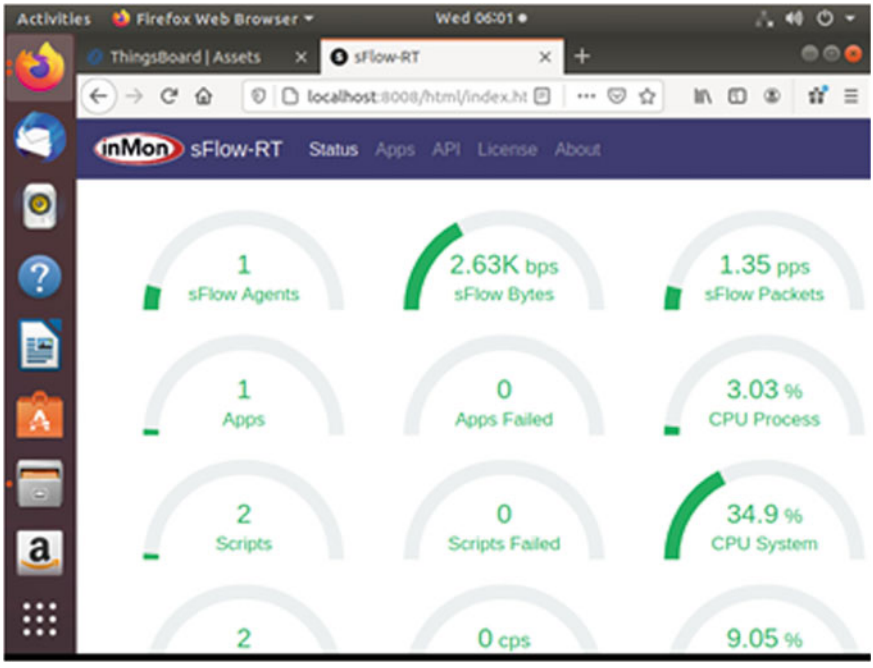

Fig. 4 sFlow GUI

```
\$ ryu-manager l4_switch.py ryu.app.ofctl_rest
loading app l4_switch.py
loading app ryu.app.ofctl_rest
loading app ryu.controller.ofp_handler
instantiating app None of DPSet
creating context dpset
creating context wsgi
instantiating app l4_switch.py of L4Switch13
instantiating app ryu.controller.ofp_handler of OFPHandler
instantiating app ryu.app.ofctl_rest of RestStatsApi
(19185) wsgi starting up on http://0.0.0.0:8080
```

Fig. 5 Ryu controller

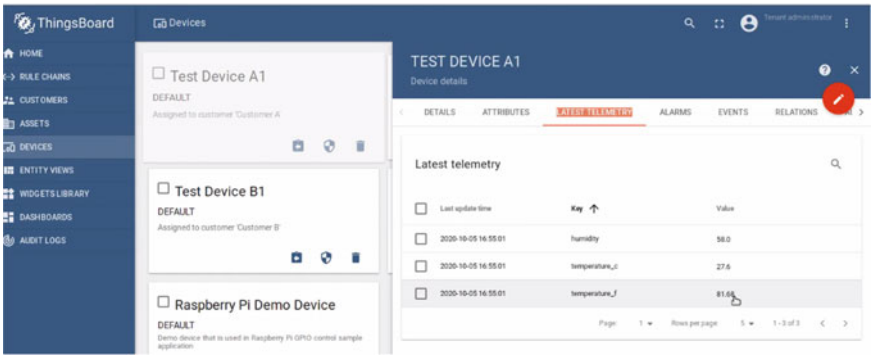

Fig. 6 ThingsBoard result

called access tokens or X.509 certificates. It stores data received from devices as telemetries of data associated to specific device [11].

The ThingsBoard is cloud IoT platform configured to upload data from IoT environment Fig. 6. The unique key value provided by this platform is given along with protocol for uploading the data. At the end of execution of whole test bed in dashboard, the view of Iot data is visible. The setup required to set up the test bed for SDN and IoT integration is summarized in Fig. 7.

5 DDoS Attack and Mitigation Simulation

There are possibilities that in normal network, attacks like denial of service or distributed denial of service attack can take place. In such cases, the attack detection and mitigation in traditional network are time consuming also causes loss of data. When such unreliable network is used for sending time-sensitive data of Iot domain security is great concern. In the proposed architecture with SDN and Iot integration, such attacks are more efficiently detected and mitigated. In current test bed for

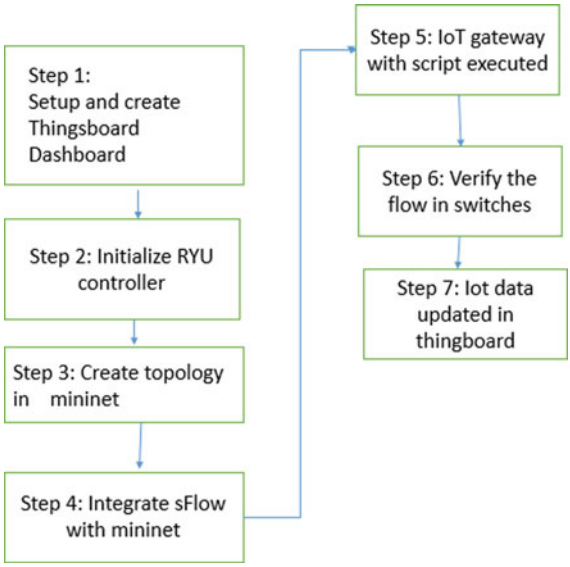

Fig. 7 Summarized steps of test bed setup

```
containernet> h1 hping3  -S -p 80 -c 10000  h4
HPING 10.0.0.4 (h1-eth0 10.0.0.4): S set, 40 headers + 0 data bytes
len=40 ip=10.0.0.4 ttl=64 DF id=14449 sport=80 flags=RA seq=0 win=0 rtt=19.7 ms
len=40 ip=10.0.0.4 ttl=64 DF id=14605 sport=80 flags=RA seq=1 win=0 rtt=11.6 ms
len=40 ip=10.0.0.4 ttl=64 DF id=14659 sport=80 flags=RA seq=2 win=0 rtt=11.4 ms
len=40 ip=10.0.0.4 ttl=64 DF id=14717 sport=80 flags=RA seq=3 win=0 rtt=11.3 ms
len=40 ip=10.0.0.4 ttl=64 DF id=14948 sport=80 flags=RA seq=4 win=0 rtt=11.2 ms
len=40 ip=10.0.0.4 ttl=64 DF id=14954 sport=80 flags=RA seq=5 win=0 rtt=15.0 ms
len=40 ip=10.0.0.4 ttl=64 DF id=15018 sport=80 flags=RA seq=6 win=0 rtt=18.5 ms
len=40 ip=10.0.0.4 ttl=64 DF id=15150 sport=80 flags=RA seq=7 win=0 rtt=10.4 ms
len=40 ip=10.0.0.4 ttl=64 DF id=15291 sport=80 flags=RA seq=8 win=0 rtt=34.3 ms
len=40 ip=10.0.0.4 ttl=64 DF id=15481 sport=80 flags=RA seq=9 win=0 rtt=19.7 ms
```

Fig. 8 TCP attack

```
~/mimi $ env "RTPROP=-Dscript.file=$PWD/milestone1/sflow/ddos.js" sflow-rt/start.sh
2020-10-05T16:46:33+05:30 INFO: Starting sFlow-RT 3.0-1519
2020-10-05T16:46:34+05:30 INFO: Version check, running latest
2020-10-05T16:46:35+05:30 INFO: Listening, sFlow port 6343
2020-10-05T16:46:35+05:30 INFO: Listening, HTTP port 8008
2020-10-05T16:46:35+05:30 INFO: /home/suresh/mimi/milestone1/sflow/ddos.js started
2020-10-05T16:46:35+05:30 INFO: app/mininet-dashboard/scripts/metrics.js started
2020-10-05T17:00:29+05:30 INFO: TCP SYN Attack
2020-10-05T17:00:29+05:30 INFO: blocking 10.0.0.1,10.0.0.4,80,000000010
```

Fig. 9 sFlow attack blocked

simulation of DDoS attack, the traffic can be created using TCP, ICMP or UDP packets. In Fig. 8, TCP packet is flooded in the network between host h1 and h4.

Currently, RYU controller is monitoring the network for adding flow rules and in parallel sFlow-RT is keeping watch over network. In Fig. 9, the API on Ryu controller has detected the TCP flood packets and added the new flow rule to block. The log

```
2020-10-05T16:46:35+05:30 INFO: app/mininet-dashboard/scripts/metrics.js started
2020-10-05T17:00:29+05:30 INFO: TCP SYN Attack
2020-10-05T17:00:29+05:30 INFO: blocking 10.0.0.1,10.0.0.4,80,000000010
2020-10-05T17:02:10+05:30 INFO: unblocking 10.0.0.1,10.0.0.4,80,000000010
```

Fig. 10 sFlow unblocked

```
sudo ovs-ofctl -O OpenFlow12 dump-flows s1
OFPST_FLOW reply (OF1.2) (xid=0x2):
 cookie=0x0, duration=765.496s, table=0, n_packets=618, n_bytes=49614, priority=0 actions=CONTROLLER:65535
sudo ovs-ofctl -O OpenFlow12 dump-flows s3
OFPST_FLOW reply (OF1.2) (xid=0x2):
 cookie=0x0, duration=766.673s, table=0, n_packets=400, n_bytes=33411, priority=0 actions=CONTROLLER:65535
sudo ovs-ofctl -O OpenFlow12 dump-flows s2
OFPST_FLOW reply (OF1.2) (xid=0x2):
 cookie=0x0, duration=11.285s, table=0, n_packets=1108, n_bytes=46536, priority=4000,udp,in_port=1,nw_dst=10.
0.0.3,tp_src=53 actions=drop
 cookie=0x0, duration=855.173s, table=0, n_packets=629, n_bytes=50802, priority=0 actions=CONTROLLER:65535
```

Fig. 11 Ryu manager

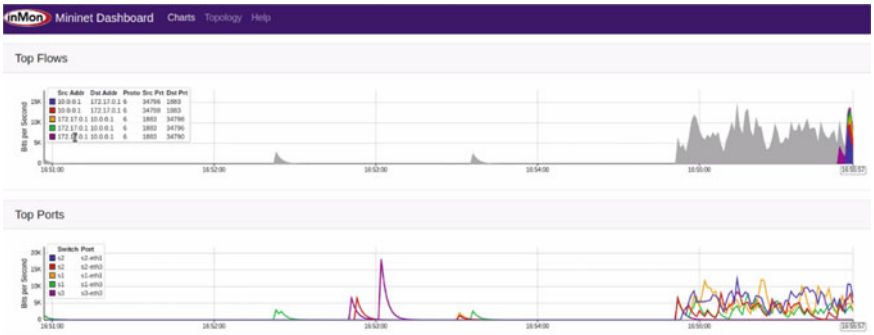

Fig. 12 DDoS detection in sFlow

record of sFlow shows that TCP SYN attack was detected, and it was blocked. The controller flow rule took action of blocking the switch flow with DROP as action.

sFlow keeps watch on network after blocking it checks every 10 s whether attack has stopped. Once the attack has stopped and no more packets are flooded in network, then the rule is unblocked and normal traffic flow is allowed between these hosts. In Fig. 10, it can be seen that in sFlow-RT log the unblock request is handled.

Similarly, UDP attack can be blocked as well. In Fig. 11, RYU manager it can be seen that both TCP and UDP attacks were taken place, and later, they were blocked by the API created.

In Fig. 12, it can be seen that in sFlow-RT, there are peaks of network traffic due to DDoS attack. In Fig. 13, the peaks are reduced and DDoS mitigatio is done. sFlow detects the DDoS attack and informs the controller through Northbound REST API which blocks the flow of traffic. Later, after a time interval, it reconfirms if attack not taking place then acceptance flow rule added and its unblocked as well.

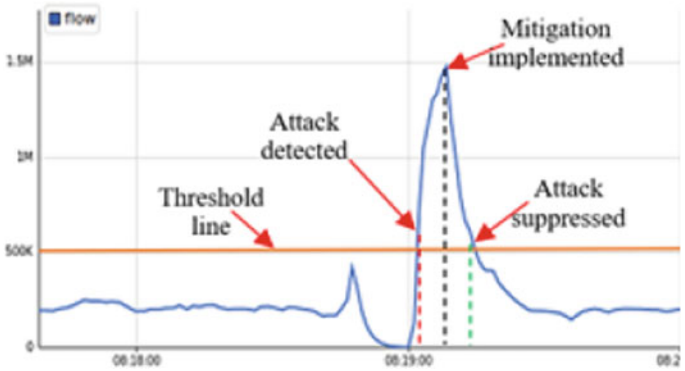

Fig. 13 DDoS detection and mitigation

6 Conclusion

In the test bed created for IoT-SDN-cloud integration, it enables the user to send end to end starting from collection of raw data from live IoT environment to cloud using SDN as backbone network. The advantages of SDN and IoT integration are recognized in many domains like smart grid settings, smart homes or smart transportation. SDN-IoT integration is also provided security in IoT, because security mechanisms can be implemented easily. The sFlow-RT can monitor the attacks and inform Northbound REST API over RYU controller. The Northbound API is programmable to mitigate these attacks. The test bed provides scope for many researchers to do further research or analysis on different network parameters like comparative study between different SDN controllers, IoT protocols or scope of API for resolving different security issues and load balancing.

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Low Rate Multi-vector DDoS Attack Detection Using Information Gain Based Feature Selection

R. R. Rejimol Robinson and Ciza Thomas

Abstract The number of connected devices is exponentially growing in the world today and they need to work without having any interruption. This scenario is very challenging to cybersecurity and needs proper attention of network administrators, service providers, and users. Implementing security frameworks in this scenario is very difficult because attackers are using very sophisticated easy to operate weapons to launch huge attacks such as Distributed Denial of Service. Intelligently detecting and mitigating the attacks in the network requires the use of machine learning algorithms. This work proposes a strategic way involving feature selection based machine learning for the detection of stealthy attacks. The detection system works by performing ınformation gain-based feature selection as a preprocessing step. This ensures case-based preprocessing of each attack vector present in the traffic and is proved to be effective empirically. The proposed method has been tested using two supervised machine learning classification algorithms, namely Random forest and J48. The evaluation results show that the Random forest algorithm gives a satisfactory True Positive rate of 99.6% in detecting stealthy layer 7 attacks. The overall accuracy obtained is 99.81%. This approach causes the algorithms to exhibit improved performance while doing classification.

Keywords Machine learning · Feature selection · Low rate attacks · Information gain · Stealthy attacks · Network security

1 Introduction

The digitally connected modern world demands uninterrupted connections, even the disruptions are unavoidable. Distributed Denial of Service (DDoS) attack is one such

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annoyance that makes an online service unavailable. Its impact is devastating unless it is detected and mitigated properly. Formally, define the DDoS as a cyber-attack launched with overwhelming traffic from multiple sources to make the target machine (server) or other network resources unavailable to its intended users temporarily or indefinitely. So it is impossible to stop the attack by simply blocking a single source of the attack. It is the responsibility of network administrator to monitor and supervise their network and guarantee the proper functioning of the network.

There are several strategies for launching an attack and the most prevalent used in these days are zomby attacks or otherwise known as botnet attack. The attack is carried out by a handler that infects vulnerable hosts and recruits them for their purpose. These machines are called zombies on the ınternet and under the control of the handler, zombies are directed to launch an attack by bombarding false packets towards a target to limit its performance or crash it.

Instead of depending on traditional methods of DDoS detection based on Firewalls and Intrusion Detection System (IDS), it is desirable to switch on to machine learning and deep learning based detection strategies. The detection and mitigation system needs to be more agile and intelligent as the attacks are getting more and more sophisticated. But the performance of algorithms is affected due to massive and high-dimensional data received in real-time. Worldwide Infrastructure Security Report by Netscout declared that hackers entered into the era of terabit attacks. According to them, 1.7 TBPS DDoS was recorded in the year 2020 [1]. It indicates the fact that DDoS attack has continued to increase both in size and sophistication.

The stealthiness of DDoS attacks is also getting higher such that multi-vector, slow, and low rate attacks are common. Combination of volumetric and protocol attacks aiming at different layers of network such as layer 7, transport, and network layer are very common nowadays. Multi-vector attacks are also known as polymorphic cyber attacks. They use two or more methods of infiltration. They are launched for a variety of reasons. Some attacks aim to steel sensitive data which is later handed over to a third party merely for monetary benefit and some attacks to take down the network. These are automated attacks and they dynamically change parameters and vectors in response to the defense mechanisms. The Corero Network Security Inc., explained in their blog that sometimes the multi-vector attacks layer different vector types and sometimes they vary the attack vector itself to evade detection. When it is continually modified, it becomes much more difficult to mitigate them. They often start with one vector, such as a simple UDP flood and, if unsuccessful, they try a second technique such as a DNS flood [2]. Hence it is very difficult to detect modern DDoS attacks due to their varying features and different points of entry to infiltrate the network. In this scenario, it is highly essential to do some intelligent preprocessing steps before the machine learning algorithms are applied for detection.

Network traffic data processing comes in two flavors namely, packet-based and flow-based approaches. A flow can be formally defined as a unidirectional stream of IP packets that share a set of common properties; the IP-protocol, source, destination IP addresses, source, and destination ports used. It is often desirable to analyze data inflows rather than packets since it greatly reduces the complexity of data. It is logical

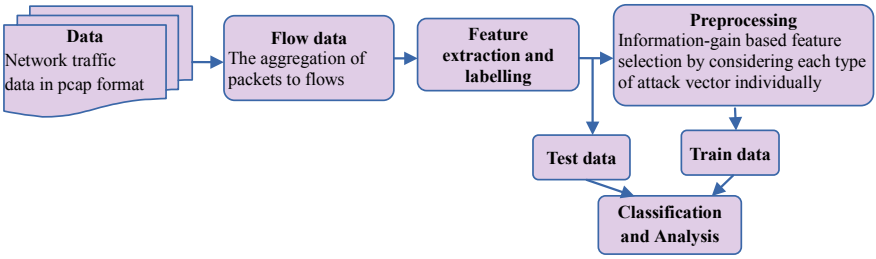

Fig. 1 Workflow diagram of the proposed method

to consider a connection as benign or anomalous rather than packets and hence flow-based analysis is the efficient and fast way of detection. Hence network traffic in the form of flows is used in the proposed work.

The proposed work, mainly concentrating on modern stealthier attacks especially multi-vector stealthy attacks. The workflow diagram showing the conceptualization of the proposed work is given in Fig. 1. The number of benign packets passing through the network per unit time at a particular point is enormous compared to several attack instances. So DDoS attack detection is regarded as an imbalanced dataset problem. Hence it is required to make the features more and more bright to make detection easier. So feature selection is considered an essential preprocessing step in this work. According to Jain et al, feature selection is an effective way of dimensionality reduction and can reduce the complexity of attack detection and thereby increase the detection accuracy [3]. To employ an intelligent strategy initially select the features, and the stealthier attacks. Stealthiness is considered as the resemblance of attack vectors to benign traffic. Different attacking vectors have different prominent features. Hence case-based feature selection is proposed, where each attack vector is treated separately to select features. Making features very prominent is crucial, as it is an imbalanced dataset problem. Feature selection algorithm which can project the maximum information regarding minority attack samples is recommended. So ınformation gain-based feature selection is proposed for doing preprocessing. It is one of the popular feature selection methods due to its computational efficiency and simplicity. This method selects a feature that has high relevance to the output class and also has the highest occurrence rather than simply performing the dimension reduction.

There are two algorithms selected namely J48 and Random forest for doing the performance analysis. The parameters of the algorithms are set in their default settings and it is proposed to evaluate the algorithms with and without doing the information gain-based feature selection on the training data. The important factor of the proposed method is that the classification is being done using a supplied test set rather than doing cross-validation.

The contributions of this work involve:

1. Stealthier multi-vector attack detection with Information gain-based feature selection to get an optimal set of features based on its distinguishing property related to each attacking vector.
2. Enhancing the performance of machine learning algorithms in detecting stealthier attacks.
3. Comparison of methodology with results obtained in other related literature.

1.1 Stealthy Attack Variants

(a) *Low and slow attacks*

These types of attacks use a low volume of data and operate very slowly. Designed to send small amounts of data across multiple connections to keep ports on a targeted server open as long as possible, these tools continue to utilize server resources until a targeted server is unable to maintain additional connections. Uniquely, low and slow attacks may be effective even when not using a distributed system such as a botnet and are commonly used by a single machine.

(b) *Slowloris*

Apart from being a slow-moving primate, Slowloris is an application designed to investigate a low and slow attack on a targeted server. The elegance of Slowloris is the limited amount of resources it needs to consume in order to create a damaging effect.

(c) *TCP flooding*

The attacker exploits the three-way handshake of TCP communication. The attacker sends SYN packets to the server pretending to establish a TCP connection, the server sends SYN-ACK packet back to the client and keeps a port open to receive ACK from the client, but the attacker never sends a final ACK to the server. So the attacker keeps on sending the SYN packets to the server and the server keeps opening a port temporarily for a specific time. The server stops working and responding to legitimate clients after all the ports are utilized.

(d) *UDP attack*

In a UDP attack, the attacker sends a bogus UDP packets to the server using a random port. The server is actually looking for the application on that port. If the service was not running on that port, the server replies with ICMP unreachable message to the attacker. The attacker continuously sends UDP packets and the server also replying ICMP unreachable message back to clients, that will lead to maximum resource consumption of the victim and the network as well. Eventually, the server can not respond to its legitimate user.

The rest of the sections in this article is organized as follows. Section 2 deals with the detailing of the literature survey. Section 3 describes the proposed case-based

feature selection methodology. Section 4 analyze the results and conclusion of the work is presented in Sect. 5.

2 Literature Survey

Due to the proliferation of data to be handled in this new digital world and the high dimensionality of collected data, feature selection is considered as one of the most important factors in determining the efficiency of detection systems. But to have an efficient model, the redundant and less sensitive features need to be dropped.

Combinations of feature selection methods with other optimization techniques are employed in almost all the application domains to improve the detection accuracy of machine learning algorithms. The work of Chuang et al, achieved comparable accuracy when K-nearest neighbor (KNN) with the leave-one-out cross-validation (LOOCV) is used for classifying eleven different gene expression data set. The preprocessing technique employed to bring out this performance is by doing hybrid feature selection methods involving correlation-based feature selection (CFS) and the Taguchi-genetic algorithm (TGA) [4].

According to the work of Gunal et al., a hybrid of both filter and wrapper feature selection steps is being proposed to analyze the redundancy or relevancy of the text features. The experiment done in this work proved the effectiveness of selecting features using different methods rather than stick on to a single method. The combination of the features selected has a profound impact on text classification [5].

The work of Wang et al, mainly deals with DDoS detection based on feature selection involving SU genetic algorithm. The number of features of the NSL-KDD dataset, reduced to 17 from 41 and the machine learning algorithms such as J48 and Random Forest yields 99.8% of detection accuracy. [6] Singh et al, in their work, considers Naive Bayes as the classifier and use information gain-based feature selection and attained 99.5% accuracy in detecting DDoS traffic present in CAIDA 2007 dataset. They have analyzed the results on packet-based data and the features selected are SYN value, ACK value, and Time To Live (TTL) [7].

According to the work of Osanaiye et al., the Ensemble-based Multi-Filter Feature Selection (EMFFS) method is the amalgamation of Information Gain (IG), Gain Ratio, Chi-squared, and relief is used to select important features. The experiments are done on the NSL-KDD dataset and the accuracy is found to be 99.6% using the J48 algorithm. The number of features employed in this method are 13 [8].

In the work of Kamarudin et al, a hybrid feature selection model combines the strengths of the filter and the wrapper feature selection procedure. This hybrid solution selects the optimal set of features in detecting attacks. Correlation feature selection (CFS) together with three different search techniques known as best-first, greedy step-wise, and genetic algorithm are used. The wrapper-based subset evaluation uses a random forest classifier to evaluate each of the features that were first selected

by the filter method. Tested on KDD99 and DARPA 1999 dataset with ten-fold cross-validation in a supervised environment and yields satisfactory results [9].

Lima et al., proposed a smart detection method using machine learning, and this work is designed to detect both high and low volume DDoS attacks. The preprocessing method such as Recursive Feature Elimination with Cross-Validation (RFECV) is used in this work. The datasets CIC-DoS, CICIDS 2017, CSE-CIC-IDS2018, and the ISCXIDS2012 Dataset are mainly employed in this work to evaluate the model [10].

Gu et al., proposed a semi-supervised weighted k-means detection method. A Hadoop-based hybrid feature selection method is used to find the most effective feature set. Then a semi-supervised weighted k-means method using hybrid feature selection algorithm (SKM-HFS) is employed to achieve better performance. The datasets used are DARPA DDoS dataset, CAIDA DDoS attack 2007 dataset, CICIDS DDoS attack 2017 dataset, and real-world dataset [11].

In the work of Wu et al., employed a hybrid feature selection method to detect network anomalies [12]. Wang et al., proposed a combination of sequential feature selection with dynamic MLP to select the optimal features during the training phase and designed a feedback mechanism to reconstruct the detector when perceiving considerable detection errors. The work is mainly done on the NSL-KDD dataset, ISOT, and ISCX [13].

3 Proposed Methodology

During the network traffic data in PCAP format utilize the UDP, ICMP, and TCP flooding attack packet which traces the CAIDA dataset to form multi-vector attack. TC Preplay tool is mainly employed to generate such traffic. TCPreplay is a free Open Source utility suite for editing and replaying previously captured network traffic. It is designed to replay malicious traffic patterns to the Intrusion Detection/Prevention System. All the remaining experiments are done using Python Pandas and WEKA. Pandas is a software library written for the Python programming language for data manipulation and analysis. WEKA, a data mining software, and an open-source software facilitates data preprocessing and implementation of several machine learning algorithms [17].

There are two important phases, one of which is the strategic feature selection phase and the other one deals with the evaluation of machine learning algorithms. Before going to the actual preprocessing step, the data in PCAP format must be processed to form flows and along with that, features are also extracted. Data is the real matter of concern while evaluating the method. CAIDA (Center for Applied Internet Data Analysis) DDoS Attack 2007 dataset is selected to form the sufficient dataset for multi-vector attacks. These traces consist of TCP, UDP, and ICMP flooding instances [15]. To analyze low and slow attacks, Canadian Institute of cybersecurity, CICIDS 2017 dataset has been selected. This dataset contains realistic background traffic and up-to-date attacks [16]. CAIDA data comes in PCAP format only. To implement a

feature extraction module the above process is handled. It extracts features of each flow related to the packet trace namely: Average_Packet_Size, Number_of_Packets, Time_Interval_Variance, Packet size_Variance, Number_of_Bytes, Packet_Rate, and Bit_rate are the seven extracted features [18]. The feature vector formed in this process is represented as $X = (x_0, x_1, x_2, x_3, x_4, x_5, x_6, x_7)$, where x_i is the ith feature extracted from the traffic flow, x_7 is label and X represents the feature vector by the feature extraction module. The CICIDS 2017 dataset comes in CSV format, a collection of flow instances with a total of 79 attributes including the label.

The prepared data is represented in CSV format and is ready to give as input to the next phase. The steps involved in the case-based feature selection using information gain is depicted in Fig. 2. The supervised learning algorithms are evaluated to prepare training and test dataset and they are set as 70% of train and 30% test. Then the training data is split into subsets of training data which comprises any one kind of attack vector and normal data. Then the CfsSubsetEval and information gain based feature selection methods are applied to these subsets. The features at the top positions in the rank list produced by these algorithms are selected.

For having a comparison with other feature selection methods, employ the CfsSubsetEval algorithm available in WEKA. This is a correlation-based feature selection method and is based on the logic such that, relevant feature subsets contain features

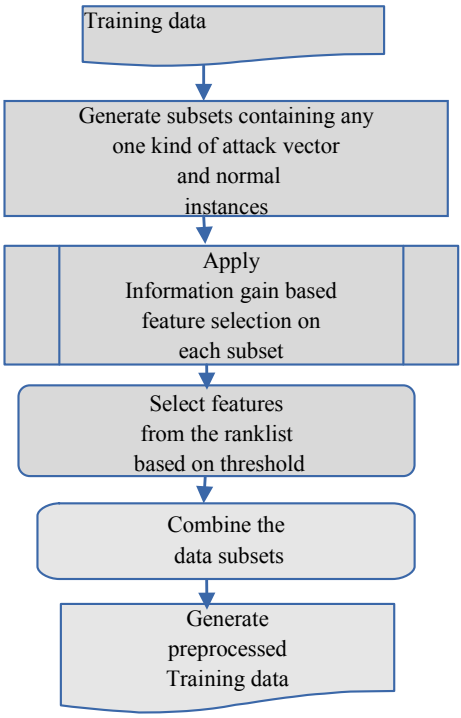

Fig. 2 Flowchart of preprocessing steps involved

highly correlated with the classification, but uncorrelated to each other. The Information Gain (IG) based feature selection is suitable for multi-vector attack feature detection, as it can select the features which contain more relevance which in turn makes the detection easier. It quantifies information based on the contribution of the presence or absence of a feature in making the correct classification decision for any class and is computed according to Eq. (1). The higher the value of mutual information between classes C and feature f, the higher the relevance of feature f in classes C.

$$IG(C, f) = H(C) - H(C|f) \tag{1}$$

where, $H(C) = -\sum_{c \in C} p(c) \log p(c)$ the entropy of the class C and $H(C|f) = -\sum_{c \in C} p(c|f) \log p(c|f))$ is the conditional entropy of class given feature f. The minimum value of $IG(C, f)$ means that $H(C|f) = 1$. That is class C and feature f are not at all related. That is the most distinguishing feature will be the one that is related to a particular class. Due to the feature interactions among the instances, it is not possible to have the ideal case [19].

The next step is to build the new training and test dataset with these selected features. A threshold is set such that those features having information gain value greater than the threshold value are selected as best features. Then new train data is created by joining the subsets of data and it is shuffled to evenly distribute the instances. The next phase of the proposed methodology is the evaluation of machine learning algorithms. J48, the WEKA implementation of decision tree and Random forest algorithms are selected for evaluation. Our earlier work in which the ranking of ten machine learning algorithms has been done. J48 and Random Forest are the algorithms placed in the topmost position in detecting DDoS attacks [20].

A Decision Tree (DT) is one of the well-known supervised classification algorithms in which a tree is generated which acts as a multistage decision system. The concept is based on the measure of the variance of data which demonstrates the presence of different categories of data. A feature vector is assigned with a class label through a sequence of Yes/No decisions along a path of nodes of a DT. The most important factor of splitting criteria for a particular node is to decrease the entropy such that homogeneous vectors can be brought under one particular node since entropy is the measure of impurity [21].

Random forest is an ensemble classification method that combines a collection of classifiers (i.e., decision trees) to make a "forest". Each of the decision trees is generated by using a random selection of attributes at each node to determine the split [22].

4 Result and Discussion

The machine learning algorithms are evaluated based on the True Positive rate (TP) of detecting attack vectors. Among the variety of evaluation metrics such as precision,

recall, F-measure, etc, TP rate is selected to deal with highly skewed data of network traffic. The true positive rate or sensitivity is calculated as given in Eq. (2). TPR is the probability that an actual positive will test positive. TP is the number of instances predicted as positive and TP+FN is the total number of positive samples present in the dataset, where FN is the positive samples misclassified. Misclassification of attacks is costlier than misclassifying benign traffic, so more importance is given to the TP rate of attacks rather than normal traffic. The TP rate comparison is given in Tables 1 and 2.

$$\text{TP_rate} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{2}$$

But when evaluating the J48 and Random Forest with this dataset, the detection rate of SlowHTTPtest is considerably very low compared to other attack vectors. The proportionality of the Hulk attack is very high compared to other attacks in the dataset. 33.3% Hulk attack is there while only 0.7% SlowHTTPtest, 0.8% slowloris, and 1.48% GoldenEye in the dataset. The considerable distributional overlap is there between SlowHTTPtest and slowloris attacks. So the TP rate obtained for SlowHTTPtest is very low compared to other attack variants. The features of the GoldenEye attack are very prominent, so the TP rate obtained for this attack is competitively good without any preprocessing. The proportionality of attacks in the CAIDA 2007 dataset is also very low and is 2% only.

The result of the preprocessing step is very important to be analyzed. The CICIDS dataset comes with a total of 79 features and CAIDA 2007 dataset contains 8 features.

Table 1 Table showing the results of CAIDA 2007 dataset

TP rate						
Predicted	CFS		Information gain		Without preprocessing	
	J48	Random forest	J48	Random forest	J48	Random forest
Normal	0.98	0.994	0.993	0.996	0.981	0.992
Attack	0.943	0.989	0.965	0.995	0.995	0.99

Table 2 Table showing the results of CICIDS 2017 dataset

TP rate						
Predicted	CFS		Information gain		Without preprocessing	
	J48	Random forest	J48	Random forest	J48	Random forest
Benign	0.999	0.999	1	1	0.995	0.996
Slowloris	0.991	0.993	0.994	0.994	0.991	0.993
Slowhttptest	0.875	0.874	0.985	0.988	0.856	0.865
Hulk	1	1	1	1	1	1
Goldeneye	0.989	0.989	0.996	0.997	0.989	0.989

Table 3 Comparison of accuracy obtained

Dataset algorithm	CAIDA2007	CICIDS 2017 (%)
Random forest	99.56%	99.81
J48	98.21%	99.77

The number of features selected is greatly reduced especially in the case of CICIDS 2017 dataset. CFSsubsetEval algorithm selects only 6 features for CICIDS 2017 dataset as a whole namely: Destination_Port, Total Length_of_Packet, Bwd_Packets, Init_Win_bytes_forward, Init_Win_bytes backward, and Idle_Max. Similarly, only two features are selected for CAIDA 2007 dataset namely, Time_Interval_Variance and Number_of_Packets. Competitively the number of selected features is more in the case of case-based feature selection. The prominent features of each attack vector are selected separately. It makes each attack more distinguishable even though their proportionality is very low. The bottom line is that a combination of the features selected by information gain based feature selection methods is more effective than the features selected by the CfsSubsetEval. The performance of the machine learning algorithm depends on so many factors among which feature selection is very important. The other important factor is data proportionality. The results show a considerable improvement in detection rate even without any oversampling or synthetic sampling steps, which are the normal preprocessing steps for an imbalanced dataset problem. Effective discriminating power is increased when all the individually selected features together were concatenated.

For having a comparison with the literature published very recently, compute the detection accuracy which is given in Table 3. The literature selected for comparison is briefed in Table 4. The literature which explains the work on modern stealthy attack datasets such as CICIDS 2017 and CAIDA 2007 were considered. This comparison

Table 4 Summary of literature used for comparison

Reference	Feature selection	Model	Dataset	Accuracy (%)
Singh et al. [7]	Information gain	Naive Bayes	CAIDA 2007 and CAIDA anonymous trace 2015	99.5
Lima et al. [10]	NA	Random forest	CIC-DoS, CICIDS2017 and CSE-CIC-IDS2018,	98.6
Gu et al. [11]	Hadoop based hybrid feature selection	Semi-supervised K-means algorithm	DARPA DDoS dataset, CAIDA DDoS attack 2007, CICIDS DDoS attack 2017	99
Singh et al. [14]	NA	Multi layer perceptron with a genetic algorithm	CAIDA 2007	98.04

shows improved performance of machine learning algorithms can be achieved using the proposed method.

5 Conclusion

This work aims to detect stealthier DDoS attacks such as low rate Layer 7 attacks and multi-vector attacks present in the network traffic. Hence it is proposed to have an intelligent approach by preprocessing each attack vector separately to select the most bright features using Information gain. The method is tested with UDP, TCP, ICMP protocol attacks of the CAIDA dataset and the layer 7 low rate attacks such as slowloris, Slowhttptest, Hulk, and GoldenEye attacks of CICIDS 2017 datasets. Machine learning algorithms selected are Random forest and J48 and they are evaluated mainly based on the TP rate of detecting attack vectors. Much improvement of learning algorithms can be claimed over the sub-optimal performance exhibited while performing the classification in the highly imbalanced network traffic. The true positive rate of SlowHTTPtest attack, without any preprocessing is 0.875 but it is improved to 0.985 according to the proposed method and an average TP rate of 0.993 is achieved in detecting multi-vector attacks when tested with supplied test data. The proposed method works superior to any other works found in other literature examined especially in detecting low rate and multi-vector attacks. The accuracy obtained for the Random forest algorithm on CICIDS 2017 dataset is 99.81%.

The work can be extended to include hybrid feature selection methods and can be tested with other combinations of machine learning algorithms as well. Selecting the more distinguishing feature or make the features more and more prominent is the preprocessing method required to make the attack detection more effective.

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A Framework for Monitoring Patient's Vital Signs with Internet of Things and Blockchain Technology

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Abstract In this prevailing situation of automation, private data related to the public needs to be stored for all businesses and transactions. Most often, the private data of the patient's name, mobile number, diseases, laboratory report, and treatment undergoing is breached by intruders. Automation in the healthcare sector can be made in a highly secured and less complicated manner by integrating patient's health records and health insurance agencies by adopting blockchain technology. In this article, a real-time patient health monitoring system has been built and implemented on an IoT platform which can allow healthcare agencies like hospitals and doctors to monitor critical data of the patient in real-time and respond to the needs of the patient accordingly. The proposed system will prove to be beneficial for patients as well as the doctors and nurses and will lead to the implementation of an intelligent system which can automate various overviews being conducted by healthcare agencies adopting blockchain technology.

Keywords Smart healthcare · Blockchain · Internet of things · Body area network · Sensors · IoT tools

1 Introduction

Internet of things (IoT) was first proposed by Kevin Ashton who had worked at MIT's Auto-ID Center though the overall concept of implementation of a system architecture that is connected to a network and can be likely monitored by the use of smart devices date back almost four decades back when a Coke machine at Carnegie Mellon University was connected to the Internet which allowed the vendors to prepare reports on the drinks. In the present context, the Internet of things is recognized as the next big step in the field of technology alongside artificial intelligence, big

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data, blockchain among others, which allows many devices and gadgets traditionally connected through Internet, to interact with each other and share data, which would then allow the user to automate various tasks.

Every IoT application consists of various layers in which the perception layer occupies the top of the system hardware and consists of all the hardware which includes chips, sensors, and actuators which collects data from various nodes and gadgets connected to the Internet, which it then proceeds to send through an underlying networking layer. The networking layer plays the role of an interface between the hardware layer and the IoT appliance. The collected data can be fed on a NoSQL framework which is then analyzed by algorithms and the processed data is visualized on a user interface which allows the user to draw inferences from the data collected from various ends. The user interface is implemented through a computer/smartphone (Windows, iOS, Android) application which makes the whole process more versatile and automated by the usage of embedded systems.

In recent years, there has been a surge in the adoption of new and novel technologies in the field of medical science and treatment to make the medical and healthcare machinery more efficient. In this field, the Internet of things can operate as a natural amendment to the problems that are faced in the field of real-time monitoring of patient's health parameters. The proposed system employs the use of three sensors namely, peripheral pulse oximetry to measure the oxygen content in the blood, LM35 temperature sensor to measure the temperature of the human body, TCRT1000 transmitter to measure the heartbeat and finally a blood pressure sensor that can assess the muscular functions in arteries and veins to calculate the blood pressure which can be displayed in real-time. Using these sensors, aided by a power supply unit and a Raspberry Pi microcontroller, the data can be displayed by processing it on an application that will allow the doctors to assess the patient's data in real-time (Fig. 1).

The Raspberry Pi functions as the heart of the whole system as it connects all the sensors in a single chip which is wearable and is connected to the Internet by a MAC address, with the data completely available on the website which can be accessed and graphed into suitable data for various applications. The implementation of such a

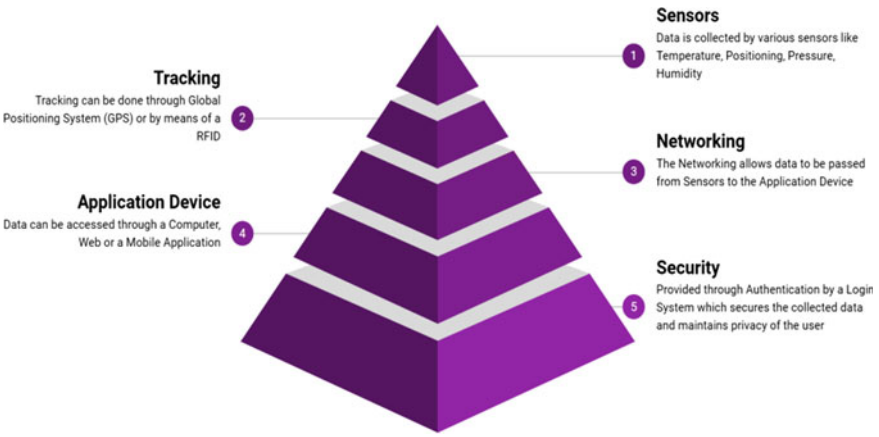

Fig. 1 Connectivity of IoT

system will be a big step in revolutionizing the automation of healthcare management and hospitals as it allows the concerned agencies to keep track of multiple individuals in a single time by using the Internet of things.

2 Motivation

Security and privacy remain a major concern in the Healthcare sector. Privacy deals with granting or revoking accessing rights to private information with others. Privacy determines the actors involved with sharing and managing the information. Consensus with providers of healthcare and regulators can make privacy effective. Security standards such as HIPAA, COBIT, and DISHA are deployed to protect the EHR of the patients. With the availability of big data and IoT, many countries have developed security standards and regulations to protect the patient's EHR.

Data related to a patient is collected from heterogeneous data sources, and often, they are remaining in the form of duplicated, inconsistent, and incompleteness. The bulk of repositories owned by hospitals, healthcare providers, and pharmaceutical companies do not share information among themselves. Security breaches can happen easily some data contain patient's private information such as addresses, mobile numbers, previous history, etc. Currently, most healthcare systems use centralized client–server architectures, in which data is maintained in a centralized server. Intruders can hack the system and manipulate patient's data which is of primary importance.

The industry version 4.0 has brought in revolutions in the form of cloud computing, fog computing, edge computing, machine learning, artificial intelligence, and big data analytics to process patient's clinical healthcare data using blockchain technology. Industrial version 4.0 envisages providing virtualization across personalized healthcare. The concept of blockchain was introduced by Satoshi Nakamoto in 2008. The adoption of blockchain technology can provide security and integrity to EHR thereby improving trust among patients.

3 Literature Survey

According to Wright and Bates (2017) Electronic Health Records helps in improving safety, quality and reduces cost in storing patient's data. For maintaining security and privacy, techniques such as cryptography, anonymization and blockchain are adopted in literature. In cryptography, techniques such as hash functions, digital signatures, symmetric and asymmetric keys, and public key certificates are adopted [1]. RFID tags in medical terms provide quick and smart identification of medical records over IoT [2–4]. The sensors enabled with IoT are used to detect anomalies in day-to-day activities [5–7]. Talukder et al. (2018) have proposed an ethereum-based consensus

protocol named proof of disease (PoD) which can solve the challenges raised by EHR [8].

Some of the blockchain algorithms are proof of work, proof of stake, delegated proof of stake, proof of elapsed time, deposit-based consensus, proof of importance, Byzantine fault tolerance, federated Byzantine agreement, hybrid proof of work and proof of stake, and proof of DDoS [9]. Vora et al. (2018) have proposed blockchain approach for secured access and storage of EHRs. Blockchain consists of service contracts, owner contracts, classification contracts, and permission contracts. The authors have proved that by using the cipher manager and adopting encryption/decryption, the unauthorized access can be reduced [10–12].

Yang et al. (2019) have proposed an IoT-based healthcare system with self-adaptive access control. The medical files can be encrypted to provide security, whereas decryption is a time-consuming process in cases of emergency. The authors have implemented a twofold access control technique, a cross-domain technique adaptive for normal as well as emergency. Various attribute-based encryption methods are adopted to impose access control over encrypted data [13–22].

According to Swan (2012), one of the biggest advantages in the usage of IoT is the availability of a large number of low-cost sensors with increased functionalities [23–28]. In sensor networks, public operations are performed using the RSA cryptosystem and design protocols [29].

Blockchain technology improves the traceability of drugs for their originality and helps in investigating foodborne outbreaks. The solution for data privacy and security could be done by blockchain technology. Blockchain technology protects data from failure and data privacy. The blockchain can store all transactional data and the blocks within the blockchain relate to each other in the form of a chain. Each block is identified with a unique hash address which is present in the header. This hash is unique and is generated by the secure hash algorithm (SHA-256) algorithm. The algorithm accepts any plain text and calculates a key of size 256. Each header of the block contains the address of the previous block in the chain. The blockchain has the advantage of not allowing any information to get deleted from the blocks. The major challenge of deploying blockchain in MoT requires high computational power, low scalability, and long latency. Dwivedi et al. (2019) have adopted double encryption using algorithms such as ARX ciphers and public encryption schemes [13]. For the secure transmission of cryptographic keys across a public network, the authors have adopted a Diffie–Hellman key exchange technique. Thus, the above technique is considered a lightweight adaptation technique. Frames and tools such as Hyperledger Fabric, Composer, Docker Container, Hyperledger Caliper, and the Wireshark capture engine are used to improve the performance of Blockchain technology [30].

3.1 Blockchain Technology

The blockchain is a simple digital platform for recording and verifying transactions so that blockchain technology is trending in recent times, since it stores and shares data

in a distributed trust, and immutable manner. Blockchain removes the intermediaries and facilitates a less challenging method for providing access to ledger-based transactions connected with a network. It connects multiple nodes with varying computing powers thereby improving scalability. The techniques and services are supported by blockchain technology.

(a) **Consensus protocol**: Blockchain technology uses healthcare experts, pharmaceutical companies, and insurance agencies to provide a secure environment that can provide data transparency and accountability. Ethereum provides structured data in a secured manner among healthcare sectors with the help of decentralized databases. This structure is designed in such a way that it can protect patient data with integrity and confidentiality. Ethereum provides a platform for the patients through which they have complete control over granting access to particular data to a specialized doctor. The consensus protocol adopted is the ethereum based on future ready proof of disease (PoD) consensus protocol which can identify the disease accurately.
(b) **Provenance**: This is a shared or private immutable ledger used for recording the history of data from its inception throughout its life span. The provenance adopted for this study is the IoT data provenance framework. Data provenance can ensure trust among IoT infrastructure.
(c) **Immutable ledger**: Once a block is written into a blockchain, it cannot be changed.
(d) **Distributed P2P network**: Peer-to-peer network known as a P2P network is decentralized network communication. Nodes are connected at random with the components in the pipeline.

4 System Architecture

The blockchain-based patient care monitoring system is explained with four participants such as system admin, patient, doctor, and report. In this system, various functions such as CreatePatientRecord, GrantAccessToDoctor, GrantAccessToLab, RevokeAccess are shown in Fig. 2.

Patients can register through the client application and get enrolled in a certificate authority via a membership service provider (MSP). Upon enrollment, the certificate authority issues the certificate to the patient along with a private key. All transactions to be processed are carried through the Hyperledger blockchain network. Doctors can access those records that are granted permission by the patients. The system admin creates a patient with the required key attributes. The patient in turn can edit the record and complete his profile using the client application, which in turn invokes the chain code for committing a transaction. After committing the transaction, the updated transactions are distributed over the network, so that the data remains in an immutable manner. Transactions are added by a hash value, connected with the previous block.

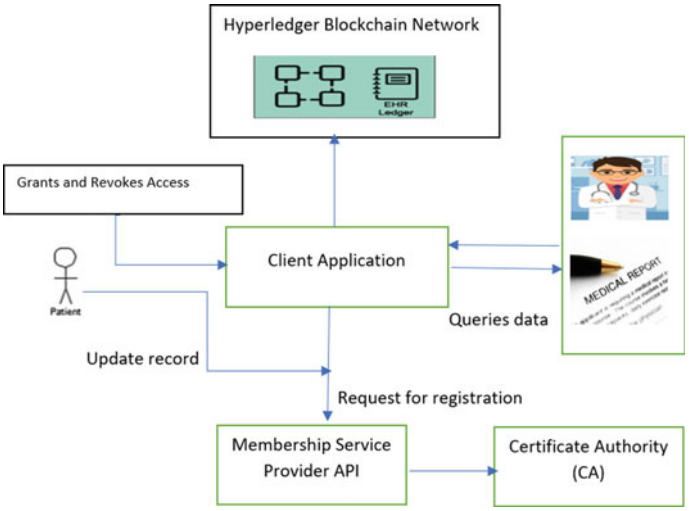

Fig. 2 System functionality

4.1 A Scenario in the Patient Health Monitoring System

Consider a scenario of a hospital that is monitoring their patients. Sensors like temperature sensors, heartbeat sensors, peripheral pulse oximetry, and blood pressure sensors are attached with a Raspberry Pi microchip. The readings are stored in a database. The previous history of the patients, their alignments, allergic to medicines, previous doctor seen, diagnosis done are in records. It will be better if the current situation of the patient can collaborate with his previous history. These requirements can be incorporated well with blockchain technology with can improve the efficiency and coherence of healthcare delivery. Fundamental issues in the healthcare industry which include lack of data management and distribution can be overcome by blockchain technology which can provide automated, immutable, aggregated, and secure data.

4.2 Proposed Algorithms

The patient care monitoring system deals with four participants, namely system admin, patient, doctors, and reports. The procedure adopted by the system admin is depicted as an algorithm in Table 1. The system admin checks whether the participant (patient or doctor) is valid and requests with the certificate authority to register the participant and issues a public key, if the participant is valid. The admin has complete control over the system to add, read, update, and delete participants. If the activities of the participant are invalid, the admin can block him over the Hyperledger blockchain network.

Table 1 Algorithm for system admin

```
Input:   Credentials given by the participants (Id, Name, Phoneno, Address)
         Registration certificate requested from Certification Authority (CA)

Output:  Granting access to Patient (P), Doctor (D), Report generator (R)
Procedure SystemAdmin(CA)
  while (True) do
      if (P is valid) then
          add Patient (P_ID, P_name, P_phoneno, P_address) to blockchain network
          grantaccess (P_ID, P_pvtkey)
       else
          invalid participant (P_ID)
       endif
      if (P_ID) is valid
          add Doctor (D_ID, D_name, D_specialization) to blockchain network
          grantaccess(D_ID, D_pvtkey)
      else
          invalid participant (D_ID)
      endif
      if (R_ID) is valid
          add Doctor (R_ID, R_type, R_summary) to blockchain network
          grantaccess(R_ID)
          else
            invalid report (R_ID)
          endif
 end while
 for (all transactions) do
    if found (illegal)
        block (P_ID, D_ID, R_ID)
    endif
end for
end Procedure
```

The procedure to illustrate the role of a patient is depicted in Table 2. The patient requests a private key from the system admin. After being granted access, the patient has access to doctors as well as reports. If PID is in the Hyperledger, the concern person can grant access to the doctor for reading and writing the reports.

The procedure adopted in the working of the module doctor is depicted in Table 3. The input deals with the request given by the doctor to the system admin to enable login. The output is the accessing grant given by the system admin to access the

Table 2 Algorithm for patient access

Input : Patient (P_{ID}) and Key request from system admin
Output: Granting access to P_{ID} transactions in Blockchain network (BN)

```
Procedure Patient (PID)
        while (true)
          if (PID € BN) and  grantaccess(PID € DID)
                grantaccess_read_update (PID, DID, RID,BN)
          else if (PID € BN)
                grantaccess_read_write (PID, DID, RID,BN)
          else
                invalid (PID)
          endif
end Procedure
```

Table 3 Algorithm for doctor access

Input : Doctor (D_{ID}) and Key request from system admin
Output: Granting access to Patient ID (P_{ID}) and Report ID (R_{ID}) in Blockchain network (BN)

```
Procedure Doctor (DID)
        while (true)
          if (DID € BN) and  grantaccess(PID € DID)
                grantaccess_read_update (PID, DID, RID,BN)
          else if (DID € BN)
                grantaccess_read_write (PID, RID, BN)
          else
                invalid (DID)
          endif
end Procedure
```

patient as well as the doctor. Based on the permission provided by the patient, the doctor will be able to update/access the reports.

5 Results and Discussion

For implementation, data recorded from 20 patients was considered. The patient's vital symptoms like temperature, blood pressure, and oxygen saturation level were

Fig. 3 Screenshot representing creation of blocks in blockchain

monitored and this information is kept on the patient's table. The doctor table contains details of doctors with their specialization and the report table contains the lab reports and ECG reports of the patients.

It is possible to create the functions of the blockchain using flask microframework. The scripts generated with flask can be decentralized by making them run on multiple machines. The data is stored as blocks and the blocks are linked with each other using cryptographic hashes. In this application, a simple interface for sharing data through the posting is created. A post consists of the author's name, content, and time stamp. Every transaction is considered as a block. Each block will have a unique ID. The unique ID is created by the SHA 256 hash function. This hash id is then used to identify the block. The blocks containing transactions are generated one by one and added to the blockchain. If both input and hash are known, the input can be passed through the hash function to proceed to the next block.

In our example, one instance of the blockchain is made to run at port 8000. Two more nodes are located at port 8001 and 8002, so that the new nodes are unaware of the base node 8000 and able to participate in the mining process. When all the nodes are created and transactions are complete, the nodes in the network have complete a chain. A conversation between the patient → doctor, doctor → patient, patient → report is created by creating three blocks that are linked with the hash functions as depicted in Figs. 3 and 4.

5.1 Advantages

The advantages of our existing model are detailed below:

A **Automated**: The whole architecture is completely automated requiring almost no human intervention to function except during installation. The sensors collaborate and analyze the data which is then passed over to databases with alerts and reports generated as and when required. An automated system is a lifesaver

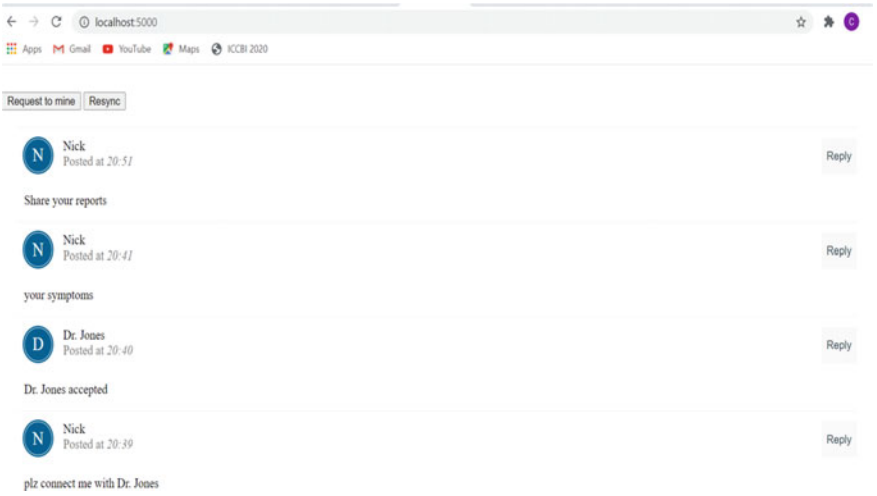

Fig. 4 Screenshot representing blocks generated in blockchain

for the patient and a relief for the healthcare agencies from which both parties can mutually co-benefit.

B **Robust and versatile**: The whole architecture has been built to be robust and versatile as it can handle the data inflow with a great degree of ease and can be easily implemented in real-time. In the future, several sensors and data nodes can be attached to the microcontroller chip to generate several parameters that can be looked into for data generalization.

C **Cheap**: The whole architecture is cheap in setup and can be implemented seamlessly without any difficulty. This allows even the local healthcare agencies in small towns and villages to set up this system without going into much of the complexities and allow better care for the patients.

D **Real-time monitoring**: Our proposed system allows the healthcare agencies to perform their operations in real-time with the data collected by the sensors, which is a step over the vintage frameworks which required heavy take care and high maintenance costs. With real-time monitoring, the error percentage has also been eliminated uniquely.

6 Conclusion

In the proposed system, the model for setting up an Internet of things framework consisting of a Raspberry Pi microcontroller chip and sensors which can collect data from the patient and automate the process by displaying results and inferences from the data collected. This system is expected to revolutionize healthcare management by relaying real-time data to a Web Server/Mobile Application which can be reviewed using a login system for healthcare staff. Further to diagnose the patient efficiently,

patients, doctors, and reports are connected with blockchain technology. Every block is linked to the previous block with the hash field. The consensus proof of disease is adopted for diagnosing the patient. Since the order of transactions is linked with the chain, the data once stored will not be tampered. This application in the future can be implemented with live data and the scalability can be checked.

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IoT Based Smart Transport Management and Vehicle-to-Vehicle Communication System

Vartika Agarwal, Sachin Sharma, and Piyush Agarwal

Abstract Vehicle-to-vehicle (V2V) communication is an advance application and thrust area of research. In the current research, the authors highlighted the technologies which are used in V2V communication systems. Advantage of such technology is that it helps to detect live location and tolling. It plays an important role if there are huge amount of traffic. The current research work can obtain more information about Li-Fi, RFID, VANET, and LORAWAN technology. Li-Fi is known as VLC communication system that uses visible light for high data transmission and reception. RFID technology helps the emergency vehicle to reach destination quickly by avoiding any kind of traffic. LORAWAN is a large-scale network technology with a long range and VANET with low power that allows to obtain accurate traffic information on each route and this saves time. The comparison between the different technologies is reviewed in order to obtain the optimized technology as per the applications.

Keywords Internet of things (IoT) · Vehicle-to-vehicle (V2V) communication · Li-Fi · RFID tag

1 Introduction

IoT is one of the most significant, dynamic, and groundbreaking research contributions of the twenty-first century [1]. IoT has brought a drastic change in the lifestyle of every individual through its vast range of applications. The best part in the current development is the storage of data in cloud. The use of IoT based application is implemented in almost all the fields. Transport management system has several limitations and is constrained by existing technologies. Advance tools like Li-Fi, RFID, LORAWAN, and VANET are discussed in the current research. Currently, the use

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of IoT with Li-Fi technology is implemented and executed in transport management system by using V2V communication system. Authors have described the effectively the use of Li-Fi in V2V communication [2]. This technology uses several input and output devices. The use of Li-Fi has created the easiness in the data transmission and storage capacity. The hardware and software components, Li-Fi communicator system, etc., are required for Li-Fi technology which are discussed below.

1.1 Hardware Component Needed for Li-Fi Technology

Following are the conventional hardware components used in the execution of Li-Fi Technology:

- **Sensor**—Sensor is useful to find out the speed and distance of vehicle.
- **LED Light (Transmitter)**—White LED will be used for data transmission from vehicle 1 to vehicle 2.
- **Photodiode**—Photodiode will be used for data detection.
- **Wi-Fi Module**—The proposed system requires efficient communication using the internet.

1.2 Software Used for Li-Fi Technologies

Following are some of the software which are very useful in the development and execution of Li-Fi Technology:

- **Arduino IDE**—Arduino is used to install Arduino UNO board. Program written using Arduino software is called sketches.
- **Telegram App**—Telegram App is used to directly send the accident location to the hospitals and police station.

1.3 Li-Fi Communicator Systems

Li-Fi communication system as shown in Fig. 1 which consists of accelerometer, Arduino UNO, cloud intimating device, ultrasonic sensors, Li-Fi transmitter and receiver, LCD display, node MCU, DC motor, etc. Some important points that need to be considered while using Li-Fi for transport management system includes:

(a) Activation of sensors and actuators is necessary to enable vehicle-to-vehicle communication between two vehicles.
(b) The sensor reads the received data, interprets it, and then transmits it in the suitable form to another vehicle under communication.
(c) The complete data is processed by microcontroller.

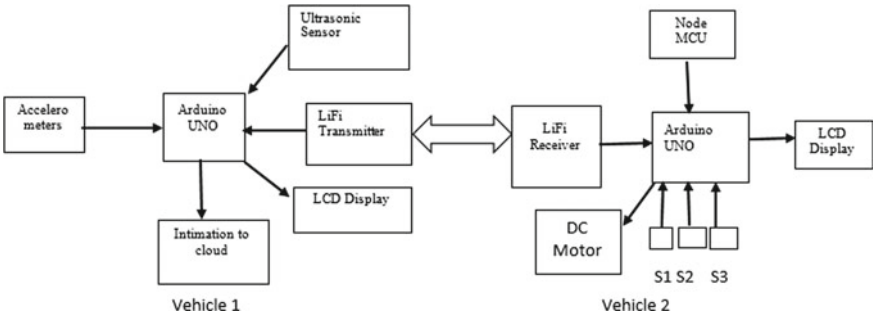

Fig. 1 Systematic block diagram for Li-Fi communication

(d) The updated and real-time modification is done by using cloud-based technology.

1.4 Limitation of Li-Fi Technology

When it comes to technological advancements, there are several limitations associated with the technology. Following are some of the limitations of Li-Fi technology which can be treated as further area of research in the field of V2V communication.

(a) Li-Fi works on limited light range (suitable under visible light only).
(b) Interference in Li-Fi occurs in sunlight.
(c) The major drawback in Li-Fi fidelity is that it shows poor performance in dark.

For fulfilling the limitation of Li-Fi, radio-frequency identification (RFID) tags are used for leveraging vehicle-to-vehicle communication. It is also considered as an important cloud-based tool.

2 Radio-Frequency Identification (RFID) Tag Technology

RFID tag is used for transmitting and receiving information via an antenna and microchip. It is also called as integrated circuit (IC). RFID tag is used for live tracking, tolling, and real-time vehicle tracking application. Many researchers have effectively highlighted the design and working of RFID tag to track data in V2V communication application [3]. They are small in size, lightweight, and can potentially last a lifetime.

2.1 Working of RFID Tag

According to this system, all vehicles have radio frequency identification tags placed on them. RFID reader reads tag from vehicle and turns green. It is basically used to count no of vehicles passed through signal [4]. When emergency vehicle passes on the road, it will convert into red.

2.2 Limitations of RFID Tags

There are several limitations of RFID tags as compared to other labels. Though it has wide range of applications, RFID tags needs lots more improvement in terms of security. Some of the limitations are mentioned below:

- RFID tags are not suitable for no reasons including protection and technical problems compared to other marks.
- RFID tags are not possible for readers to differentiate. Almost everyone can read details.

2.3 Vehicle to Everything Communication (V2X Communication)

IoT based vehicle to everything communication is another good technology which is very helpful in vehicle navigation, vehicle transportation management, and vehicle security management. The insights for this are mentioned below [5].

(a) **Communication Type Insights**—V2I and V2V play an important role if there are huge amount of traffic.
(b) **Connectivity Type Insights**—Such systems are being installed in cars.
(c) **Vehicle Type Insights**—Scope of vehicle to everything technology is increasing day by day.

For connecting to the cloud, LORAWAN is used. With the help of LORAWAN, the parking area in which the vehicle has to be parked can be easily identified.

3 LORAWAN Technology

LORAWAN, a long range, low-power wide area networking technology, enables several advance services, which are not possible through other network-based technologies [6]. LORAWAN provides best battery life, and it is very economical for a wide area network due to its reduced cost and good battery life.

3.1 Implementation of Proposed Framework

LORAWAN implementation requires a specific set of framework for implementation [7].

V2V Communication—Beacon is used for scanning nearby devices. In this, the first 8 bit consists of manufacturer code, the next 20 bits has the vehicle information, the next 2 bits has the information about type of vehicle, and the last 2 bits shows the emergency situation.

UUID—Universally Unique Identifier (UUID). Further, it can be divided into five groups.

3.2 Proposed Framework

Lights are used for scanning surrounding vehicles. For instance, if one vehicle journeys steadily and the second vehicle travels at high speed. With the help of a beacon, an alert message will be passed to second vehicle. Hence, collision is avoided, and the vehicle can pass easily without any interference.

V2I communication—With the help of V2I communication, information can be collected from the cloud.

V2V communication—Here, transmission is possible between nearby vehicles. It had some major problems like Bluetooth low energy consume less power.

Limitations of LORAWAN

LORAWAN has several limitations, where it can only send small packets through LORAWAN. For large packets, it is not suitable. LORAWAN is not suitable if you want to control light in your house.

4 Vehicular Adhoc Network (VANET) Technology

VANET is a developing technology nowadays [8]. It helps an emergency vehicle to select best routes with no traffic for reaching the destination easily. System also generates a warning message if an emergency vehicle meets an accident.

4.1 Working of VANET

VANET can be used in simple cases as shown in Figs. 2 and 3. In Fig. 2, an emergencies vehicle is initially at rest in the parking lot of the hospital. Following this, the vehicle allocated a destination of urgency with two separate roads. Emergency vehicles should select the best route in order to reach their destination fast [9].

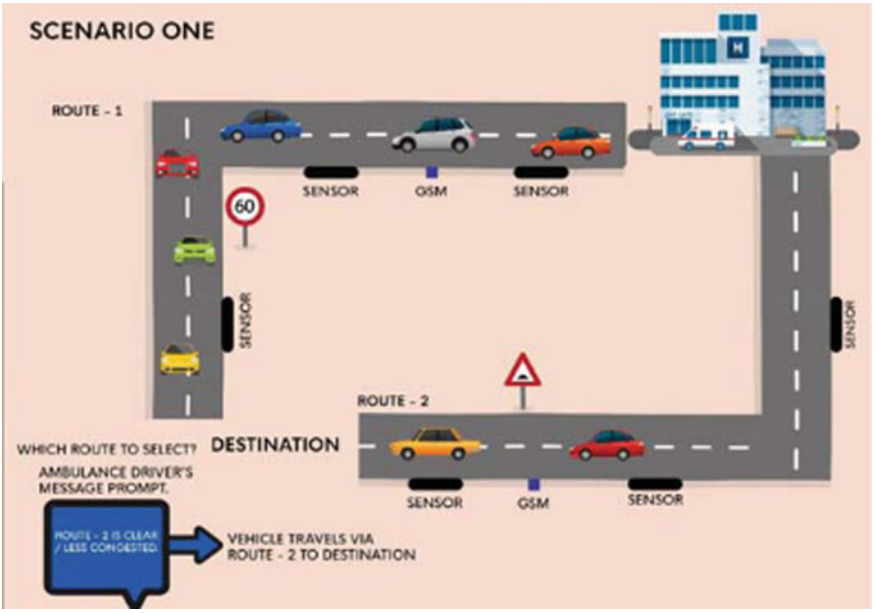

Fig. 2 Case 1: traffic management system testing [8]

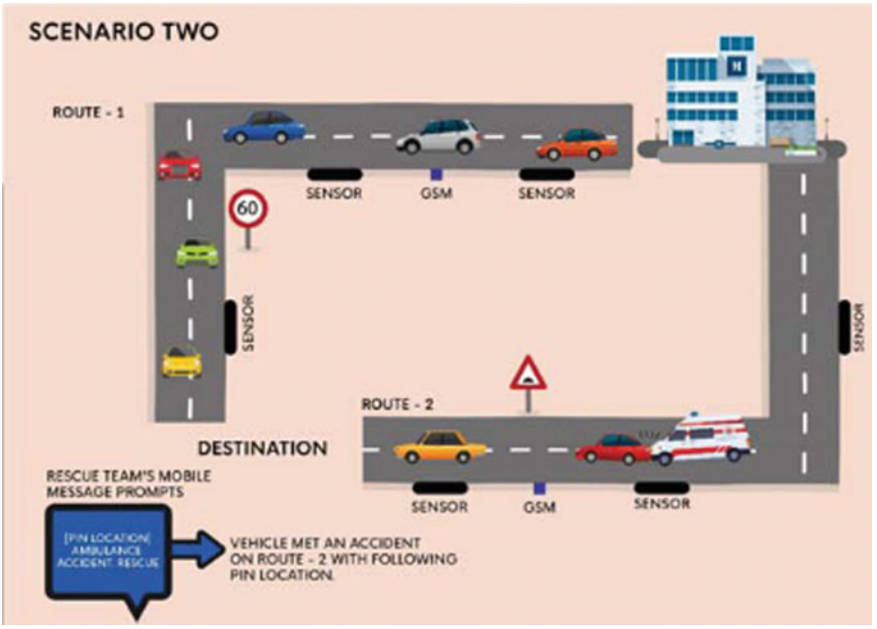

Fig. 3 Case 2: traffic management system testing [8]

Driver can know more about best route by sending a message 'route status.' The optimized and less traffic route can be identified. When the message is sent, GSM will send information to the hospital informing about best route which is more preferable. Vehicle now travels in the best route. The use of this technology enables the driver to provide the fastest, safe, and least traffic route which saves life, money, and time of the complete process [10].

Figure 3 highlights the scenario 2 for traffic management system testing where different sensors and GSM module are installed in the vehicle under communication to rescue the uneven happening through mobile messaging. This is even advanced concept then simple IoT. In case, if an emergency vehicle meets an accident, a message with location will be automatically sent to the relevant rescue authorities [11].

4.2 Emergency Application for V2V Communication

In an emergency application for vehicular network, warning messages included auto collisions, street traffic, and so on, and then, large number of duplicate packets congest networks [12, 13]. The V2V communication works under ultra-low latency of data and information sharing among users [14, 15]. Several corporate and business issues can be easily rectified using the advance industry 4.0 based technology. Reduction in response timings can be systematically analyzed in V2V communications.

4.3 Vehicle to Infrastructure Communication

It is a combination of V2V and V2X, and vehicle to infrastructure communication is the communication from accident vehicle to base station. The message is for emergency situation which forwards it to the nearby rescue center. The architecture also works in security management along with the traffic management system.

5 Conclusion

The current manuscript reviewed on the applications of IoT in vehicle-to-vehicle communication system. Different technologies like Li-Fi Technology, RFID tag, VANET, and LORAWAN technology are highlighted along with its limitations and applications in vehicle-to-vehicle communication system. Also the limitations of all the systems are highlighted in the research. The amalgamation of different IoT based tools can finally summarize the utility based on the application, specification, and the nature of use. The further scope of research is being tried to identify from the

limitations in existing technology and infrastructure. Also the use of V2V communication using advance Industry 4.0 tools can reduce the efforts, time requirements, and money in different monitoring and security applications. Data capturing and modification is optimized using these technologies.

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An Analytical and Comparative Study of Hospital Re-admissions in Digital Health Care

Aksa Urooj, Md Tabrez Nafis, and Mobin Ahmad

Abstract Medical re-admissions are expensive and indicate poor quality of hospitals. A remarkable re-admission rate has a huge financial impact on the patients and the hospital. Through the increasing use of medical health records, enormous data is available to us for review which can identify high-risk patients effectively and decrease the mortality rate. According to the 2010 Affordable Care Act, hospitals may be penalized for re-admitting patients within 30 days of discharge. However, hospitals claim that the root cause of re-admissions lies similar to the populations served. In this paper, various re-admission prediction techniques that have been used earlier to estimate the re-admission rate of patients after being discharged from the hospital have been discussed. This article will also give a summary of various socioeconomic and demographic factors that play a vital role in medical re-admissions. Moreover, it will cover some of the measures that can be taken to reduce hospital re-admissions.

Keywords Digital health · Electronic medical records · e-Health · Hospital re-admission · Intervention · Big data analysis

1 Introduction

Hospital re-admission is the unnecessary return of the patient to the hospital following an original admission and discharge from the hospital. For research purposes, various time windows like 30 days, 90 days, and 1 year re-admissions were used. The time period often used is 30 days [1]. Re-admission may take place at the same hospital as the original or to another hospital for planned or unplanned medical treatments [2]. High re-admission rates indicate relatively low performance and have adverse

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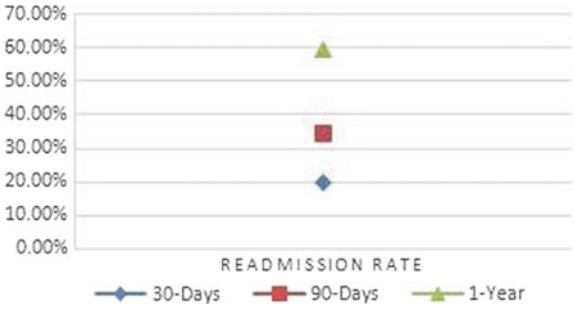

Fig. 1 Hospital re-admissions within 30 days, 90 days, and 1 year

effects on both patients and hospitals [2]. It is recorded that about 19.6%, 34%, and 56.1% of the patients released from the hospital were re-hospitalized within 30-days, 90-days, and 1-year, respectively, according to a study in the New England Journal of Medicine [3] (Fig. 1).

The study carried out by the Medicare Payment Advisory Commission (MedPAC) showed that within 30 days of discharge from the hospital, approximately 17.6% of patients are readmitted, reflecting $35 billion of medicare expenditure a year [4]. Also, around 75% of the re-admissions are avoidable which can save around $17 billion every year [2, 5] (Fig. 2).

As per the Affordable Care Act, hospital re-admission reduction program (HRRP) was established by the US Center for Medicare and Medicaid Services (CMS), which aims to penalize hospitals with immoderate re-admissions within 30 days. Initially, only three conditions were taken into consideration, i.e., heart failure (HF), acute myocardial infarction (AMI), and pneumonia (PN), and three more conditions will be included starting 2015 [6].

According to the HRRP data (Figs. 3, 4, and 5), it is quite evident that re-admissions from 2013 through 2016 dropped marginally, and rates differ based on the type of diagnosis. During 2015 and 2016, re-admission rates for acute myocardial infarction (AMI), heart failure (HF), and pneumonia (PN) remained the same, however [7].

CMS calculated the re-admission rate from 2008 to 2011 discharge data and used it as a benchmark which changes every year by considering the previous three years

Fig. 2 Overall re-admission expenses per year

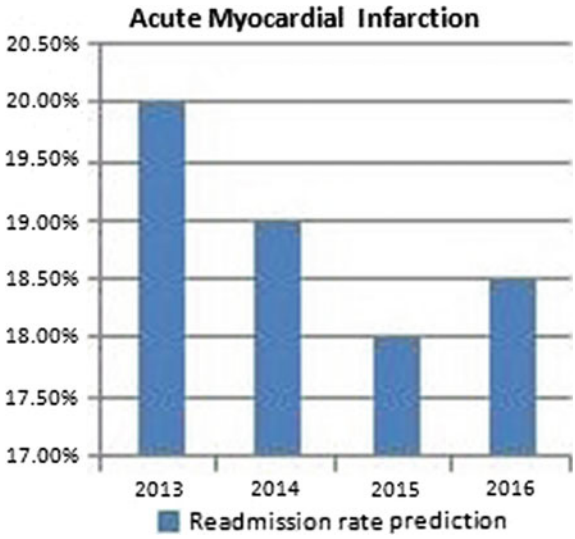

Fig. 3 Re-admission rate for AMI [7]

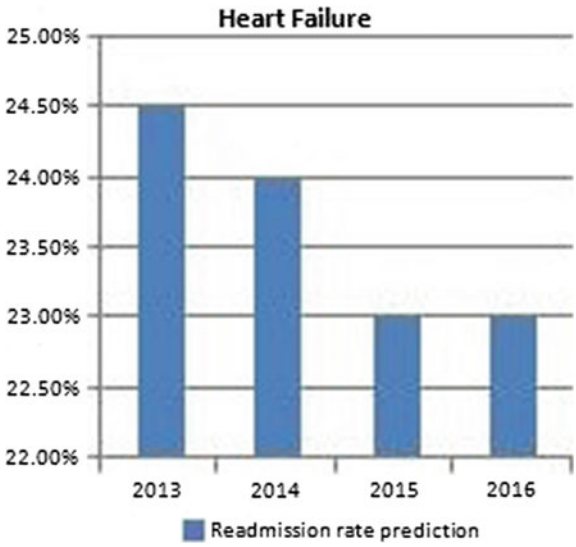

Fig. 4 Re-admission rate for heart failure [7]

[8]. The fine for each hospital was fixed as 1% of the overall medicare payments from October 1, 2012, and will gradually increase to 3% in 2015 and beyond. Noticeably in 2013, at least 2000 hospitals were reimbursed, with a gross forfeited amount of $280 million [9] (Fig. 6).

This article is organized as follows. In Sect. 2, a brief overview of the techniques previously used for estimating hospital re-admissions is presented. In Sect. 3, a summary of the causes responsible for high re-admission rate is discussed. Section 4

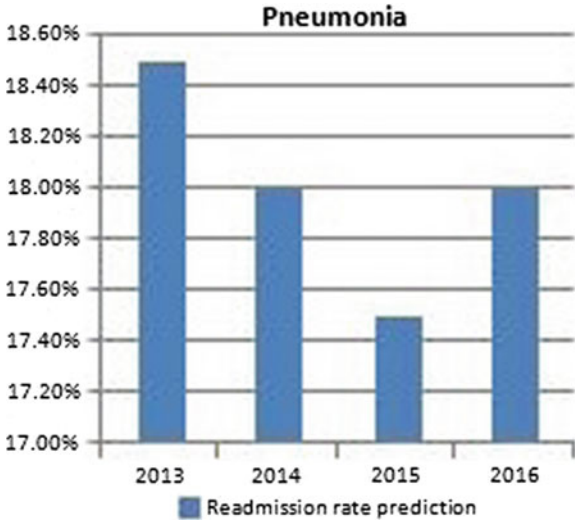

Fig. 5 Re-admission rate for pneumonia [7]

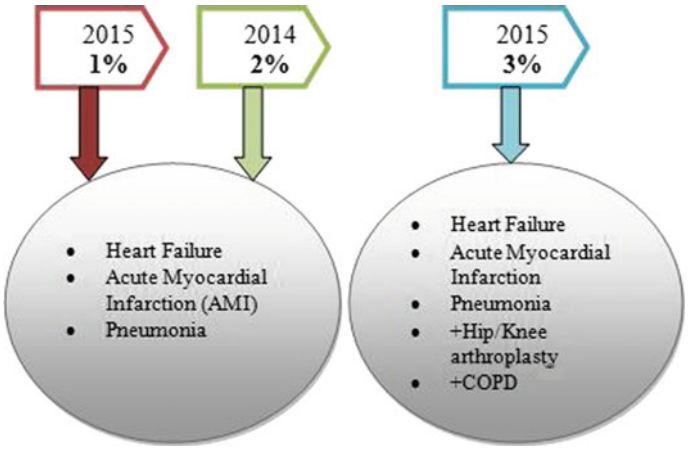

Fig. 6 Hospital re-admission penalties

introduces some of the ways to reduce hospital re-admissions. Finally, Sect. 5 draws the conclusion of the research work and future scope.

2 Existing Work on Re-admission Prediction

Re-admissions after procedures are expensive and indicate the poor quality of a hospital. There are a large number of prediction algorithms that use clinical and administrative data to the forecast re-admission risk of patients [10–12]. To estimate the re-admission risk of a patient, dedicated efforts are embedded in the learning of effective features that are most relevant to a patients' re-admission. A short summary of research work performed earlier to predict re-admissions at hospitals was discussed.

1. Risk-O-Meter is a standalone system used to forecast the re-admission risk factor of CHF patients [13]. However, it is only accessible via a Web interface and lacks the ability to interface with other systems.
2. Re-admission score as a service (RaaS) is the first re-admission risk calculator. It leverages cloud computing to estimate the 30-day re-admission score of heart failure (HF) patients and also displays the leading factors responsible for their re-admission. The main advantage of RaaS implementation in comparison with previous efforts is that it is deployed on Microsoft Azure which provides access to both clinicians and patients without any requirement of analytical infrastructure. Moreover, it is flexible enough to integrate with other medical systems and data sources [5].
3. To reduce penalties and increase the life span of patients, [1] used clustering-based actionable knowledge mining to decrease the average number of re-admissions. First of all, patients are clustered based on the similarities in their diagnoses, and then, novel algorithms are applied to predict the order of treatments that the patients have to undergo to reach the desired condition. Finally, a scoring metric is used to evaluate the clusters and treatments, so that a better procedure can be estimated for the new patient, which decreases the hospital re-admission rate to a large extent.
4. Some traditional modeling approaches, for example, logistic regression or support vector machine (SVM), is commonly used for classification problems [14–17]. Work done by Ref. [18–20] result in more statistical features that are used to enhance re-admission prediction using modern modeling methods. However, most of these methods focus on the ability to extract and classify features, which restricts the efficiency of their methods.
5. A data-driven approach was implemented for forecasting the re-admission of hospitals based on administrative results [21]. However, this technique cannot integrate clinical laboratory data into the model and thus cannot equate its results explicitly with other methods. Thus, [22–24] used a range of data sources covering patient social and demographic profiles, medications, treatments, illnesses, and laboratory tests. They used the features built for a particular illness and failed to consider the negative impact of misclassification errors, however.
6. Choi et al. [25] exhibit deep learning models that outperform conventional modeling methods in the medical field and therefore can be interpreted for the

analysis of health care [26]. These works, however, mainly focused on deep learning; do not pay attention to the problem of skewed data.

7. Therefore, [2] used convolutional neural networks (CNN) to extract important characteristics that are most relevant to hospital re-admission. They used categorical feature embedding to encode clinical features with feature vectors. Then, both these categories of features were fed into the multilayer perceptron (MLP) as input. To overcome the imbalanced data problem, a cost–sensitive deep learning model was proposed to train MLP during re-admission prediction. This approach performs better on real clinical datasets than the existing methods and is being used in a large hospital for treatment and decision making on a real system.
8. Most models concentrated on a particular section of the population, for example, a model for classifying heart failure patients at re-admission risk within 30 days was designed in [27] using a comprehensive dataset consisting of 12 separate cohorts of 1100 to 14,500 patients each.
9. Alluhaidan and others [28] designed a telehealth system for heart failure patients to fill the gap as patients come to their homes to improve self-care, and therefore, reduce re-admissions. Similarly, [29] developed a decision tool for assessing and decreasing the chances of re-admission in patients diagnosed with CHF. However, this tool was designed particularly for an urban teaching hospital in the USA.
10. The ongoing studies on medical re-admissions continue to include clinical data which is available merely in the advanced electronic medical records (EMRs). It is troublesome because most heart disease victims belong to the population whose hospitals are not able to adopt modern EHR systems rapidly. Vedomske et al. [30] used the random forest machine learning methodology to forecast emergency re-admissions within 30 days of discharge for CHF patients. However, this technique had some drawbacks. First of all, data was taken from a particular hospital, and other locations were not taken into consideration. Secondly, death rates within 30 days of discharge were not taken into account. Lastly, a huge portion of data was excluded due to missing re-admission details.
11. A latest comprehensive and in-depth analysis of models for forecasting hospital re-admissions explaining their efficiency and evaluating clinical suitability is described in [31].
12. This article determines the efficacy of care interventions in older adults with chronic illnesses in minimizing short- and long-term hospital re-admission following discharge from the hospital [32].
13. Likewise, a model was created for older patients over 65 years of age [33]. This experiment utilized medicare inpatients from the general US community, with a comparatively limited collection of data. The aim was to forecast complex 30-day treatment changes. Comparatively, the model gave a good performance (0.83 AUC).
14. This study provides a model for evaluating the optimum time frame when defining re-admissions for patients. Initially, by fitting a special case of a coxian phase-type distribution, which is expressed as a mixture of two generalized

Erlang distributions, it captures the re-admission process. And then, the optimal time period is determined by applying the minimum classification error method [34].

15. Within this article, it demonstrates that a broader study of re-admissions, utilizing clustering, gives a richer and more complex interpretation. Several commonly used U.S. datasets available publicly were combined: medicare inpatient provider utilization, CMS impact file, hospital cost report, hospital compare data, data from re-admissions reduction program (HRRP), payment data, and U.S. census data. The primary hospital characteristics that were mainly related to re-admissions were examined and are given as patient satisfaction, the effectiveness of care, caring for poor, structure measures, case mix, hospital funding, and use of hospital beds [7].
16. This article suggests an analytical framework using hospital inpatient administrative data from a nationwide healthcare dataset. The stacking algorithm is integrated with an updated weight boosting algorithm to form a joint ensemble learning model [35].
17. This project aimed to build a model that predicts the risk of re-admission within 30 days. The risk of re-admission calculated by the proposed model was then tested with the LACE index and patient at-risk of hospital re-admission (PARR)—the most popular models for finding out the risk of re-admission [36].
18. Chronic obstructive pulmonary disease has been recently introduced to the list of diseases for which hospitals in the U.S. are penalized by the CMS. While attempts have been made to statistically forecast those most vulnerable to re-admission, rare studies have worked on unstructured clinical records. It has designed a framework for analyzing clinical records and estimating re-admission using natural language processing [37].
19. A study of five statistical models for COPD re-admission prediction including generalized estimating equations, logistic and Bayesian logistic regression, logistic regression tree, and generalized linear mixed model is discussed in [38]. Hasan et al. [39] present a simple model that uses logistic regression to determine patients at high risk of re-admission.
20. Researchers at Deakin University developed a framework to assess the re-admissions of chronic diseases [40]. The framework can predict the re-admission rate in COPD patients within 30 days with an AUC = 0.67 and was an enhancement upon baseline co-morbidity methods which are commonly used for re-admission prediction.
21. The project proposes a causal Bayesian network model to find ways of reducing re-admissions for patients diagnosed with chronic obstructive pulmonary disease (COPD). This model uses a Bayesian network approach and adopts domain knowledge. This study provides early intervention plans which prove really helpful to reduce COPD re-admissions [41].
22. The main objective of this paper is to develop an optimization model that helps to predict the re-admission rate of chronic obstructive pulmonary disease

(COPD) patients within the budget constraint. This model will also assist the hospitals to plan the required budget and reduce the re-admission levels [42].

23. Moreover, healthcare delivery systems such as nutrition analysis, radiation therapy treatment planning, resource allocation, and scheduling (e.g., [43–47]) heavily used linear programming models. But, no such study has been done on COPD re-admission.
24. This study used various machine learning approaches such as logistic regression decision tree, neural networks, and gradient boosting to classify different demographic, clinical, and socioeconomic variables that play a key role in forecasting the loss of revenue due to re-admissions. For this purpose, three medical conditions were mainly used, namely total knee arthroplasty (TKA), chronic obstructive pulmonary disorder (COPD), and total hip arthroplasty (THA). These models are then tested and contrasted based on area under ROC (AUC) and the rate of misclassification. With the help of visual data, this tool not only helps the hospitals to measure financial costs but also to track their service efficiency in a real-time fashion [8].
25. This study proposes a deep learning model aggregating deep forest and wavelet transform to predict the re-admission risk of diabetic patients. The model has been validated with actual health reports and contrasted with other patient prediction strategies. The findings of the experiment indicate that the deep forest is capable of performing better than the existing state-of-the-art methods for diagnosing diabetics [48].
26. Duggal et al.'s recent research makes use of Apache cTAKES to annotate the unstructured electronic health record (EHR) [49]. This study looks primarily at the re-admission rate of patients with diabetes in an Indian hospital for over 30 days. Several machine learning algorithms such as Adaboost, logistic regression, random forest, neural networks, and naïve Bayes were compared. The highest AUC of 0.688 was achieved using random forests.
27. This paper initiates the study of predicting the risk of re-admission for congestive heart failure (CHF) incidents within 30 days using big data solutions [50].
28. This project develops a software tool that not only calculates the re-admission probability of CHF patients but also assists the hospitals to determine the various factors that have a profound impact on the calculated re-admission risk. Depending on the patient's social factors and medical comorbidities, the decision support tool determines a list of post-discharge resources to reduce the probability of re-admission for patients [29].
29. A detailed list of models for forecasting the heart failure patient's re-admissions risk is given in [51].
30. Research by Wasfy et al. aims to use the unstructured details in the electronic health record (EHR) to forecast re-admission in percutaneous coronary intervention patients within 30 days [52]. In this analysis, the primary tool of NLP was the use of regular expressions to derive particular queries from the clinical report. The AUC for this study was 0.69.

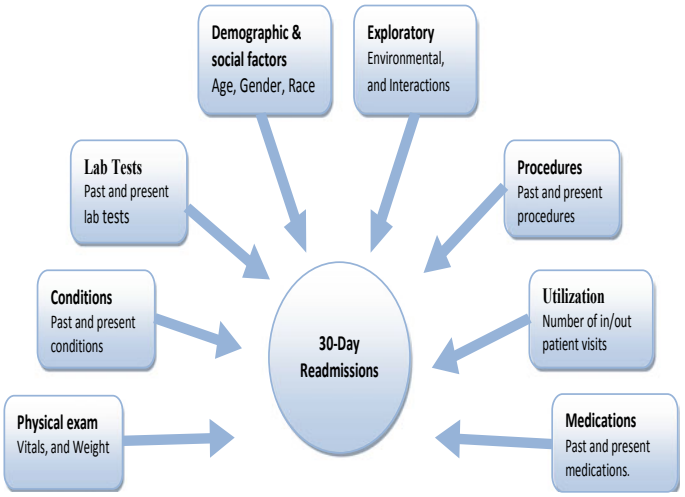

Fig. 7 Re-admission risk prediction conceptual model

31. Kansagara et al. conducted a systematic review in 2011 which compares data, methodology, and results [53]. The study concluded that estimation of re-admission is a complex issue and that recent models do not outperform research a decade before.
32. In this paper, the authors worked on a general framework for hospital-specific re-admission prediction. It extracts patient data (medications, demographics, labs, CPT and ICD codes, etc.) from a health system and generates a statistical model to predict re-admission. If a model for a particular disease is required, the framework can also adjust the model for only those patients suffering from that disease [6].
33. Some models were also developed for general population environments. A common model named LACE is discussed in [54], which used data from 4000 patients in 11 hospitals to predict emergency re-admissions after discharge from hospitals in Ontario, Canada. Other models that focus on data from general population include [55–57] (Fig. 7).

3 Causes of Hospital Re-admissions

Over the past years, hospitals across many developed countries such as the UK and the USA experience high re-admission rates [58]. One reason behind this could be a rapid discharge of the patients, as hospitals are accused of discharging patients "sicker and quicker" [59]. Therefore, the rise in early discharges may lead to high re-admission rates, which could probably be perceived as the premature discharge of patients from hospitals.

However, hospitals believe that re-admissions depend on the type of populations being served [7]. The argument is backed by conventional statistical analyses. Particularly, while the patient population is an important factor, patient satisfaction and quality of care also contribute a lot. Hospitals with higher patient satisfaction rates, serving less poor populations, and dealing with more complicated cases have lower re-admission rates across 1518 hospitals across the United States and are less likely to incur fines, according to research. There are poor associations: The frequency of re-admissions is more for the low-income population, and less for patients with high satisfaction; quality of care is negatively correlated with poor populations; resource availability is positively correlated with complex cases [7]. In short, continuity of care services prevents hospital re-admissions particularly in elderly people with serious illness [32]. On top of that, social characteristics play a vital role in predicting the patient's risk of getting readmitted to a hospital [60].

Drug consumption such as cocaine, alcohol, and tobacco harms re-admission of CHF [61]. It is evident from the fact that CHF patients who use tobacco and/or alcohol are more vulnerable to re-admissions compared to other patients [62]. Several researchers report that patients receiving medication for tobacco dependency have lower chances of re-hospitalization within 30 days of discharge. Similarly, cocaine use is known as a major social element in 30 days of re-admission or death [63].

Recent findings across the general population found smoking to be a leading cause of re-hospitalization. With a re-admission's odd ratio of 1.33 after one year of release, patients with mental disorder plus smoking addiction have a 33% higher probability of re-hospitalization relative to those who never smoked [64].

Social isolation is also found to be responsible for increasing re-admission rates, according to a study [60]. The possibility of re-admissions can be reduced if patients get continued support from their family members [62]. It has been shown that the availability of resources, such as travel arrangements, affects the re-admission rate [65].

Research has shown that there is a lack of responsibility to provide additional medical care for CHF such as patients refusing their diagnosis and declining to continue engagement with their doctors which further affects re-admission rates [65].

Besides, the stress caused by demographic variations, for instance, elderly people in advanced countries, may influence the rise in re-admissions. The main triggers of premature re-admission in the UK are considered to be chronic obstructive pulmonary disorder (COPD), stroke, congestive heart failure (CHF), and hip and thigh fractures [66, 67]. The re-admission rates are high for patients diagnosed with CHF, as per a report released by the American Heart Association (AHA). Such that within 30 days of discharge, 21.2% of overall CHF patients were re-hospitalized [28].

In addition to exploring medical, demographic, and ethnic causes, North Carolina data provided by HCUP found that social and economic factors such as eating habits, sleeping patterns, smoking, diet, and income play a vital role in these re-admissions [8].

Another reason behind patients getting readmitted to hospitals is the undesirable outcome that may occur after the recommended treatments and may not be anticipated

beforehand [68]. Furthermore, statistics demonstrate that 10% of patient fatalities occur due to diagnostic mistakes and are the most common type of litigation for medical malpractice in the USA [69].

According to a study released as a review letter in JAMA, Sepsis is found to a leading cause of medical re-admission and expenses. Nationwide re-admissions database 2013 was used to examine costs of unplanned re-admissions for heart failure (HF), pneumonia, chronic obstructive pulmonary disease (COPD), acute myocardial infarction (AMI), and sepsis in adults in the USA. The predicted re-admission costs for sepsis ($10 070) were significantly higher than for heart failure ($9051), pneumonia ($9533), COPD ($8417), or AMI ($9424) [70].

4 Reduction in Hospital Re-admission

The huge expenditure on healthcare each year and the need to improve the quality of healthcare make it mandatory to reduce hospital re-admissions. Early re-admission prediction in the process of hospitalization will help prevent severe or life-threatening accidents, which serve as a significant contributor to decrease medical costs. Previous research on forecasting re-admission mostly concentrates on some important features that are most relevant to the cause of re-admission [71].

A wide research area is working to reduce re-admissions. A large portion of this concentrates on enhancing discharge procedures and quality of care, e.g., ensuring that patients are properly informed regarding their post-discharge care [6]. It is essential to educate patients about their sickness and the various treatment procedures that they can have to maintain a stable state. Research conducted by Sara Paul showed that education can decrease the chances of re-admission by 54% [72].

One study showed that setting up a clinical care program, that includes regular telephonic meetings between the pharmacist and a patient, reduced chances of re-admission by 26% [18], for example, re-admission risk in hospitals for high-risk aged people released from hospital wards can be minimized with home-based pharmacist follow-up that detects and fixes drug-related issues (DRIs), claims Australian researchers.

Specifically, when prolonged re-admissions are related to socioeconomic and clinical determinants, improved coordination and integration through multiple boundaries (health, social, cultural) and structured collaborations between community-based organizations and acute-care hospitals may deter them (Liner-tova et al. 2011) [32].

Existing research has found that improved assistance to patients at home can have a drastic impact on healthcare costs and efficiency [73, 74], for example, [28] designed a telehealth system for patients diagnosed with congestive heart failure (CHF). It collects patient information, for example, glucose, heart rate, weight, blood pressure, etc., and displays it on the dashboard present on the clinician's end. Daily measurement of vital factors (blood pressure, weight, heart rate, glucose) and regular tracking

of patient symptoms can decrease re-admissions and improve patients' condition to a great extent.

Many behavioral considerations, such as non-adherence to drugs and eating patterns, greatly affect the risk of a patient's re-admission [75]. It is advised that an individual with CHF-related problem limit their sodium intake to 3 grams or less [76]. The chances of heart failure that can get doubled due to hypertension can be controlled by reducing the amount of sodium intake [77]. Recently, the new guidelines released by the American Cancer Society suggest that women with acceptable breast cancer risk should begin mammograms at 45 years of age (5 years later than previously recommended by ACS) [78–80]. According to Fogg's behavior model, the three important elements to adopt a healthier lifestyle are motivation, ability, and trigger to change your behavior. If anyone among these is missing, behavior does not change (Fig. 8).

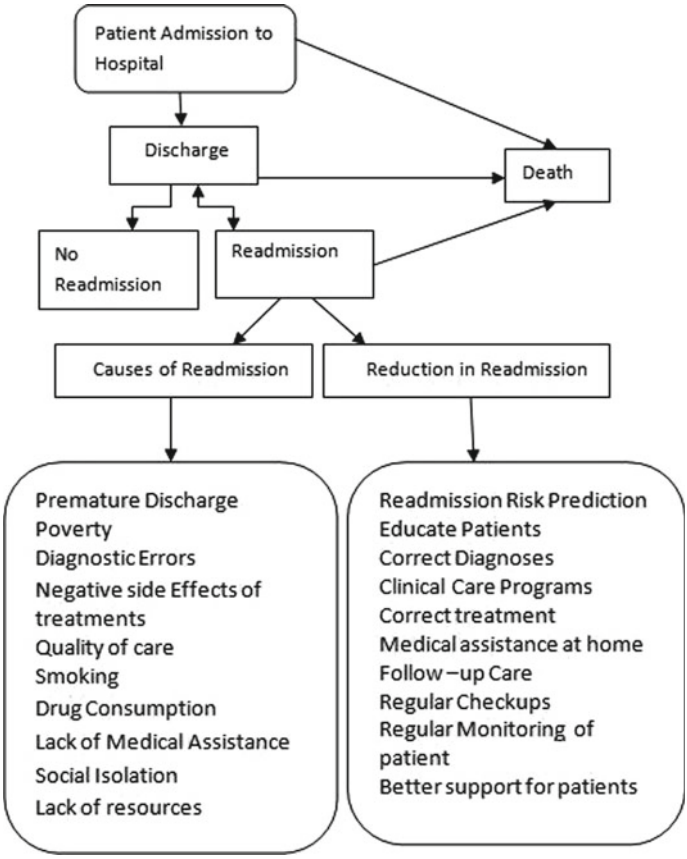

Fig. 8 Re-admission process: causes and ways to reduce hospital re-admissions

5 Conclusion

Re-admission is the major cost driver for medicare systems. The explanations for why people return to the hospital soon after discharge are complicated. Unnecessary medical re-admissions reduce not just the quality of medical care, but it also results in high resource wastage in hospitals. Few attempts have been made to find out the appropriate time frame in forecasting re-admission. Factors such as poverty, gender, type of population, age, and seriousness of illness may lead to differences in the predicted time periods of the specified clinical conditions. Patients who are identified at high re-admission risk while hospitalization can aid to cut down re-admissions. Socioeconomic factors are mostly helpful in prediction, but usually, they are not present in the electronic medical record system of hospitals. Hence, even if there is a design of risk prediction models for a particular hospital, it does not offer outstanding performance.

Re-admissions influence the demographics of patients such as social, cultural, health, and financial factors; resource availability, care quality, and hospital bed. Hospitals treating underprivileged people and delivering inadequate treatment are the two major reasons for increased re-admissions. Another concern worth noting is that hospitals with fewer/no re-admission fines are more likely to be hospitals with adequate funds to devote their resources to improving the quality of treatment. Therefore, the penalization of hospitals with financial problems is not favorable. However, it is the responsibility of hospitals to strengthen patient care and adhere to follow-up services, but should never, at the same time, be prevented from helping the poorer and sicker populations. Larger, well-accomplished research should continue to gather evidence on the long-term efficacy of quality of treatment approaches.

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An Edge DNS Global Server Load Balancing for Load Balancing in Edge Computing

P. Herbert Raj

Abstract The information technology era faces an inflection spot due to current changes in the network industry due to the surrogation of cloud application implementation instead of data centre-based application implementation. The fiery growth of portable devices, sensor, and IoT-based devices would cause a stern effect on cloud application development and deployment in the network industry. The edge computing model is developed to enhance cloud application deployment. Edge computing is defined as where the computed calculations and storage of data are located in close physical proximity to improve the response time, reduce the latency, and improve the network bandwidth. This article analyses the ways to achieve the goals of edge computing with the assistance of load balancing.

Keywords Edge computing · Data centre · Global server load balancing (GSLB) · Disaster recovery plan (DRP) · Distributed denial of service (DDoS) · Internet of Things (IoT) · 5G · Latency

1 Introduction

This is an epoch of cloud computing. Currently, many people are using personal computers and desktops to access many of the centralized server computers. At the same time, IBM, Amazon, Microsoft, and Google are providing cloud services to their users to improve scalability, efficiency, reduce IT expenditure, 24 × 7 connectivity, and much more [1]. The cloud computing business could surpass $330 billion in 2020 due to the embracement of cloud computing [2]. This happened because users could access the resources from anywhere at any time. The upcoming 5G technology will enhance these capabilities because edge computing must provide high bandwidth to the connected users [3–5].

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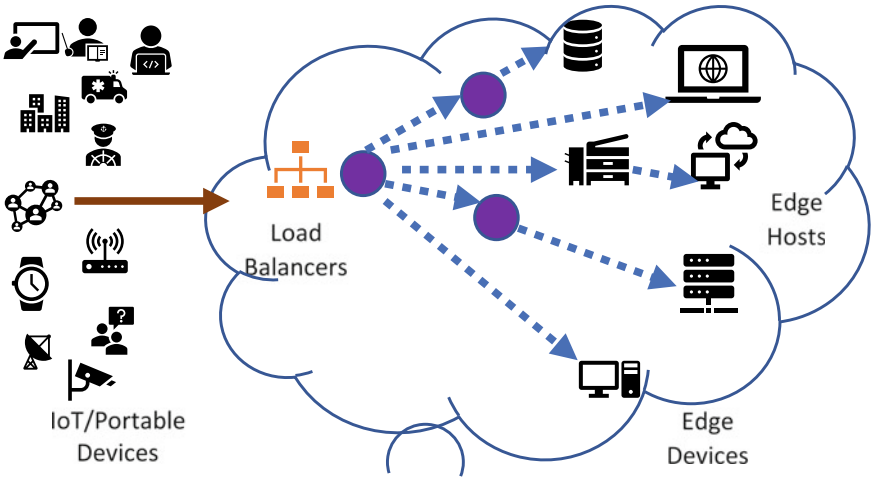

Fig. 1 Edge architecture with load balancers

1.1 Need for Load Balancing in Edge Computing

Edge computing tries to move the computations nearer to clients to minimize the delay and to reduce the bandwidth usage. The edge of a communication network is very close to the client; unlike the cloud network, the servers are placed in a faraway place. Cloud computing is a central network management system where applications are functioning in the data centres. Edge computing is also a central network management system but here applications are operating either in the device or in the network edge [6]. It intensifies the confidentiality and solitude of data being processed. Network instability or disruption will not affect the overall operations in edge computing [7]. Figure 1 depicts the edge computing architecture with load balancers.

1.2 Need for Load Balancing in Edge Computing

Scalability is the key issue in load balancing. Some services may not be available to clients due to the network or website or server failure. This may lead to disparity in the network traffic distribution. Load balancing algorithms take a lead to resolve the unbalanced traffic distribution. Even though numerous algorithms are available, achieving optimal load balancing is an ultimatum. The cloud bursting method is used in some servers to settle the load balancing issues in the edge environment [8]. The application of load balancing is greatly influenced by the tendencies of edge computing. The job of the load balancer is to migrate together with other apps. Data centres of edge have load balancers that utilize the global server load balancing

(GSLB) for linking the different edge data centres. This will maintain an effective reply time by spreading the load over multiple edge servers [9].

1.3 Load Distribution

Load in the network will be distributed evenly between clients and servers by using various load balancing algorithms. The algorithm will be selected based on what sort of facility provided, and the present stage of the network will be taken into consideration. There are few load balancing algorithms used to balance the load, namely round-robin, weighted least connection, and resource-based.

1.4 Edge Computing and Load Balancing

Internet of Things can able to nexus with numerous portable and smart gadgets and automatically turn out to be a component of varying cutting-edge applications. This produces a huge volume of data, and it may increase in future [10, 11]. The data centres of clouds are positioned very in far-flung locations from these gadget users, and the bandwidth is limited [12]. So, latency in request-reply is inevitable. Edge computing assists to reduce this distance and moving closely from federal services to the boundary of the network. These edge devices may handle a huge sum of data and concurrent tasks without any latency [13]. Nevertheless, this might lead to unbalanced traffic distribution due to the huge amount of data to be processed. Multiple data centres in the edge can be combined as a single virtual one. So, load balancing can be done here by using GSLB. Nowadays, edge computing load balancing is drawn the attention of scholars because of its physical proximity to the users and latency reduction [1]. In this article, the process of GSLB comfort edge load balancing is discussed in detail.

2 GSLB Load Balancing

In GSLB, the network traffic is disseminated to the numerous linked servers in this universe. This is one of the most credible load balancing methods for industries, and it greatly minimizes latency. GSLB empowers multi-edge data centres to control and manipulate the availability of the resources placed across the world. This can be achieved by incorporating virtual multi-edge data centres, several servers, and a cloud environment. It has optimized traffic redirection methods in case of any failure or service intrusion over the network distribution. The user's request is sent to a location where it can obtain the best service and also examines the availability of the resources.

2.1 Need for Edge DNS GSLB

(a) **Load Balancers**: Load balancers function well on a smaller scale, which means when the end users' devices and servers are limited. LBs may not function well in the multi-cloud with numerous data centre architectures due to their complicated topology. For the LBs, there is a need for definite design and bandwidth to link the data centres and user devices. It is not possible to provide these facilities for all the services. To alleviate this problem, DNS can be used [14]. Here, user requests can select one of the offered IP address at random and send their traffic to a particular destination. This will disseminate the load amid data centres. The LBs mounted in the local data centres lever the remaining traffic.

(b) **DNS**: DNS disseminates the network load to numerous addresses with a similar application label. Setting up a DNS connection is very straightforward, and the service provided by DNS can be easily used by users. In load balancing, DNS redundancy cannot be updated automatically when a server is added or removed. Some automatic updates or manual updates are needed at this point. This may lead to application unavailability for some clients. Global DNS system may provide a similar reply to all the connected users. Some may need a different reply according to their site location. So vibrant updates and site-specific replies are mandatory here. To alleviate this sort of problem, DNS global is hosted [14].

(c) **DNS GSLB**: DNS GSLB is able to reply vibrantly to the client requests and robotically updates the server. The disadvantage of this method is that those who need to use this service have to be in this geographical zone. This system is highly centralized. Always on service availability may not be possible due to the capability to find out the available servers. This problem leads to find another better method to route the traffic smartly and directly.

(d) **Edge DNS GSLB**: Edge DNS GSLB is considered to be the best solution for traffic routing because it offers the best routing decision to reach the destination for a requested client. It can answer any client's request without any centralized committed zone. The traffic routing of edge DNS GSLB can be integrated with characteristics of a recursive DNS server which offers a lot of benefits to the clients. The benefits of this method are scalability, swift responsiveness, obtainability of local data, proficient caching, security, optimized DNS traffic, and augments multicentre robustness [14].

3 Edge DNS GSLB and Multi-cloud

Edge DNS GSLB produces a professional and modest way to load balance the network load. The application routing choice will be made at the location of users which is closer to the edge network. The forthcoming sessions describe the advantages of executing Edge DNS GSLB.

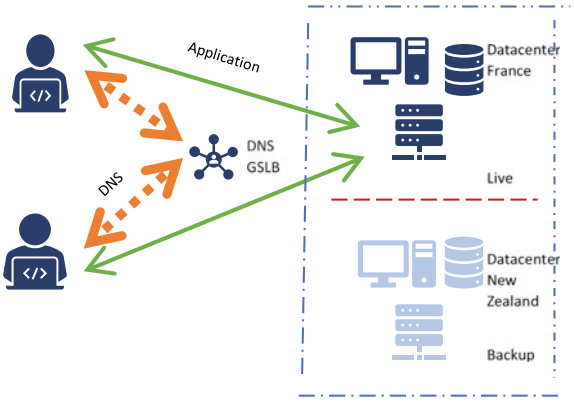

Fig. 2 Live connection. *Source* https://www.efficientip.com/wp-content/uploads/2020/10/sp-GSLB-Use-Cases-EN.pdf

3.1 Advanced Disaster Recovery

Industries host significant applications in a particular server that will be available in the disaster recovery plan sites. These kinds of applications will be accessed and used by numerous users. IP address maintenance will be handled by DNS. In case of any failure arises, these applications will not be accessible. The new location of the network must be reflected in the IP address. Without blunders, changing the DNS information is impossible. Moreover, it is a time laborious task. All users switching over to the DRP site would complicate things furthermore.

At the application level, Edge DNS GSLB permits amalgamating manifold design facilities and switching over.

(a) **Failovers**: Here, each application is established with two nodes, one is to link the key site and another one is to link the reserve site. If the key site is incapacitated, then all the applications are connected to the DR site. This will be done automatically [14]. Figure 2 shows the live connection between the user and the application data centres.

3.2 Sharing of Network Load Between Multiple Data Centres

Consider a scenario, an application is accommodated in several data centres for distributing the network load. The users' requests will be directed according to their own site to the desired data centres. The challenge is how to make this possible for a user-specific site. Figure 3 describes the traffic routing with a health check.

(a) **Dynamic Distribution**: The level of the application server link will be checked on an ordered basis by Edge DNS GSLB to determine whether the users can be pointed to it. This will decide on which is the best link for the user [14].

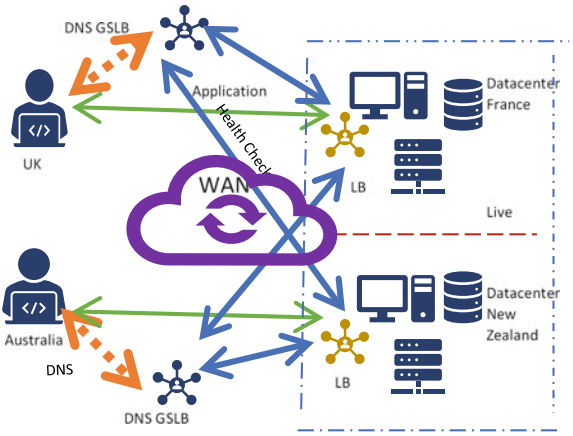

Fig. 3 Application traffic routing with a health check. *Source* https://www.efficientip.com/wp-content/uploads/2020/10/sp-GSLB-Use-Cases-EN.pdf

3.3 WAN Failure Detection

In the case of WAN failure, clients' requests should be led to the application server which is accessible and the top pick. The challenge is that accessing from a middle of a server to a client placed in a far-flung site may not be possible all the time. Edge DNS GSLB identifies any differences in the network among the far-flung location and the application server and gives the best solution for routing [15]. Figure 4 shows the selection of the best destination routing.

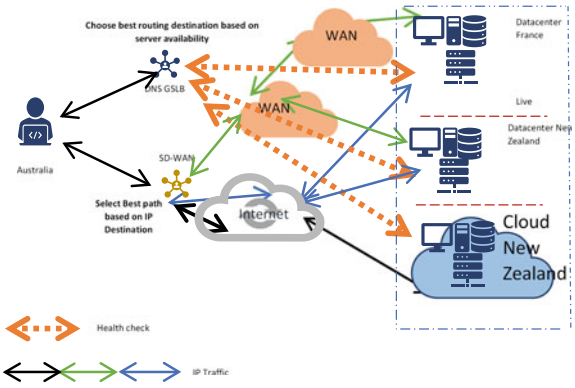

Fig. 4 Selecting the best destination. *Source* https://www.efficientip.com/wp-content/uploads/2020/10/sp-GSLB-Use-Cases-EN.pdf

4 Conclusion

Until now, IP address resolution is done by DNS service. This is a significant procedure in IP networks because it permits users to access the application server. The operational requirements made the network engineers devise new protocols and devices to enable the users to access everything smoothly and securely. When data centres provide services to the users to store or retrieve data and a lot of security measures are devised to access the data securely. The design complications are diminished with the help of Edge DNS GSLB. Load balancing and multi-cloud management can be designed undoubtedly with the help of Edge DNS GSLB. The significant benefits of Edge DNS GSLB have increased scalability, dexterity, robust multi-cloud management, user experience, and simple DR plans. Most importantly, this load balancing technique minimizes the energy consumptions of the processor without lowering the edge network functioning. Finally, this method guarantees the application accessibility for the clients, if any WAN breakdown happens. The implementation benefits of Edge DNS GSLB perfect match for load balancers, SD-WAN, and application delivery controllers to make correct routing decisions. This is very straightforward to implement and expands huge benefits.

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Network Intrusion Detection Using Cross-Bagging-Based Stacking Model

S. Sathiya Devi and R. Rajakumar

Abstract Network-based information transmission has brought huge convenience for users in terms of the ease of use. However, the increased transaction not only lures fraudsters but also makes attack detection with a complicated process and mandates scalable models that can handle big data. This paper presents a network intrusion detection model that uses a hybrid ensemble model to identify intrusions in network transmission process. This work proposes the cross-bagging-based stacked ensemble model, which is a two-layered prediction mechanism used for operating on the complex network data. The first layer that contains a modified bagging mechanism is called the cross-bagging, where the results are passed to the second layer for final prediction. Experiments were conducted by using the NSL-KDD dataset. The usage of ensemble modelling enables the model to be effectively parallelized and also ensures high scalability of the model. This ensures effective prediction even on data with large volumes and high velocity. Comparisons with recent models show high performance for the proposed model.

Keywords Network intrusion detection · Cross-bagging · Stacking · Anomaly detection · Ensemble model

1 Introduction

Increased usage of networks and network-based transactions in recent times is mainly due to the ease of use. However, the flexibility comes with the vulnerability associated with it [1]. Packets transmitted in networks are prone to attacks by creating a huge security risk in the transmission process. Although this cannot be avoided altogether, it can to a large extent be detected and prevented at the earliest [2, 3]. Network intrusion detection systems play a pivotal role in performing this process effectively. Faster detection process results in a better system by providing elevated levels of security. Further, the large amount of data created in the current scenario makes

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intrusion detection in networks as a significant challenge. This further results in the requirement of big data processing techniques for the detection process.

Technically, intrusion detection systems can be categorized into two; they are intrusion detection systems (IDS) and intrusion prevention systems (IPS) [4]. IPS is a proactive model, while IDS is a reactive model. IDS is a more adopted problem when compared to IPS [5]. This work presents an IDS model called the cross-bagging-based stacked ensemble (CBSE). Network data is complex, hence requires a complex model for prediction. The proposed CBSE model is composed of two levels; the begging process and the stacking-based prediction. This enables the model to create higher-level abstractions, hence provides better predictions.

2 Literature Review

Intrusion detection plays a pivotal role in networks paradigm with the effective network functioning parameters. IDS systems are categorized based on their operational nature. This section categorizes the IDS models into three categories; they are hybrid/ensemble models, machine learning-based models and ensemble models.

A hybrid model for detecting intrusions in network data was presented by Aljawarneh et al. [6]. This model is built in two layers; the first layer is composed of vote algorithm based on the information gain, and the next layer is composed of multiple machine learning models for prediction. Another hybrid technique that combines multiple models for prediction is presented by Ravale et al. [7]. A bagging-based intrusion detection model was proposed by Gaikwad et al. [2]. It uses partial decision trees for the prediction process. A context-aware IDS model for real-time environments was proposed by Pan et al. [8]. This model is designed for automated operations on networks. Other hybrid models include unsupervised model by Carrasco et al. [9], reinforcement learning-based model by Caminero et al. [10], deep learning-based model by Gurung et al. [11] and fuzzy cognitive maps (FCM)-based model by Chen et al. [12].

A support vector-based model that uses both classification and regression for prediction was presented by Bamakan et al. [13]. The model has been designed to operate on data imbalance and the skewed distribution of the data. Several other models utilizing support vector machine (SVM) for the prediction process are incremental SVM model by Yi et al. [14], principle component analysis (PCA)-based SVM model by Kuang et al. [15] and feature selection-based SVM model by Ahmad et al. [16]. An IDS model using lazy Learning was presented by Chellam et al. [17]. This model aims to reduce the computational complexity of the detection mechanism. An extreme learning machine-based model that uses incremental learning as the learning strategy was presented by Wang et al. [18].

A genetic algorithm-based IDS model was proposed by Pawar et al. [3]. It uses chromosomes of varying lengths for the prediction process. A combination of meta-heuristic models is also used in literature, creating hybrid models. An artificial bee colony (ABC) and AdaBoost-based IDS model was presented by Mazini et al. [19].

ABC is used for feature selection and AdaBoost is used for the detection process. A linear genetic programming-based IDS model was proposed by Hasani et al. [20]. It also incorporates the bees algorithm in its prediction process. Other swarm optimization models include articles by Gupta and Shrivastava [21], Sujitha and Kavitha [22], and firefly-based model by Selvakumar and Muneeswaran [23].

3 Cross-Bagging-Based Stacked Ensemble (CBSE)

Intrusion detection in networks has become a major concern due to the sensitivity of the information transmitted via them and also because of the increased attacks in network by fraudsters. This work proposes an ensemble-based model, cross-bagging-based stacked ensemble (CBSE) that aims to provide a complex analysis architecture that detects network intrusions significantly faster than the conventional models.

The proposed CBSE model is composed of three major phases; the initial preprocessing phase prepares the data for predictions, the cross-bagging ensemble modelling phase reads the data and prepares the decision rules for predictions, the final stacking phase operates on the predictions from the previous phase to determine the final predictions. Algorithm for the proposed model is given below.

Algorithm

1. Pre-process training data
2. Data segregation to form training and testing data
3. Divide training data into ten distinct subsets
4. Create base learners (Decision Tree and Random Forest)
5. For every subset s created (except for the last):
   (a) Pass to a distinct base learner for training
6. Use the last subset for prediction
7. Append prediction to the result set
8. Shuffle training data
9. Repeat steps 3–8 until required number of prediction results are obtained
10. Create training data (second level) for the stacking phase using the predictions and actual class
11. Train logistic regression model using the second-level training data
12. Pass predictions from this as the final predictions.

4 Data Preprocessing and Segregation

Network data in general is composed of several network attributes. Several of these properties represent details about the source, destination and some standard attributes

that are to be inserted into the network packets. These attributes however might not be needed for the machine learning model.

Data preprocessing is performed by identifying categorical and string attributes and converting them to numerical formats. Numerical features are the only type of features that can be processed by machine learning algorithms. Hence, categorical attributes are encoded to form numerical attributes. This work uses one-hot encoding method to convert categorical data to numerical formats. String data corresponds to data that cannot be encoded due to the generic (like Address) or very specific nature of data (like ID). Hence, they are eliminated from the data. This forms the end of the data preparation phase. The data is then segregated into training and test data. The division is performed in the ratio 7:3, where 70% of data is used for training and 30% of data is used for testing.

5 Cross-Bagging Ensemble Creation

Ensemble modelling is the process of using multiple machine learning models to perform predictions rather than relying on a single model. Ensemble models are considered to operate best when data involved for prediction is complex. Several ensemble modelling techniques are available in literature, namely bagging, boosting, stacking, etc. This work uses a combination of bagging and stacking models for prediction. This phase creates a bagging model for the prediction process.

Bagging or bootstrap aggregation is the process of creating various subsets of the data called bags and training multiple machine learning models based on the created bags. These models are used for prediction and the predictions are aggregated using a combiner to provide the final results. The proposed model modifies the bagging process by varying the bag creation mechanism and by replacing the combiner phase with the stacking process.

The proposed bag creation process is performed by splitting the data into ten distinct subsets. Overlaps between the subsets are eliminated in order to constrain the training data within a specific size. The number of subsets to be divided depends on the training data and the data similarity levels. This is determined by the domain expert. Nine of the generated subsets are used for training and the final set is used for prediction. The resultant predictions are recorded for processing by the stacking model. The dataset is then shuffled to rearrange the data instances. The shuffled dataset is again split into ten segments, nine of which are used for training and one for prediction. The predicted results are appended with the previous prediction set. The process of shuffling, splitting and prediction is repeated multiple times, and the results are iteratively appended to the prediction set. This process is repeated until sufficient amount of data is obtained for the next level stacking process.

Predictions are performed by multiple heterogeneous classifiers, rather than a single model. This aims to improve the prediction level of the data. This work uses decision tree and random forest for prediction. Although both are tree-based models, decision tree is a weak classifier, while random forest is a strong classifier. Being

weak classifiers, decision trees have the capability to handle dynamic data. Since the domain requires dynamism, decision trees are used as a part of the ensemble. Random forest, being a strong ensemble, can effectively overcome the overtraining issue experienced by the decision tree model. Predictions of both these models are combined to form the input data for the stacking model.

6 Stacking Phase for Final Prediction

The predicted results obtained from the previous phase are combined with the actual results to form the training data for the stacked model. Stacking is the process of operating on predictions of a model rather than on the actual data to determine the final predictions. Stacking operates to determine the predicting nature of a model. The model creates rules based on the predicting behaviour of models in the previous phase, rather than creating rules from the training data. This provides a two-level abstraction, hence makes the model effective even on highly complex data.

Logistic regression is used as the model of choice for the stacking phase. Although being a primitive model, logistic regression was observed to operate effectively on less complex data to provide highly effective predictions. The low-computational complexity exhibited by the CBSE model makes it a suitable choice for the second-level prediction.

The test data is passed to decision tree and random forest and the predictions are aggregated and passed to the stacked model. The predictions from stacked model are passed as the final predictions.

7 Results and Discussion

The cross-bagging-based stacked ensemble (CBSE) model has been implemented in Python. NSL-KDD is used to validate the model performance [24]. ROC curve for the CBSE model is shown in Fig. 1. ROC curve creates plots between TPR and FPR values. High TPR and low FPR are indicative of an effective classifier. The CBSE model shows TPR of 0.99 and very low FPR (<0.1), indicating good performance of the CBSE model.

PR curve for the CBSE model is shown in Fig. 2. PR curve is plotted with precision and recall in the axes. Precision represents the effectiveness of the classifier in correctly identifying the intrusions, while recall represents the capability of the model in labelling intrusions from all of the test instances. Both are expected to be high in a good model. High precision represents that most of the positively labelled instances are actually positive and high recall represents that the model has correctly labelled most of the positive instances as positive. CBSE model exhibits high precision and recall showing its prediction efficiency.

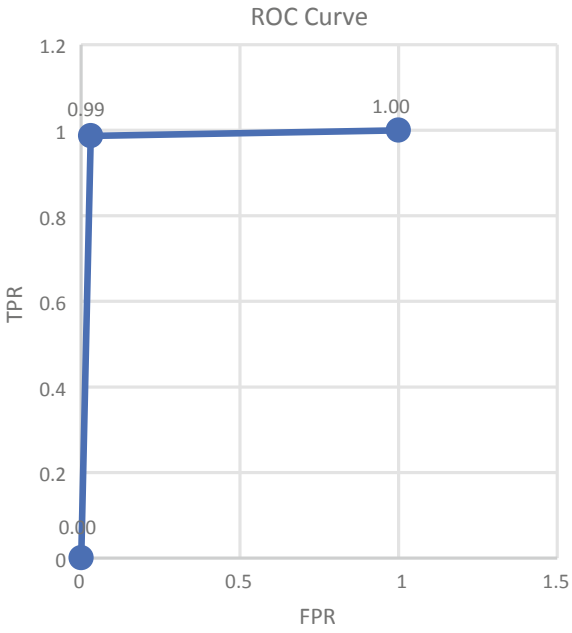

Fig. 1 ROC curve

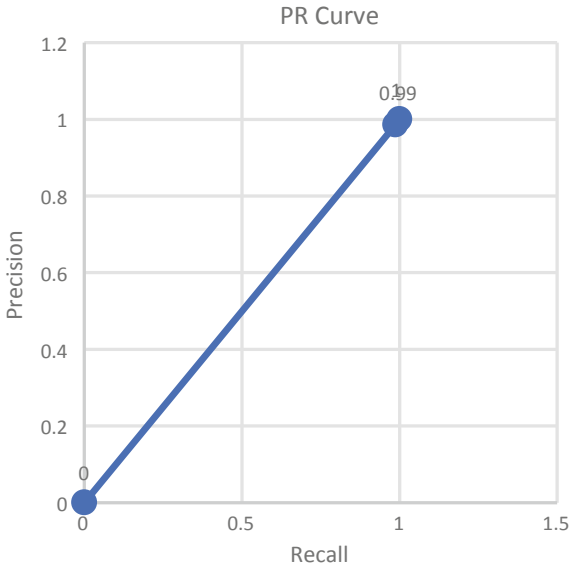

Fig. 2 PR curve

Aggregate metrics indicate an overall view of the classifier performance. This work considers accuracy, precision and F1-score for analysis (Fig. 3). A comparison is also performed between the CBSE model, RampLoss model [13] and deep learning-based model [11]. RampLoss is the recent state-of-the-art model for intrusion detection in networked environments. The CBSE model exhibits either equivalent (accuracy at 99%) or higher performance (improvement of 1% on F1-score and 2% on precision) in terms of all the metrics. The high prediction capability of the CBSE model is explicit in the comparison. Although the predictions are similar, the ensemble model is parallelizable in nature and hence exhibits high scalability levels, making the model effective in big data environments.

The performance of CBSE is tabulated and shown in Table 1. The metrics show high performance (>97%) in terms of all true prediction metrics and (<3%) in terms of all the false predictions. This indicates high performance of CBSE.

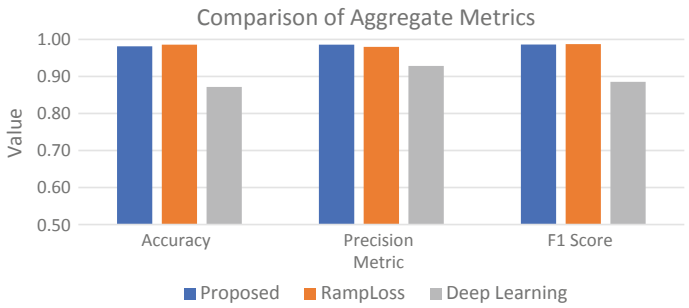

Fig. 3 Performance comparison of aggregate metrics with RampLoss and deep learning models

Table 1 Performance of CBSE model

Metric	Value
FPR	0.03
TPR	0.99
Recall	0.99
Precision	0.99
F1-score	0.99
Accuracy	0.98
TNR	0.97
FNR	0.01

8 Conclusion

Detecting network intrusions at the earliest enables secure network environments, hence encourages users to perform even highly sensitive transactions. This work presents an effective intrusion detection model, CBSE, to perform intrusion detection. The model is composed of two layers; the cross-bagging layer and the stacking layer. Experimental results and comparisons indicate high performances by the CBSE model.

Novelty of the model is based on the usage of varied combination of training and test sets in the cross-bagging layer results in forming rules that can handle the complex nature of the data under analysis. General bagging models are homogeneous in nature. The heterogeneity introduced in the process results in handling data insufficiency and also avoids overtraining. The stacking layer enables handling the complexity of the input data with the secondary abstraction. This high efficiency makes the proposed CBSE model highly effective in terms of predictions in real time.

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Enterprise Network: Security Enhancement and Policy Management Using Next-Generation Firewall (NGFW)

Md. Taslim Arefin, Md. Raihan Uddin, Nawshad Ahmad Evan, and Md Raiyan Alam

Abstract Network security is considered as a major task in network architecture. A network administrator had to focus, and it is defined and demonstrated as the rules, plans, and procedures followed by a network administrator to protect the network devices from different threats, and simultaneously, the passive and active attacks are generated from various vulnerable sources. Further, the unauthorized users must be prevented from accessing the network. There are different types of threats that need to be identified, explored, and take a step for preventing it, wherein the attacks are like DoS and DDos attracts, Aurora attacks, malware attack, port scanning, password sniffer, IP spoofing, session hijacking, and man-in-the-middle attacks, and cyber-attacks. This could be done with the help of firewalls, which can secure the network from malicious attacks. This paper is more focused on strong policy and performs incredible directions for averting the mentioned attacks. Firewalls are one of the strongest hardware attachments to secure the zone of networking sectors like local large, multinational, or enterprise networks. The deployment of firewalls that enforce an organization's security policy is network devices. For this kind of tiresomeness, the concern of this paper is to enhance and develop network security like IPsec VPN, strong masquerades, port forwarding, create a trusted zone on WAN and LAN side, etc., based on the firewall by the execution of various tasks and different policies.

Keywords Network security · NGFW · Firewall · Enterprise network

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1 Introduction

Now, in this modern world, computer network system increases rapidly day by day. Therefore, a strong security system is very much important to protect the network. In a computer network, users interface are threatened from all kind of attacks from hackers. So, the development of network systems is the most required step where unwanted attacks are rising significantly. A large number of these dangers have turned out to be cunningly practiced assaults causing harm or submitting robbery. Moreover, government and business are massively dependent on the use of the Internet, and there are numerous advantages for using of Internet. So, ensuring secure applications for this sector to prevent the risk. Firewall concepts and technologies are nowadays a major topic that should be a part of any information security curriculum. Firewalls are security devices or software tools that are used to apply by implementing security rules to filter inward and outward network traffic of an organization's security policy. However, commercial firewalls are nowadays designed to be used by professionals and are not usually very appropriate for the academic environment. That is the most commercial firewalls do not allow educators to suggest advanced hands-on lab exercises on firewall concepts and technologies and offer usually complex user interfaces to con the firewalls and manipulate the filtering rules. For example, [1] low-level filtering rules are not to be allowed in commercial firewalls by manipulating the six flags of TCP, [2] also do not allow the lack of the ability to deal with the efficiency and the consistency of the filtering rules, [3] do not allow managing and viewing the table of stateful sessions, do not offer means to enhance the firewall packet processing performance by reordering the orders of the filtering rules and their rule-fields or using early packet rejection and acceptance mechanisms [4, 5] do not allow implementing rules to filter the application layers' contents (known as deep packet inspection (DPI)) and are unable to deal with common denial of service (DoS) attacks targeting the firewalls [6]. Consequently, commercial firewalls do not allow both the instructors to offer advanced hands-on lab exercises on firewalls, and the students to better anatomize advanced firewall concepts and technologies. An enterprise network is a network that helps to connect associate's PCs and related gadgets crosswise over offices and work group systems. An enterprise network decreases correspondence conventions, encouraging framework, and gadget interoperability and also enhanced the interior and outside enterprise data management which is called a corporate network. An enterprise network is to eliminate different clients and work groups as the key motivation. All methods should be able to communicate with each other and provide and recover data. Also, physical processes and devices should be able to maintain and give favorable reliability, performance, and security. Enterprise computing models are developed of established enterprise communication protocols and strategies for this purpose, facilitating exploration and improvement [7]. On the other hand, an enterprise network includes the LAN/WAN based on departmental and operational supplies [7]. Since the improper security model of an enterprise network exists, this paper gives an overview of the different kinds of security attacks of an enterprise network and how to prevent these attacks. And, finally, gives a properly deployed security The objectives of this work are to publish and define the

idea of attack and threat to a computer network, to highlight different allaying techniques used to complicate threats and attacks, to illustrate the procedure to implement the best security model for an enterprise network [8]. The various types of attack and different kinds of mitigation techniques are discussed in this paper. Finally, it implemented a secure network which prevents those attack. Finally, this paper will highlight on the importance of network security and also figure out the improper configuration of security in an enterprise network and, also, explain the newly deployed security model of an enterprise network. This newly deployed security model minimizes threats to give a better secure network. Also, this security-enhanced model can be resolved the future attack.

2 Related Work

A network admin can control the authorization of access in a network by deploying network security. To prevent the attack and ensure a safe and stable network, it is mandatory to exploit security. It can be easily maintained what services are allowed and what is not by using security policies in a firewall. Using a firewall for network security can be a sophisticated way to secure the service ports from the attackers, maintain valid user access for valid services, inspect the traffic, and detect the harmful contents like malware, Trojans, and other computer worms [7, 8]. Nowadays, security specialists are using Wireshark to capture packets and taking logs for analyzing the network system. Different kinds of encryption methods and security algorithms are used for the host to host communication. The communication technology is making the world smaller by enlarging and interconnecting the IP network. People from every stage are now adopting network security for creating a safe network environment of their data. The network security is now getting more priority for the scalable service, and the research goes to analyze it [8]. To ensure a better security environment, it is important to have security in all layers of the network. There are seven layers in the open system interconnection (OSI) model, and it is required to ensure security in all layers. In general, people think about only workstation security by applying security features in the application layer. To protect the data, it is important to exploit the security feature in all layers [9]. There can be any kind of malicious attack happen from any source when any workstation gets connected with the Internet. There can be two kinds of attacks in general, and those are ‘active attack’ and ‘passive attack.’ In the active attack, the attacker will ambush the target directly and will try to modify the system or information. In another word, the passive attack will make the attacker breach the transit security of the network to analyze user data and afterward monitor. To avoid these, a network security engineer must apply some strong security framework [10]. As a next-generation firewall, ‘Fortinet’ has a tremendous contribution by delivering high performance, sophisticated security solutions, and integrated features. This is more capable to analyze the vulnerable traffic and a better option for the security engineers [11]. Security architecture added the feature like intrusion prevention system (IPS) which will analyze the outgoing

and incoming traffic to the network. The firewall device needs to have this additional module to implement it. This feature analyzes the packet and filters the infected portion [12]. There are two kinds of firewall, and these are hardware based and software based. Software-based firewalls are generally installed in a host workstation and have so many drawbacks. Hardware-based firewalls are dedicated a device to operate security systems, and it can be set up in any position of the network. This ensures better protection and solution than software-based firewalls. At present, there are new kinds of firewalls, which is called as cloud-based firewall. These kinds of firewalls are easily accessed from remote and operated by specialized security professionals [9].

3 Methodology

Most of the organizations found out the existing security system controls are reducing their effectiveness and preventing them from getting something done. An organization needs to share some information with the general user, customer, or newfangled business partners. If there are any kinds of security issue occur, what will be the business impact? For the outcomes of this kind of security issue, it needs to be developed an innovative, effective security program. So, the risk depends on the security system and security policy that the administrator applied to the network. Sometimes good security of an organization creates a good business opportunity because the customer, business partners want to be sure that their data is secure as new risks are introduced daily, so the administrator needs to be aware of everything and should apply a proper firewall policy to prevent those attacks and risks. The company needs to balance the security issue and business information while sharing company information can share information easily [9] (Fig. 1).

3.1 IP Spoofing

Ip spoofing is to obtain unauthorized entree to the computers which are a kind of technique that attackers use. In this process, the hackers send illegitimate messages to the host computer IP as a trusted host. On another hand to generate traffic in the target computer and make it coming from a trusted host attacker engages with the unsuspected hosts, then the attacker floods the network. The way of transmitting packets with forged source addresses is known as IP spoofing, which is straight linked to different kinds of networks malfunctioning like DDoS [13, 14]

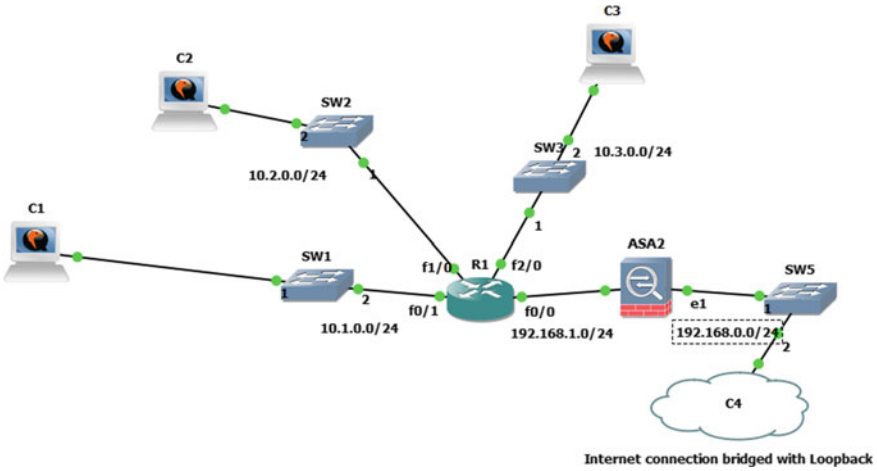

Fig. 1 Existing network model of an enterprise network

3.2 Insider Intrusion

Insider intrusion is kind of unusual type of attack; it is not like an external threat, a person who has authorized system access could be an insider intrusion attacker, so there may be less security against insider intrusion on most of the organization because most of the company focus on their external attacks, and insider attack is also recognized as insider threat [15].

3.3 Denial of Service (DDoS)

The DDoS attack is distributed for a server, website, or another network resource by multiple computer systems attack. The target system forces it to delay or even crash and even shut down as a flood of an incoming message, connection request, or malformed packets to the target [16].

3.4 No Protection Against Masquerades

A masquerade attack happens by using the fake identity of a network or system to acquire unofficial access to personal or organizational data. The attacker tries to steal user passwords and other confidential information. To prevent masquerade, attack some security features must be enabled for authorization and proper authentication.

3.5 Firewall Trusted and Untrusted Network (LAN & WAN)

In a firewall, the LAN is by default accepted as a secure network, and WAN is insecure. For that reason, security architectures named the LAN as trust and the WAN as untrusted. The trust network is defined as inside network, and the security level is higher where the untrusted network is defined as outside, and the security level is lower. It is allowed to initiate traffic from a higher security level to lower. In another way, around traffic initiation from lower to higher works opposite [17]. Security measures are appropriate or not depend on the threat profile that helps us to understand network management for a self-connected LAN network; here, no need to have network management protocol encryption or special authentication for those protocols, and the network administrator does not want his network management protocols to traverse without the special authentication of Internet protocols; so for any system, first step is to identify the threat and then apply threat prevention policy to ensure security protection.

The proposed model may overcome the above all existing problems of an enterprise network. Here is those probably improved part of the model given below:

- Strong Authentication.
- High Data Security.
- Multilevel Protection.
- Network Traffic Encryption.
- No Insider Intrusion.
- Strong Masquerades.
- IP sec used.
- Port forwarding.
- Internet traffic filtering.
- Different web access policies for users.

4 Implementation

Here, the proposed research work is focused on the main things that are required to implement and enhance the security model of our proposed system of an enterprise network. The purpose of this security of an enterprise network is to protect its valuable data, file, document, and many other things from attackers, hackers, and other dangerous platforms. To prevent those attacks and enhance our security, a proper authentication and authorization are required. Section 1 will observe what kind of tools are needed for this process to implement in the enterprise networks and proper evaluation. Section 2 will overview the process of policy to apply like NAT, ACL, WAN, and LAN zone, trust, and untrusted network determine and various things. Section 3 will illustrate the port forwarding in the LAN side to secure our potential websites, server, different devices that are accessible by the Internet with a major concern of security. Section 4 will view how IPsec VPN policy is applied for higher

security purposes and better authentication from vulnerability, and packet spoofing is resolved from active and passive attacks. And at the end of this sector, bandwidth utilization of this proposed system that is required to implement an enterprise network is analyzed.

4.1 Devices and Appliances

To enhance our proposed model, a network architecture of our desire system is drawn and makes a topology in graphical network simulator-3 (In Short GNS3). This part considers three cisco router and two Fortinet firewalls and some non-manageable switch connected with the Internet cloud separately. In the existing system, the ASA 8.42 firewall is used which is costly and expensive and also have some limitation. There are different types and better-secured firewalls in our internetworking world to secure the world of the Internet now in this era. Some of these firewalls like Cisco ASA, Fortinet, Fortinet-Hyper version FortiGate firewall, Sophos firewall, software firewall (Like ACL), Barracuda spam firewall, etc., are available. The FortiGate firewall will be implemented in this system to enhance our security. This firewall has excellent features with flexibility and comfortability both graphically and CLI mode. Fortinet with the advanced version of FortiGate has various update versions that are user-friendly and highly secured to protect our LAN and WAN portion on the Internet. Free meter tools are used for bandwidth monitoring and bandwidth utilization of our existing system as well as how much improved in our proposed system to obtain better results and help to find out the effective results and also inefficiency measuring. This tool installed in host pc that means any change in bandwidth gives us the result of bandwidth utilization. This free meter tools are designed for the Windows operating system which is almost reliable for bandwidth monitoring and also for the process of evaluation. WinMTR is one of the free tools to lookup traceroute of a networking device connected with the Internet. Having a connection with the proper establishment with actual route from source to destination can easily give us traceroute hop to hop and also ping statistics of a network. This is also called network diagnostics tools that are truly named after Matt's traceroute. A network connection with the proper route in topology or a diagram facing any network difficulties or slow speed can be determined by the WinMTR. Fortinet FortiGate hyper version is a next-generation firewall with advanced features and technology that is used for higher security in the LAN and WAN side as well as secure our network connection in the world of the Internet. In my opinion for an enterprise network, the Fortinet firewall is the best solution to fulfill or requirement and meet up the challenge of privacy and protection. The firewall leads the maximum efficiency in both platforms (Virtualized and Hardware).

The devices and tools are used in this topology are given below:

Network Design: The network or topology of our proposed system of an enterprise network is given below compared to an existing system that is already showed. In

Table 1 List of tools and devices for implementation and application

Device name	Specification	Installed tools
Host PC—PC1 PC2 PC3	CPU: Core i4, 1.5 GHz	Securecrt 8.5.2, WinMTR, FreeMeter
Cisco switch	Layer 2 device, Non-manageable	GNS3
Router c7200p	Layer3 device, Fast ethernet port, Gigabit port, Maximum speed accuracy	Cisco c7200 iOS, Wireshark
ASA 8.42 firewalls	Identity firewall, Identity NAT configurable proxy ARP and route lookup	Cisco ASA 8.42 iOS, ASDM bin
Firewall	Fortinet -FortiGate Hyper versions	FortiGate VM, FortiGate-3140B
Metasploit Framework	Penetrating tools	Windows 10 OS

this topology, it is a scenario of an enterprise network where corporate office and branch office connected to head office in the same network. In this topology, the internet cloud is connected with a Fortinet firewall to ensure security, privacy, and authentication.

Then, this head office firewall is connected with another Fortinet firewall with encryption and using Internet protocol security (IPSec) VPN for higher security purposes along with the synchronization with routers, switches, and L3 switches consecutively with end device (host PC). This is a common scenario of our proposed network to enhance the security of an enterprise network (Table 1).

4.2 Implementation of Firewall with the Integration of Different Policy

This section describes the different policies applied in Fortinet firewalls and various steps taken to remove the different attacks as those attacks mentioned before and how those attacks mitigate in FortiGate firewall. As in this network topology where the whole network is scanning, by the Wireshark software find the attacks before the action is needed from the firewall. For implementing security, both the results from the network with its scanning process are compared to show whether the reconnaissance. Figure 2 shows the FortiGate-3140B firewall graphical mode of IPS page with an observation of the Aurora attack is detected and needs to prevent it. Aurora attack

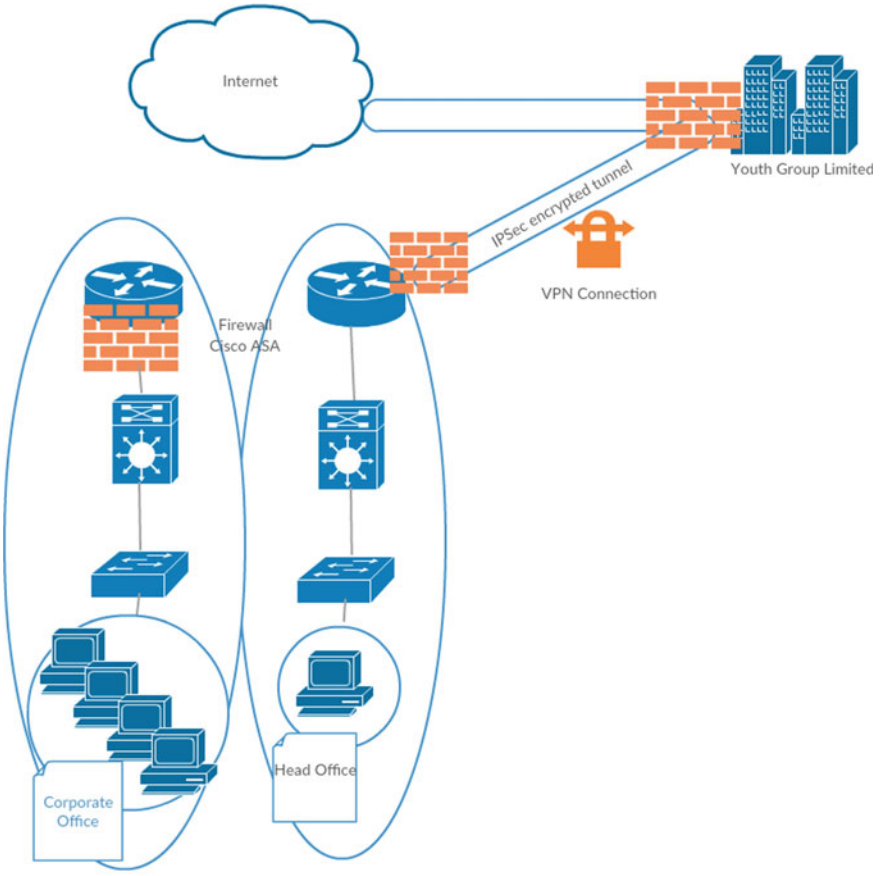

Fig. 2 Proposed model for an enterprise network

is highly harmful to the entire system. It targets s on the server host that takes place in the Windows operating system as well as various random places that are essential for protecting data.

For removing attack and secure our data, it has been required to protect HTTP, HTTPs, Telnet, SSH, and SNMP port in the firewall as well as in the router. So, it is essential to configure and monitor the firewall carefully. Setting up the FortiGate firewall and configured it properly. Figures 2 and 3 show that the iOS file configures in the VMware and established a connection host PC and virtual PC connected and setting IP and port in the FortiGate firewall in CLI mode. When all the processes of configure IP and port are successfully configured, then the graphical mode of FortiGate firewall can be accessed. The assigned IP in the port of firewall is having a smooth ping statistics from source to destination.

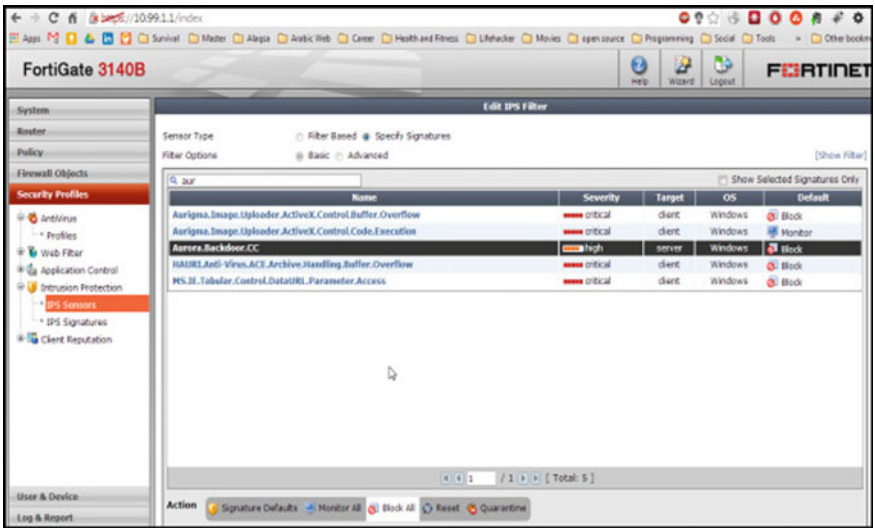

Fig. 3 Aurora attack takes place IPS page FortiGate-3140B

4.3 Implementing Port Forwarding and Policy Against Direct Internet Traffic

Port forwarding on router or firewall or any kind of device that controls or monitors traffic on the Internet allows a port address to enter into it. Port forwarding plays an important role to secure vulnerable port of potential devices form attackers and hackers to keep safe our important data. With port forwarding, the internal port of a router or firewall along with an IP address can be changed where port number forwarded to unknown port for incoming. This is a tricky way to secure and put privacy on the firewall to protect our data. This firewall, TCP port 21 is forwarded to 8000 with the private IP mapping with public IP, as it gave from Internet service provider. Port forwarding or port mapping is part of network address translation (NAT) where it is applicable. Direct Internet Traffic: Direct Internet traffic is that a hacker sends malicious virus and different kinds of direct attack through third party software like uTorrent, Bit Torrent, and much other open-source software in our window operating system with the permission of access firewall without unknowing of mind.

This is an important problem and a security concern nowadays. It can be removed by our awareness when clicking any harmful link or installing any crack open-source software in our Windows operating system. So, the rules and policies like objects (IP/Subnet, FQDN) create a FortiGate firewall and introduced them in a particular declaration with these specific objects. These objects are blocked from the firewall were trusted and untrusted zone of LAN sides. Some of the objects created FortiGate that is objects are restricted from firewalls when accessing some untrusted sites any

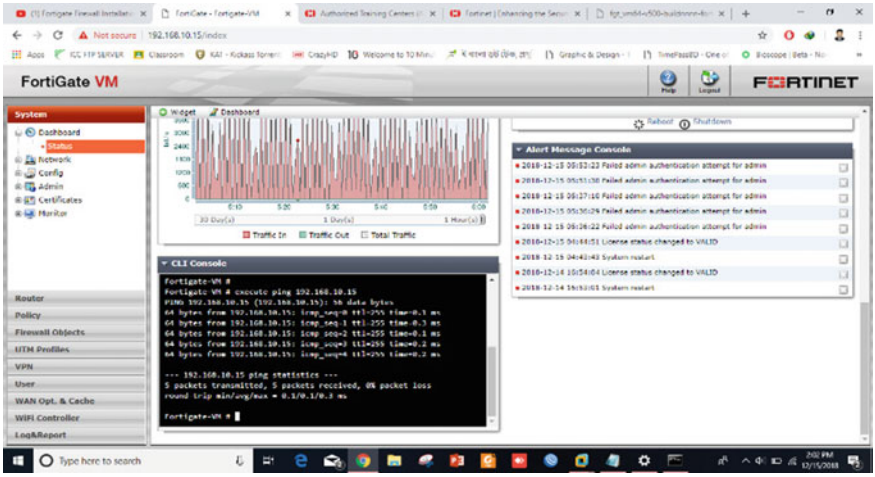

Fig. 4 Ping statistics of FortiGate VM with host PC

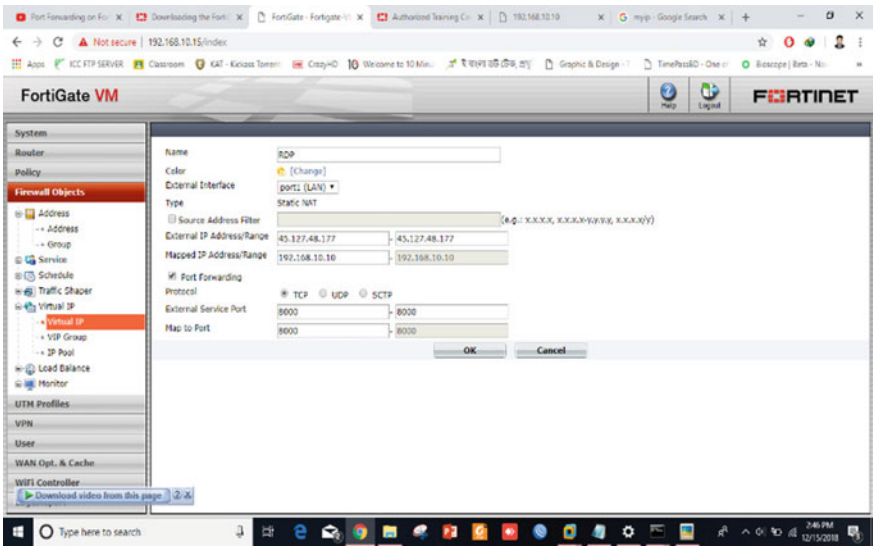

Fig. 5 Port forwarding in FortiGate firewall

suspicious websites. Then, the policy applied for direct Internet traffic to remove malicious attacks from different ports, open-source software, and create a strong zone for protecting valuable data from attackers. And the traffic for direct Internet monitoring shows in Figs. 4 and 5, in that monitoring gives us a concept or knowledge about direct traffic filtering in incoming and outgoing. From the figure, it can be understood that the problem occurs in direct Internet traffic.

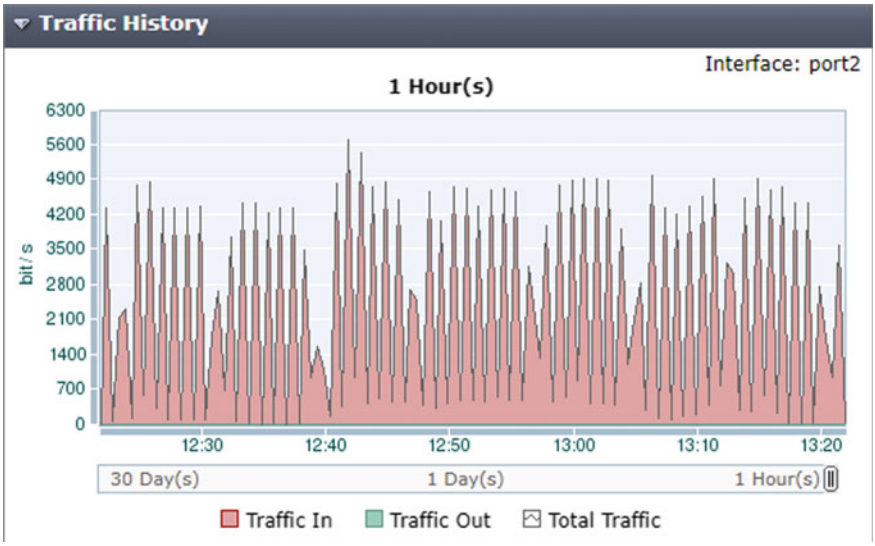

Fig. 6 Traffic history of direct Internet traffic ingoing and outgoing

4.4 Implementation of Internet Protocol Security (IPsec) VPN in Proposed Model

The IPsec is used for better security and IETF standard protocol. It maintained the encryption process in sending data from one place to another. The IP layer is being secured when data is sending with an encryption process. A cryptographic key and also pre-shared keys use during the session. The proposed modes have applied IPsec VPN between two FortiGate firewalls, which have a secure process in a big enterprise network to prevent intrusion and different kinds of threats. For a session with end to end security, IPsec VPN provides the best TCP/IP layer security along with a higher level of authentication. In WAN port LAN port where there is a route between source and destination, a pre-shared key is used for remote connection in FortiGate firewalls to another destination firewall with a virtual private connection is established. A tunnel is established between head office and the corporate office with IPsec VPN to secure data that are passing through internet. The tunneling creates a strong zone in the internal network having several conditions of firewall policy with file sharing or data coming from the outside network as well.

Another IPSec VPN configures in the remote destination in the same way along with pre-share keys encryption, a remote destination address, and port (LAN) selection. Figures 6 and 7 show the configuration of IPSec VPN for destination host. The best path chooses to give encryption to make a season with local host. And the firewall policy is applied in the FortiGate firewall.

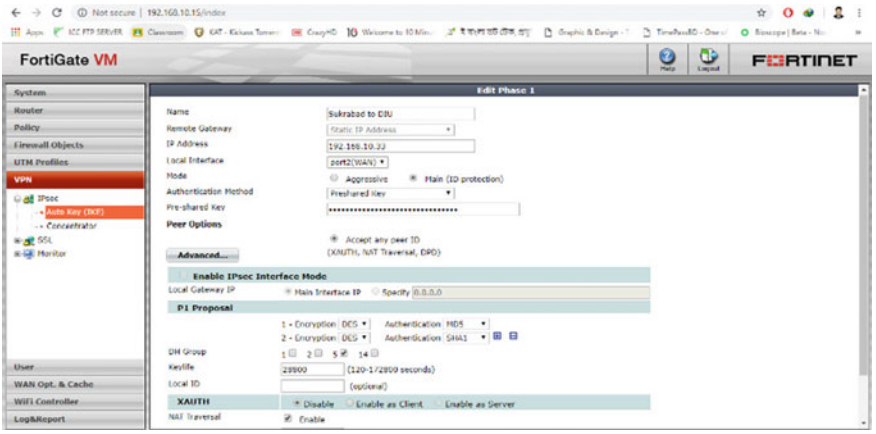

Fig. 7 VPN configuration in local interface

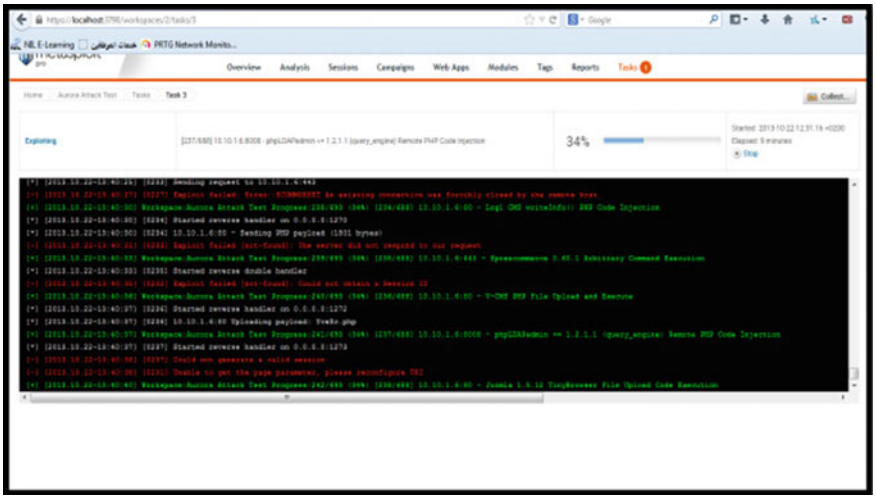

Fig. 8 Lunching Aurora in metasploit tools with port forwarding

5 Results

This section will evaluate the results of applying the different policies, rules, and various configurations in the Fortinet FortiGate firewall. The following figures show the result of port forwarding, protection against DoS attack, direct Internet traffic, port scanning, and IPsec VPN. This evaluation is for the proposed system of an enterprise network. Using the Metasploit tool for the penetrating attack in the FortiGate firewall. And this penetrating attack is done with various purposes like port scanning and Aurora attack for evaluation of log reports in the FortiGate firewall. Figure 8 shows

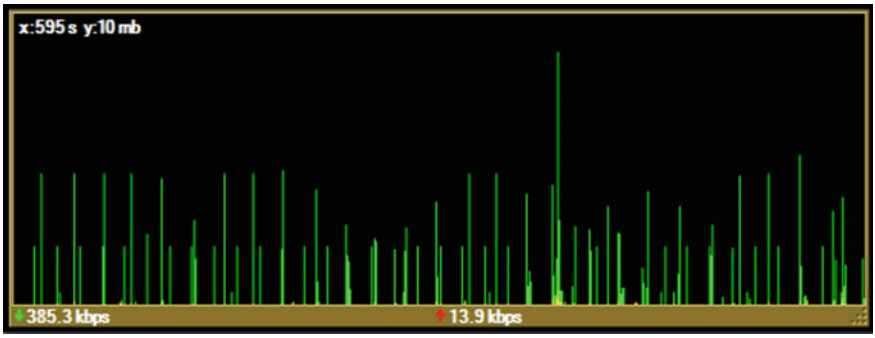

Fig. 9 Utilization of bandwidth before applying the proposed model

penetrating attack by the metasploit tool to detect Aurora attack, port scanning in the FortiGate firewall. In our paper we have checked the vulnerability in firewall by using internet explorer with local hosting.

Some object of Aurora attack with IP address and port in the FortiGate firewall. The vulnerability scan and log report generated from FortiGate firewall is given in the Fig. 8.

5.1 Performance Analysis and Evaluation

The free meter tools are used for monitoring, and the utilization of bandwidth in the proposed system of an enterprise network is compared to the existing system. One more thing to say, Fortinet firewall is comparatively cost-effective and reliable than adaptive security appliances (ASA). On the other hand, ASA firewall is costly though reliable when it has been taken into consideration to design a network topology for an enterprise network; firstly, it will consider how much it is cost-reducing when buying the network equipment. An effective network topology not only helpful and necessary for enterprise networks, but also efficient and needful for a company. When different policies and rules are applied in the firewall to protect our data from attackers or hackers, then bandwidth is also a matter of concern. The free meter tools are used for measuring and mentoring bandwidth utilization when all the processes running in the firewall. Figure 9 shows bandwidth utilization before applying the proposed model, and Fig. 10 shows the bandwidth after using firewall as the procedure already mentioned before in this paper.

So comparatively, bandwidth utilization in our proposed monitoring system is better than the existing system considering maximum usages of maximum traffic. And the obtained CPU usages is moderate than the existing system. If the attacks are differentiated between the proposed system and existing system in a chart of

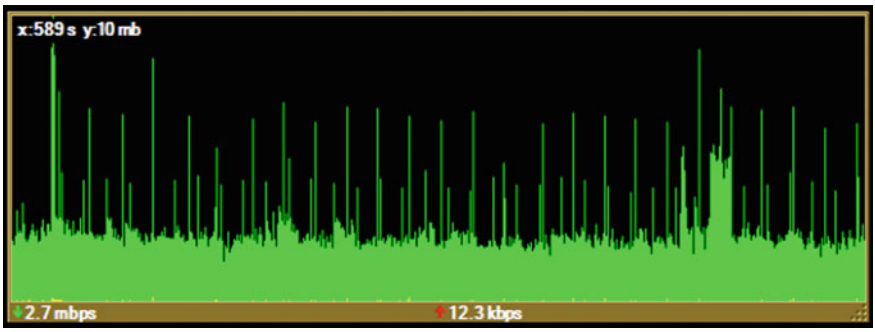

Fig. 10 Utilization of bandwidth after using firewall

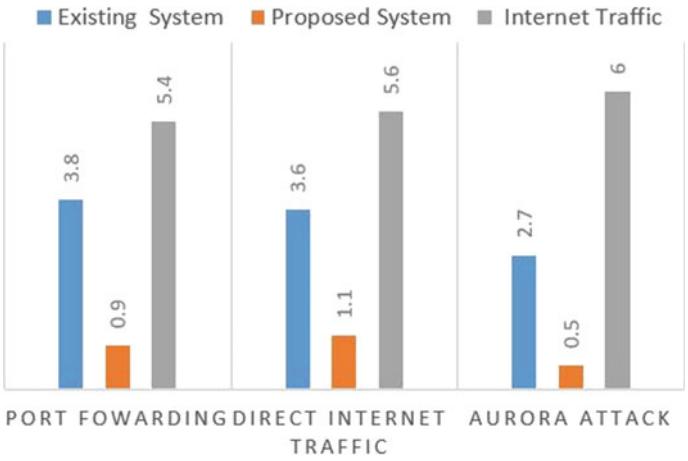

Fig. 11 Comparison between existing and proposed system

graphical view, it will be easier to understand, and the anomaly of these system can be detected.

6 Conclusions

This paper has developed a network enhanced model for an enterprise network. Basically, an enterprise network includes a different device, network, equipment, and protocol. Different devices are connected in a different layer. In layer, two different devices like switches and printers are connected to the network. And layer three core switches like routers are connected to the network. These core switches are used to connect different branches in different networks. An enterprise network is attacked by many threats like external and internal threats. Also, attacks came from different

layers. To prevent this attack, enterprise network uses different devices like VPN and firewall. Security threats become a big challenge to create an enterprise network. The proposed network model in our paper is also an enterprise network. This enterprise network is affected by different threats like IP spoofing, phishing attack, DoS attack, spyware attack, etc. The proposed model gives a better solution to prevent the attack. As an enterprise network security issue is critical, firewalls and VPN are deployed to protect the network. This research work has deeply analyzed the proposed model to prevent different kinds of attacks. The results of our proposed security model prove that it has the ability to detect and protect the network from different kinds of attacks. But there is no guarantee that the proposed security model can detect the new attack. The proposed security model only detects some attacks to secure our enterprise network.

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Comparative Study of Fault-Diagnosis Models Based on QoS Metrics in SDN

Anil Singh Parihar and Nandana Tiwari

Abstract Due to the current exponential rise in users of the Internet, a need for highly scalable and easily configurable network devices is required. To meet this growth in demand, software-defined networking (SDN) has become increasingly popular. However, despite their several advantages, there still exists a gap in the level of quality of service (QoS) required in the existing fault detection and recovery mechanisms to promote a wide-scale carrier-grade network (CGN) selection. In this study, the basics of SDN were reviewed and compared the five diverse failure recovery models as a function of their QoS.

Keywords Networking · Software-defined network · Quality of service · Carrier-grade networks · Network architecture · Fault detection · Restoration

1 Introduction

In the TCP/IP network architecture, routers and smart switches operate at the network layer. As smart switches work in a similar way to routers at the network layer, they will be referred to as routers as well from here on. Routers at the network layer consist of two main functions, namely routing and forwarding.

Routing refers to the computation done to ascertain the route a packet must take to reach from the source device to the destination device. As this function deals with the control of the routing device to route traffic through a particular path and mainly interacts in logic and software, it is known as the control plane.

On the other hand, forwarding refers to the actual displacement of a packet from the router's input to an appropriate output, based on the routing path computed earlier. Since this function deals with real data due to the packets and interacting with them on a physical or hardware level, it is known as the data plane.

Traditionally, both of these planes are an essential function of the devices operating at the network layer [14]. However, due to the importance of these functions and

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their interdependence on each other to execute the task of the network layer, much responsibility is allotted to these devices which can prove to be detrimental in many scenarios, the most obvious of which include failure in the software of these devices frustrating the role of the hardware and vice versa. Any change in the software of the device could also warrant a complete reconfiguration of it. Several other problems that may arise include, but are not limited to, the compatibility and extension of network protocols, switch software updates, network device maintenance and network innovations [1].

Hence, to overcome these failures, the need for devices operating at level 3 with a decoupled data and control layer arises. Software-defined networks (SDNs) support this by separating the control plane from the routers and hence reducing them to the function of forwarding packets alone. A centralized controller is installed globally, which performs the role of the control plane. This global controller provides support in many applications where the traditional network fails. For example, having a global control and view of the network, SDNs can easily find and configure an optimal alternate path in case the primary path of routing from a source device to a destination device was to face link failure. In contrast to this, the traditional network devices would flood the network with packets to compute an alternate route. It must also be noted that SDN defines a global controller that can use the overall view of the network to easily make optimal decisions; switches maintain connectivity amongst each other in the same way as in a traditional network [13]. A more detailed analysis on the components that make up the SDN are discussed in [11].

2 Background

2.1 Architecture

SDN separates the data plane from the control plane. The three different layers are observed for concerning the transfer of data. At the lowest level of abstraction the data layer does the actual transfer of packets via devices such as switches. Above this layer is the control layer where the intelligent decision-making of routing takes place using the global view of the controller. Finally, the application layer is at the highest level of abstraction of the network, where all the application frameworks run.

Figure 1 depicts that there are two interfaces under consideration to facilitate the talking of one layer to the other [9]. The interface between the lowest layer of abstraction and the middle layer is called the southbound interface. Similarly, the interface between the highest level of abstraction and the middle layer is called the northbound interface. OpenFlow protocol is one of the most widely used southbound application programming interfaces (APIs) to allow the data and control plane to talk to each other as it enables openness and visibility in the network. The northbound interface also uses various types of APIs to allow the controller to talk to the applications running on top of it. These applications are often used to acquire global data of the

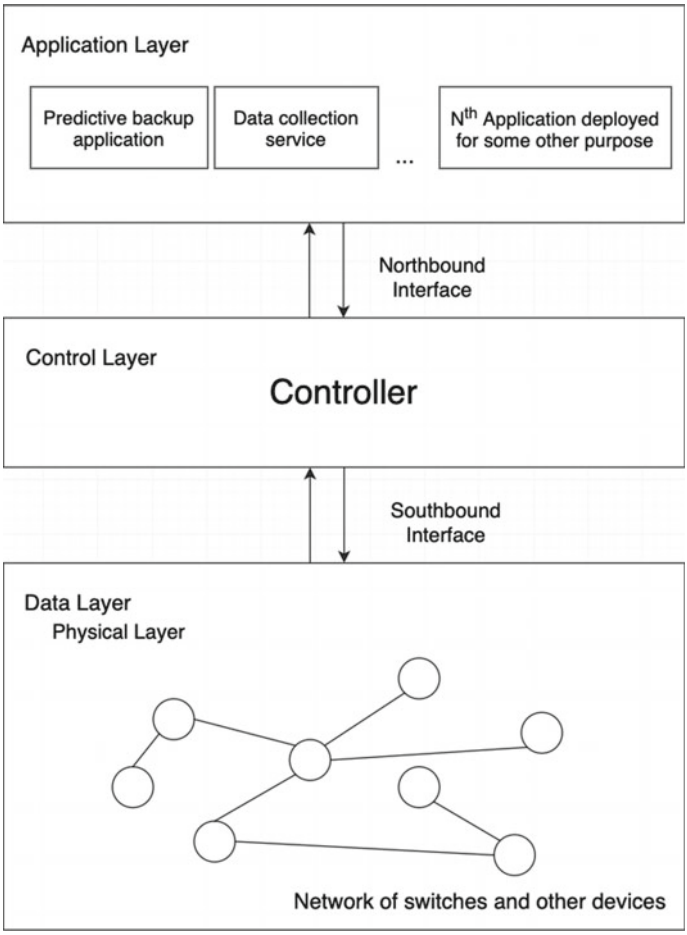

Fig. 1 Architecture of SDN

network from the controller. These APIs include, but are not limited to, REST API, Onix API, Java API.

In an ideal scenario, switches will communicate with the controller using the southbound interface to send traffic information such as packet loss ratio and transmission time. Based on the applications running on top of it, the controller sends appropriate data to them through the northbound interface. For example, a predictive learning application may request the controller for traffic metrics to predict the most optimal path for a particular flow and send this information back to the controller through the northbound interface. The controller may then configure this most optimal path in the flow tables of the affected switches using the southbound interface.

2.2 OpenFlow

The OpenFlow switch consists of three main parts: flow tables, OpenFlow channel and the group tables [2]. The OpenFlow channel is used to talk with the controller(s) involved in managing the switch using the OpenFlow switch protocol. Each flow table consists of some flow entries that have three attributes: match field, counters, and a set of instructions to apply on matching. An OpenFlow switch may consist of multiple flow tables that are connected through a pipeline that allows the sharing of metadata across the flow tables [15]. The group tables are used to perform a more complex set of actions to the incoming packet, which are contained in action buckets.

When a packet reaches a switch to be forwarded to a destination, the switch searches its flow tables for a matching entry and follows the set of instructions defined in case of a match. It must be noted that the rules in the flow tables are defined according to priority, so if a matching entry is found, the switch will not look for other potential matchings. The set of instructions to be acted on the packet can range from being a forwarding rule to performing a lookup in the group table. In the case that no such matching exists, the packet may be forwarded to the controller through the OpenFlow channel. The controller then adds new rules in the form of flow entries to define the path the packet should be routed on. The study [10] presents an Open Framework for OpenFlow Switch Evaluation (OFLOPS) that permits the development of tests for OpenFlow-enabled switches and measure the capabilities and bottlenecks between the forwarding engine of the switch and the remote control application.

2.3 Fault Diagnosis

The main types of faults that may disrupt the service of the network are defined below [3]:

(a) Link Failure
This refers to the failure in the links connecting hosts to switches, switches to switches, switches to the controller(s) and controllers to controllers (if applicable).
(b) Controller Failure.
This refers to the failure of a controller that is managing the network.
(c) Device Failure.
This refers to the failure of a router that is responsible for forwarding traffic.

As discussed in the study [4], the frequency of device failure is less than the frequency of link failure. Hence, in this study, the first two types of failures were compared. In the case of a link failure, the recovery of a failed link can be achieved in two possible ways: reactive restoration method and proactive restoration method.

3 Key Concepts and Terminologies

3.1 Reactive Restoration Method

In this section, the first approach called reactive recovery was explored. In this approach, on the occurrence of a link failure, the controller is approached for finding an alternative path for the flow that was affected and installing it in the affected switches. In OpenFlow, this is achieved by inserting new flow rules in the flow table of the OpenFlow switches. As the controller is contacted after the failure of a link, this approach may lead to delays. Apart from this communication overhead delay, another major contributor to the delay in restoration is the time required for the controller to compute the new optimal path. Due to this delay, this approach does not support speedy link fault recoveries; however, due to its simplicity, this approach can be scaled easily.

3.2 Proactive Restoration Method

This section describes the second approach to link fault recovery. In this method, all the possible alternative paths are computed and configured in the switches as backup paths and can be used in case of link failure without any delay. Although this approach provides faster recovery of flows, it is hardly scalable. As the size of the network increases, there would be an exponential rise in complexity to configure each possible path as an alternative path. This exponential rise in complexity would be observed not just in computation but also in the space that would be required to store the flow entries. Hence, it can be concluded that the reactive approaches to be more time complex and proactive approaches to be more space complex; i.e., a tradeoff is observed.

3.3 Carrier-Grade Networks

The most obvious way in which CGNs differ from other networks is that it faces a higher number of users due to their unwavering quality of service support for various protocols (e.g. VOIP applications, FTP applications). Fast failure recovery guarantee within a fixed time interval is essential for providing a service guarantee. Due to this, the CGN is governed by exceptionally high availability and reliability ($\geqq$99.999%). For an SDN system to be used as CGN, it must guarantee an unscheduled fault recovery within 50 ms. The study [8] demonstrated that a reactive restoration approach in OpenFlow could not be achieved within the Carrier-Grade Network level, whereas a proactive restoration approach could.

Table 1 Quality of service metrics

QoS metric	Definition
Throughput	It is a measure of the amount of data that can be successfully received within some unit of time
Bandwidth	It is a measure of the maximum amount of data that can be transferred within some unit of time
Availability	It is a measure of the total time the network is operational against the full time it is observed, i.e. the total uptime of the network
Tolerance	It is a measure of how operational the network as a whole is on the occurrence of some failure
Resilience	It is a measure of the level of performance the network can maintain on the occurrence of some failure
Scalability	It is a measure of how well a network can perform to a rise in the number of resources being used by it

3.4 Quality of Service Metrics

Although SDNs seem to satisfy the needs of modern-day networks, much research is continuing to enable them to meet CGN level of QoS with regard to failures in the network. QoS refers to the measure of how well a network performs when posed with constrained network capacity. Some of the metrics that can be used to ascertain the QoS of a network are defined in Table 1.

4 Comparison

In this section, the five diverse models were compared against each other. A comparative QoS analysis of these models is done in Table 2.

4.1 Fast and Adaptive Failure Recovery Using Machine Learning in Software-Defined Networks (FAFRs) [5]

This model aims to use traffic metrics to configure backup paths for a particular flow adaptively. It employs a proactive approach to compute the goodness of a path based on the environment of the network in a specific instant of time. A flowchart of its working is shown in Fig. 2. This model also compared various classifiers against each other for prediction of the goodness of a path such as decision trees, random forest, linear regression, support vector machines, neural network and found decision trees and random forests to outperform the other classifiers significantly. Since this approach aims to configure the best backup path, which is disjoint from the primary

Table 2 Comparison of the five models based on their quality of service

	FAFR [5]	PRT [6]	FT-SDN [3]	CN [7]	PFR [2]
Controller used	Floodlight	POX	OpenDaylight, floodlight, Ryu	NOX	POX
Recovery plane	Data plane	Data plane	Control plane	Data plane	Data plane
QoS optimized	Bandwidth	Availability	Resilience in controller failure; load balancing of controllers	Scalability; faster than basic reactive recovery	Packet loss; faster than basic proactive recovery
QoS degraded	Recovery time; scalability	İnstability	Packet loss	Inconsistency with respect to support to applications	Bandwidth scalability

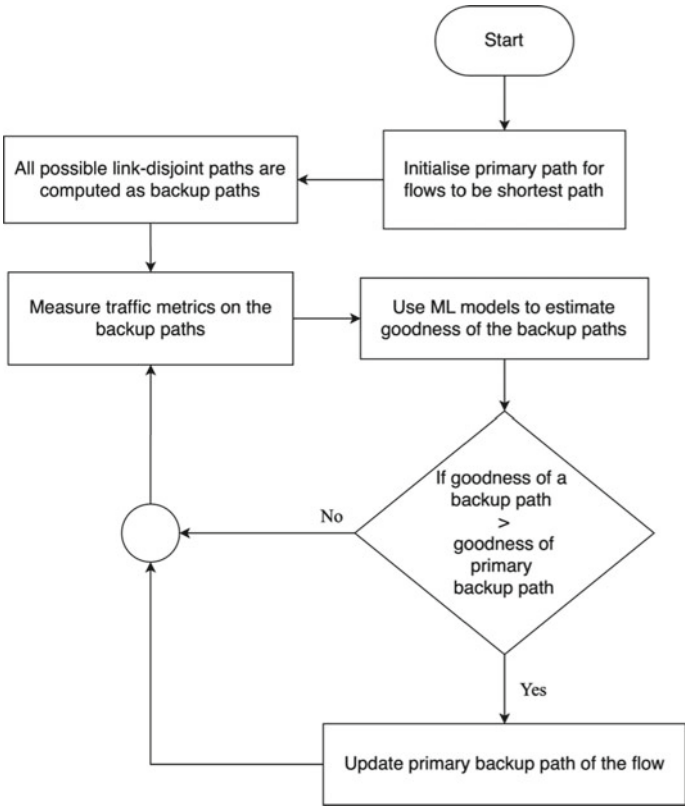

Fig. 2 Logical flow of events of FAFR

path based on traffic metrics, it also supports higher bandwidth allocation per flow when compared with a baseline approach. This model reduced failure recovery time by 50 and increased its network bandwidth allocation by 24%. However, as the number of nodes increases, the complexity of this model increases as well. This is because the goodness of each disjoint path for a flow is calculated to find the most optimal backup path. Such a procedure could result in a considerable overhead with the growth of the network. Hence, this model does not scale well. Also, since this model aims to select the path with the most favourable traffic metrics as an optimal backup path, this could result in choosing a path that may not be the shortest path between a source–destination pair. Hence, this approach has a higher number of hops for each flow in comparison with a baseline model, by an approximate of 2 hops.

4.2 A Proactive Restoration Technique for SDNs (PRT) [6]

This paper uses a model similar to the one described in the study [12]. The model proposed here is also proactive, and its main aim is to make the network highly available. It accomplishes this by predicting the failure events before their occurrence by classifying paths as risky if their probability of failure crosses a threshold value. This path is then replaced by the shortest disjoint path. In case the prediction is correct, the flow corresponding to the replaced path is inserted into a failed flow array for which Dijkstra's algorithm is run to compute the shortest route for the flow after the failure. The flow of events for this model is described in Fig. 3. However, in case the prediction is wrong, the network rolls back to its previous state. Hence, this article evaluates the model's performance based on availability and instability of the network, where the availability is prioritized at the cost of network instability. Predicting the occurrence of a fault affords the network a specific time segment to prepare for the fault to occur. As a result, the measured service availability of their network is 97%. However, the frequency of the link failure events are generated and injected into the system based on a probability function; i.e., they are not simulated against real fault events. Furthermore, performance metrics evaluated by this model are routing flaps (a measure of the instability of the network) and availability alone; i.e., metrics such as time delay for the routings are not considered.

4.3 CORONET: Fault Tolerance for Software-Defined Networks (CN) [3]

Here, the main aim is to optimize data plane fault tolerance. It does this using a reactive approach which includes four main modules. These modules are responsible for discovering topology, calculating backup path in case of a link failure, configuring the routing path, and assigning host traffic to the routing path, respectively. It

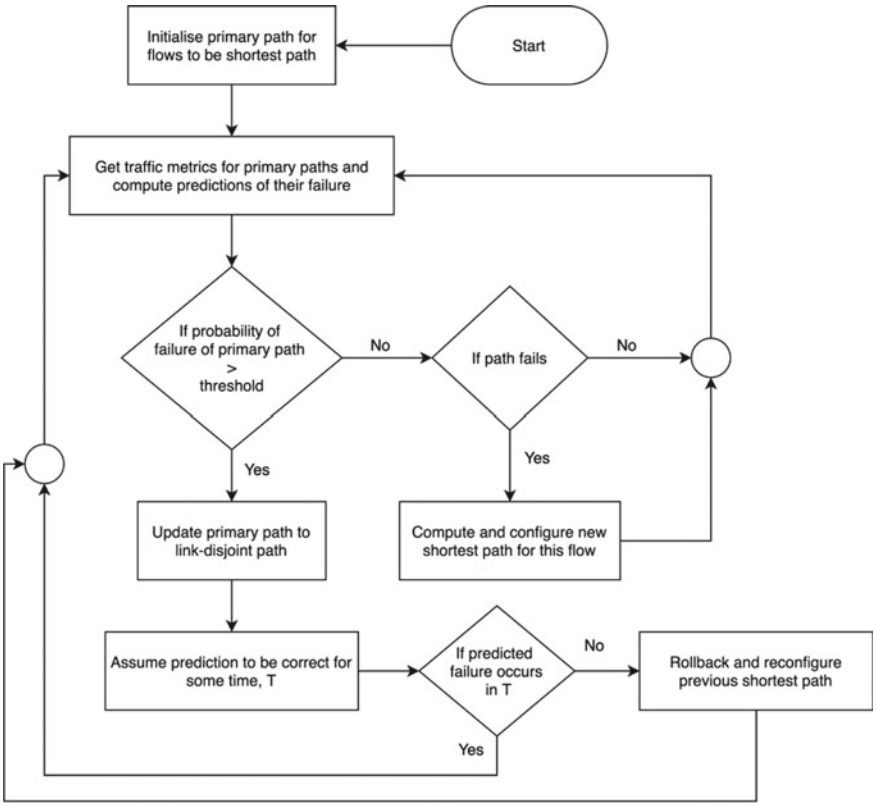

Fig. 3 Logical flow of events of PRT

avoids controller intervention altogether in the instances of discovering topology and detecting link faults; these responsibilities are handled by the switches based on local switch standards such as Link Layer Discovery Protocol (LLDP). Once the packets arrive at an edge switch, it uses VLAN to forward them to their destination. The flow of events for this model is shown in Fig. 4. As there is no controller intervention, this is a fast recovery method. It is also highly scalable since local switches handle much of the time complex activities. However, experimental evaluation concerning any performance metrics was not shown, and the use of logical paths to route the traffic may prove to be inconsistent in some applications that already use physical paths for routing.

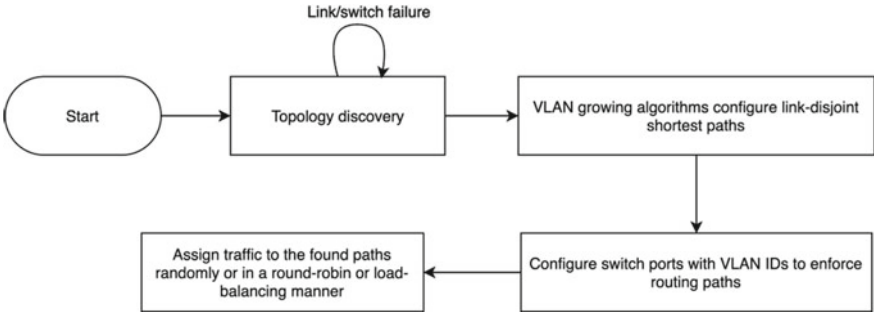

Fig. 4 Logical flow of events of CN

4.4 FT-SDN: A Fault-Tolerant Distributed Architecture for Software-Defined Network (FT-SDN) [7]

This is the only controller failure model that was analysed in this study. This model deals specifically with failures in the control plane. It aims to bring about network control plane resilience in the case of a failure. This is achieved by establishing an absolute distributed configuration of heterogeneous controllers. Each switch in the network is allotted a controller based on the distance and cost (in terms of load) between the switch and the controller. The controller selected is called the serving controller, and the rest are called secondary controllers for that switch. A database and metadata are maintained at each controller's end where it stores the states of the switches it is connected to. In the case of a controller failure, a new controller is selected to take over the failed controller's switches. The new controller is given the database information of the failed controller. The mechanism that enables this transfer of data from one controller to the other is done through the state replication method (SMR). The architecture proposed in this model also mandates a necessary amount of redundancy of state using the SMR; each serving controller updates its state to the other secondary controllers using the SMR. Figure 5 shows a flowchart explaining the flow of events in this architecture. As this is a truly distributed architecture of controllers, it is hence resilient to control plane failures. The use of heterogeneous controllers also increases the capability of the network to handle language-specific failures. However, the model deals only with the faults in the control plane and does not take link faults in the data plane into consideration. Also, if a controller fails and all other controllers are highly loaded, the model described in this paper is programmed not to overload the other controllers. Hence, packets from the switches that the failed controller was handling get dropped, lowering the resilience of the data plane of the network.

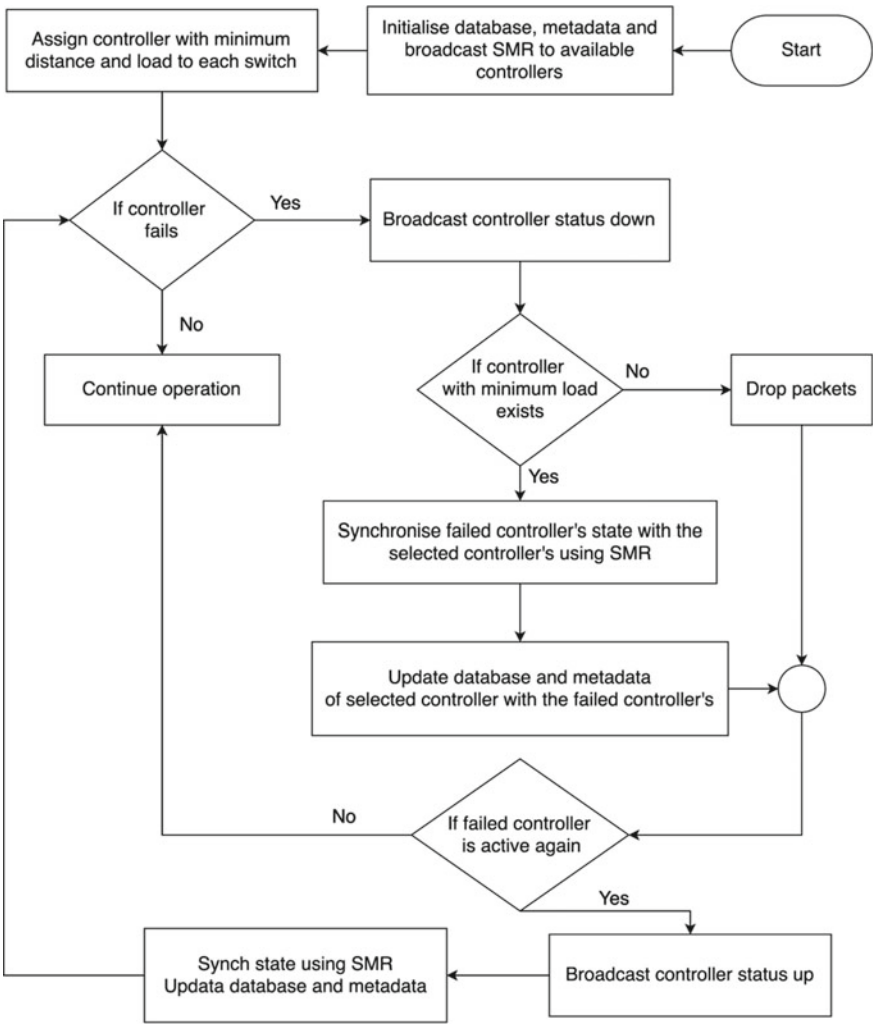

Fig. 5 Logical flow of events of FT-SDN

4.5 Proactive Failure Recovery in OpenFlow Based Software Defined

4.5.1 Networks (PFR)

The model proposed in [2] aims to provide link protection over path protection using four significant modules, similar to the previous model [3]. Path protection is defined here as the approach in which primary and backup paths are precomputed and installed in the flow table. Link protection is defined as the approach to precompute

and instal backup paths for each link. In this model, the only module that exists in the controller is the recovery module, which is responsible for computing backup paths of failed links. The rest of the modules are based on the data plane. They are responsible for detecting link failure, generating packets for allowing flow rules to persist, and for sending restoration packets to the controller to enable it to compute the shortest routing path with the new backup link operating as primary. This model provides an optimally fast recovery time of link failures and a negligible packet loss ratio, much better than the packet loss ratio over a path protection scheme. However, due to the multiple backup paths being installed in the flow tables, lesser bandwidth would be utilized by the network. It is also not a scalable solution as each link has multiple backup paths installed which would flood the flow tables with an increase in network nodes (Fig. 6).

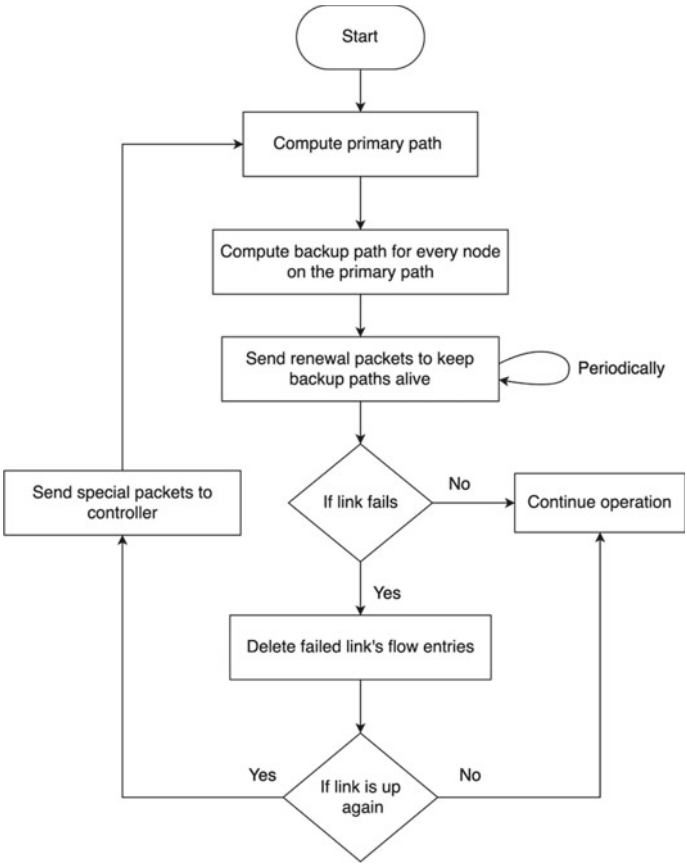

Fig. 6 Logical flow of events of PFR

5 Conclusion

In this study, the need for software-defined networks to meet CGN levels of QoS was explored. The major domains of faults that may occur in an SDN and the proactive and reactive approaches that can be used to combat these failures were also explored. Finally, five diverse models were compared against each other for the QoS metrics, optimization and degradation, since a tradeoff would always be maintained. Based on this analysis, different models can be employed to accommodate different use cases.

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A Brief Study on Analyzing Student's Emotions with the Help of Educational Data Mining

S. Aruna, J. Sasanka, and D. A. Vinay

Abstract Recently, the idea has reached toward considering the emotions in the learning procedure which prompts to design an innovative framework that empowers correlative analysis and classifications of various emotional variations of an individual. There is an absence of teaching pedagogues to distinguish the standard articulations of people. In the past decade, research articles have recorded the lacking properties and attempt to recognize the equivalent benefit to overcome the difficulties. This enhances the part of identifying emotions as a device to perceive the sentiments of understudies while learning. This article encompasses the record of all analytical examinations of student's emotions by applying different strategies, models, calculations and devices. This article wraps the considered works and gives the examination of qualities, shortcomings, openings, whose parts are addressed and the future work to be accomplished.

Keywords Emotion · Educational data mining · Data mining · Students · Educational · Students emotions

1 Introduction

'Emotion' is for the most part insinuated as a state of mind of a person, which has been distinctively involved with slants, consideration, and social retaliation. Emotion produces anatomical and psychological alterations. Initially, emotions or the state of feelings toward a certain occurrence of events proposed to empower reasonable practices reliant on past experiences.

At the present time, feelings impact our life decisions consistently with or without our understanding. It has been watched every once in a while that most of the part fail at disguising our sentiments. Even though, it is not possible to present our emotions explicitly to establish a connection of a specific inclination toward a feeling through

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our activities. The outward appearance and non-verbal communication moreover will in general be an important strategy for delineating our inclination explicitly without knowing.

Learning style basically applies to the way a person tries to learn a specific topic, thereby resulting in gaining knowledge. Hence, various individuals try to grasp in unique ways. Although people may have a combination of non-similar ways of learning, still some have a prevalent style of getting the hang of contingent upon the conditions while others may have an alternative learning style. Data mining refers to a computing technique that enables the user to extract valuable information from a pool of data, a lot of which might be irrelevant to the user. Nowadays, the use of DM in the education arena is incipient and gives birth to the educational data mining (EDM) research field [1].

Educational data mining (EDM) enables paradigm-oriented learning which is used to draft models, methods and approaches to explore context information of educational amends. The increase of technology use in educational systems has led to the storage of large amounts of student data, which makes it important to use EDM to improve teaching and learning processes [2, 3]. EDM is useful in many different areas including identifying student emotions, identifying priority learning needs for different groups of students. By analyzing student emotions may reveal a relationship between a student's grade in a particular course and the interest the student has in that particular course. It discovers examples and makes expectations that describe students' practices and accomplishments, area information content, evaluations, enlightening functionalities and applications [4, 5].

In the beginning, it looks at the course of action of EDM to learn and set the informational condition as demonstrated by the learner's profile before teaching to a class. In the initial stage where the student interacts with the system, it would be beneficial if the EDM secures log information and breaks down their importance to propose recommendations. The following stage requires the EDM to evaluate the given training data which can be, for instance, the comprehensibility of the predictions.

The layout of the article is organized into three segments. Section 1 includes the introduction. Section 2 describes the supported survey of relating research along with the tools used, and finally, Sect. 3 concludes the research work.

2 Literature Survey

Table 1 summarizes the various survey articles observed for recognizing the student emotion, whose concepts have been incorporated into our study.

Table 2 shows the various tools applied in a student emotion recognition system.

Table 1 Summary of various survey

S. No.	Title	Author name	Summary of the paper
1	Analysis of students emotion for Twitter data using naive Bayes and nonlinear support vector machine approach [6]	Ranjeeta Rana, Mrs. Vaishali Kolhe	Analysis on samples taken from tweets related to engineering students' college life is conducted. The proposed work is to explore engineering student's informal conversations on Twitter in order to understand issues and problems students encounter in their learning experiences. To classify tweets reflecting students' problems multi-label classification algorithms is implemented. Nonlinear support vector machine, naive Bayes and linear support vector machine methods are used as multi-label classifiers which are implemented and compared in terms of accuracy. The comparison result has shown more accuracy of nonlinear SVM than naive Bayes classifier and linear SVM. Future work could analyze students generated content others than texts (e.g. images and videos), on social media sites other than Twitter (e.g. Facebook Tumbler and YouTube)

(continued)

Table 1 (continued)

S. No.	Title	Author name	Summary of the paper
2	Toward building a computer-aided education system for special students using wearable sensor technologies [7]	Raja Majid Mehmood and Hyo Jong Lee Kusum Yadav, Fayez Alvarez	The selected EEG device headset certainly has several advantages over traditional EEG systems, being less expensive, convenient and easy to access. ModernEEG-based computer-aided systems may help develop the students' abilities by boosting learning, thinking communication skills and cooperation In this paper, it gives feedback to instructors which guide further treatment in case of any mood disruption in students. The instructor-on-duty may use the previous mood history and treatment guidelines of current subjects in case of any mood disruption problem. This system adopted the IAPS protocol based on academic emotions for appropriate decision-making and treatment by instructor
3	A global perspective on an emotional learning model proposal [8]	Ana Raquel Faria, Ana Almeida, Constantino Martins, Ramiro Goncalves	The main goal of this paper was to find out if the consideration of student's emotional state influences their learning process. An emotional learning model was described, and a software prototype was developed and tested. To evaluate the prototype, two pre-tests and a final test were conducted. This paper did not address long-term personal problems might have on learning process

(continued)

Table 1 (continued)

S. No.	Title	Author name	Summary of the paper
4	Prediction of sentiment analysis on educational data based on deep learning approach [9]	Ms. Jabeen Sultana, Ms. Nasreen Sultana, Dr. Kusum Yadav, Fayez Alvarez	This paper proposes a model based on deep learning approach to perform sentiment analysis on educational data (online courses). In this paper, we focused on the accuracy and performance of the training data set to predict the best model. MLP and SVM are recognized as the outperforming models. It is observed that SVM and MLP-deep learning methods perform well

(continued)

Table 1 (continued)

S. No.	Title	Author name	Summary of the paper
5	Emotional strategy in the classroom based on the application of new technologies: an initial contribution [10]	Chinua Boonroungrut	In this paper, it intended to avoid boredom in class with the introduction of EVA and determine if levels of attention based on positive emotions are maintained for a considerable time in which it is included in the teaching–learning process, theory, recommendations and evaluations. In this study, they show a learning mechanism based on the inclusion of NTICS based on our EVA robot and implemented using tools SentiStrength is a short text classifier. Google's Vision API allows to detect individual objects and faces within the images, is a software that allows you to identify emotions based on images and text classification automatically with the use of the library of text mining, intercalation, and naive Bayes is used to classify the text. Limitations of this paper it is clarified that the discourse of the teacher and students is not divided, so in future investigations an individual analysis will be carried out in order to particularize the emotional

(continued)

Table 1 (continued)

S. No.	Title	Author name	Summary of the paper
6	Exploring classroom emotion with cloud-based facial recognizer in the Chinese beginning class: a preliminary study [11]	Chinua Boonroungrut, Kim One	The facial emotion recognizer (FER) detection technology in the education field is in the early stage. Objective is to investigate the classroom emotion and the effectiveness of the Microsoft cloud-based FER interpretations The randomly selected 29 international students who enrolled the fundamental Chinese language course were investigated during five study weeks using the paper-based student outcome survey which measured teaching, assessment, generic skill and learning experience. The students' overall outcomes were over average. FER indicated that the neutral emotion was the highest detected score. The APIs reliability was still considerably questioned. Using updated quality and technology of photograph and video recording were recommended in the further research
7	Survey on analysis of students' emotions through social media data mining [12]	Ranjeeta Rana, Mrs. V.L. Kolhe	A multi-label classification algorithms to classify tweets reflecting students' problems is implemented
8	A survey and a data mining-based analysis of recent works [13]	Alejandro Peña-Ayala	The review concludes with a snapshot of the surveyed EDM works and provides an analysis of the EDM strengths, weakness, opportunities and threats, whose factors represent, in a sense, future work to be fulfilled

(continued)

Table 1 (continued)

S. No.	Title	Author name	Summary of the paper
9	Understanding student academic achievement emotions toward business analytic course: a case study among business management students from India [14]	K. Jena	A case study among business management students from India suggests that positive emotions have a positive impact on student learning and negative emotions like boredom hinders the learning process. It also talks about the role of gender of a student in determining their degree of emotions toward the course which is business analytics, the paper proposes the use of a questionnaire

Table 2 Tools utilized for student emotion recognition system

S. No	Name of the paper	Tools used
1	Correlation of student's precursor emotion toward learning science interest using EEG [15]	1. Electroencephalogram (EEG) to study on precursor emotion effects 2. Nuprep electro-gel was used to clean the scalp surface 3. Ten20TM conductive 4. Features will then be extracted using the mel-frequency cepstral coefficient (MFCC) method
2	Toward emotion detection in educational scenarios from facial expressions and body movements through multimodal approaches [16]	1. Logitech webcam software 2. Microsoft Kinect for windows was used—a face-tracking engine that processes the image captured by the device and tracks human faces 3. Face-tracking SDK's face-tracking engine
3	Facial emotion recognition with transition detection for students with high-functioning autism in adaptive e-learning [17]	1. FACEAPI—a commercial function library for tracking and locating facial landmarks, was used for frame-by-frame capture of facial coordinates, which are independent of head pose
4	Student learning context analysis by emotional intelligence with data mining toots [18]	1. Kappa statistic 2. Mean absolute error 3. Root mean squared error 4. Relative absolute error
5	Analysis of students emotion for Twitter data using naive Bayes and nonlinear support vector machine approach [6]	1. Amazon mechanical turk to create data sets for ML models 2. Confusion matrix for determining the accuracy of the various algorithms
6	Prediction of sentiment analysis on educational data based on deep learning approach [9]	1. Educational dataset taken from the Kalboard 360 dataset 2. WEKA—This tool provides methods for a whole range of data mining tasks like data pre-processing classification, clustering, association and visualization 3. Confusion matrix for determining the accuracy of the various algorithms

(continued)

Table 2 (continued)

S. No	Name of the paper	Tools used
7	Understanding student academic achievement emotions toward business analytic course: a case study among business management students from India [14]	1. Statistical package for social science (SPSS-23) software tool
8	Toward building a computer-aided education system for special students using wearable sensor technologies [7]	1. TrueScan32—an EEG device 2. Bluetooth connection adaptor (BAC) 3. Emotion recognition module (ERM)
9	Emotional strategy in the classroom based on the application of new technologies: an initial contribution [10]	1. SentiStrength—predicts the positive and negative feelings of texts simultaneously which assigns a value scale to the feeling 2. Google Ajax API—allows you to add Google search results to a website through JavaScript allowing you to display the search results easily and dynamically 3. Google's Vision API—allows you to detect individual objects and faces within the images 4. HER—is a software that allows you to identify emotions based on images and text classification

3 Conclusion

In this article, the insightful investigation of learner's feelings through educational information mining was discussed. The problems regarding learner's emotions are adjuring to be addressed have been investigated and examined, the models applied to depict various feelings, the classification procedures and various tools utilized in past research, examining the given work, its qualities and shortcomings are considered. The future degree drawn from the examination can be fused.

The use of various techniques of data mining such as the multi-layer perceptron (MLP) was suggested. The accuracies of the various concepts and tools of emotions in the aforementioned field and depending upon the metric were obtained, and the most optimal technique/algorithm to accomplish the desired outcomes and results of this research work were recommended.

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IoT-PSKTS: Public and Secret Key with Token Sharing Algorithm to Prevent Keys Leakages in IoT

K. Pradeepa and M. Parveen

Abstract In the Internet of Things (IoT) paradigm, devices involved will frequently face different types of attacks, for example flood attacks, eavesdropping attacks and so on. Once attackers have compromised the IoT device, the data materials of the IoT device will not remain confidential, and it will then be captured by the attacker; this will in turn threaten the entire network. Consequently, to safeguard IoTs, this paper proposes a public and secret key with token sharing (IoT-PSKTS) algorithm to avoid key leakages in IoT. Cryptography can be utilized for secure communication in the presence of attackers. In cryptography, a conventional public key cryptosystem will be suitable because they do not require the sender and receiver to deliver the same secret to contact without threat. But, they regularly depend on intricate mathematical calculations and are thus much more incompetent than comparable symmetric key cryptosystems. In a large number of applications, the high price of encrypting lengthy messages in public key cryptography can be prohibitive. A hybrid system tackles it by utilizing a mixture of both. In IoT network, admin generates a public key, private key, secret key and token. The public and secret key will be used for packet encryption in IoT devices and base station side, and the private key will be utilized for decryption in the admin side and token used for IoT devices access control. For encryption purpose, admin shares public and secret key with a token for IoT devices and base station. Therefore, PSKTS algorithm has been used to securely share the public and secret key with a token for IoT devices and base station in a distributed way. The experimental results show that the proposed PSKTS algorithm shares a public and secret key with token in a secured way.

Keywords Access control · Cryptography · Hybrid system · Packet encryption · Decryption · Secret sharing

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1 Introduction

Internet of Things (IoT) is a novel technology in the fields of science, engineering, manufacturing and policy. It has fascinated the significant attention of innovation, introduction and improvement proceedings as well as is a well-known topic of both social media and press. The significance of IoT is the hopeful alteration of features, for daily life proceedings and services. In the IoT, devices are mostly subject to various kinds of attacks, i.e. flood attacks, eavesdropping attacks and so on. Once attackers have compromised an IoT device, IoT device information items are nothing confidential and captured by attackers; thus, the whole network menaced. To address this issue, cryptography is required.

Cryptography is a way of securing data and communication via coding so that only those who targeted can read and process it [1]. Cryptographic algorithms utilize a set of encryption and decryption processes to protect communication between IoT devices, the IoT base station and the admin. The cypher suite uses one encryption algorithm, another authentication algorithm and another key swap algorithm. This process embedded in protocols and encoded in software that works on networked computer systems, and operating systems include public and private key generation for information encryption/decryption, digital signature and message verification and key exchange.

In cryptography, conventional public key cryptography is suitable because they do not require the sender and receiver to share the same secret to contact safely. But, they usually depend on complex mathematical calculations and are therefore often doing not work much better than symmetric key cryptography. For most applications, the high price of encrypting lengthy messages in public key cryptography may be prohibitive. Hybrid cryptography deals it by utilizing a mixture of both. Many previous security programs assume that no data about the secret key used to encrypt information during the encryption procedure will leak. But, practically, this scenario is not surely true. Data regarding the secret key could compromise for different attacks, for example side-channel attacks on the communication cable, physical memory, etc.

Consequently, a cryptographic algorithm that has theoretically proven to be very secure will be practically completely unsafe if implemented improperly. Let us take the side-channel attack as an example. By measuring the power consumption and computation time, the attacker can get the internal state of an intermediate physical device. The attacker uses this data to break a cryptographic primitive computed by the device. The attacker uses “cold boot” attack, for steal an important fraction of the bits of a cryptographic key if the key recorded in memory while key sharing. This problem motivates to generate well secured key sharing algorithm. The main objective of this paper is to prevent key leakages in IoT to enhance security.

Also, access control is a way to ensure that IoT devices are the ones they claim to be and that they have proper packet access [2]. Take two IoT devices, for example. The two IoT devices are side by side. Also, the two IoT devices joined into different

IoT networks. Each IoT network is monitored individually by each IoT base station. If there is no access control at this time, the information going to one IoT device is likely to be accessed by another IoT device. Access control becomes essential to avoid this. Token-based access control is an authentication technique that provides extra protection. Each IoT device contains a token using this technique. Without this token, it is unfeasible to use the packet. Also, secret sharing means sharing a secret between collections of IoT devices, each of whom allotted a share of the secret [3]. The secret could redo by only the proper IoT device and when enough number, or perhaps various types, of shares, merged. In this work to safely share keys to all IoT devices for encryption, this paper proposes a public and secret key with token sharing (IoT-PSKTS) algorithm to avert key leakages. This algorithm assists in admin for the distribution of keys safely.

The rest of the paper is organized as follows: Sect. 2 presents a related work of existing cryptography, access control and secret sharing techniques. Section 3 describes a public and secret key with token sharing algorithm to prevent keys leakages in detailed. Section 4 provides extensive experimental results to support the proposed PSKTS algorithm. Finally, Sect. 5 provides the conclusion of the work.

2 Related Work

This section discusses related works of previous cryptography techniques, access control algorithms and secret sharing techniques.

Carracedo et al. [1] provided an in-depth cryptography research study related to IoT safety. The authors discussed security improvements from cryptography research in response to security challenges posed by the IoT environment. By separating cryptography research, a collection of conclusions and suggestions for future research guidelines was provided.

Alramadhan and Sha [2] initially provided a comprehensive survey of previous access control systems and examined their effectiveness on IoT networks. Subsequently, both challenges in building IoT access control and future IoT access control management objectives are recognized and debated.

Tang et al. [3] presented a cost-effective secret key distribution system for multiple-input multiple-output (MIMO) IoT applications, which can detect the secret key distribution and simultaneous communication. The secret key data joined to a compilation of small active/inactive channels of the legitimate recipient, generated by single value corruption (SVC) MIMO channel of the legitimate recipient. The legitimate recipient can precisely locate the shared key and delete down the contact data with the discretionary low key BER and bit error rate (BER).

Yousefi and Jameii [4] have developed a hybrid encryption algorithm that was developed to decrease security threats and improve encryption speed and a smaller amount of computational complicated. The motive of this hybrid algorithm is the reliability of the information, privacy, non-rejection in data transmission for IoT.

Finally, the proposed encryption algorithm was developed by the MATLAB software, and its speed and security performance wastested compared to the standard encryption algorithm.

Gunathilake et al. [5] presented the need of lightweight cryptography (LWC), its present position, related protocols and technologies, i.e. LoRaWAN, and the challenges in the current circumstance by examining previous practical and theoretical studies in the curriculum.

Terkawi et al. [6] discussed models, issues and challenges raised by IoT. Also, the authors discussed different types of access controls. The standard access control models will eventually transform into something very different and more relevant to the Internet of Things, such as their proposed model combining authentication and verification. Furthermore, implementing rules will enable greater flexibility and enable decentralized management of shared resources, which is a significant goal in a certified joint environment.

Wang et al. [7] designed a reliable attribute-based access control model, which introduced the confidence rating module and passed recognition with artificial control, combining dynamic confidence attribute and multiple standard attributes. Finally, their model has very advanced features and improves the security of the IoT system with test results.

Surendran et al. [8] initially debated the requirement for IoT cryptography and their plan variations with standard block cyphers. A survey of other IoT cryptographic algorithms debated later. Also, they looked at the various kinds of attacks that researched in some of these cyphers. Lastly, they compare the effectiveness of some of these cyphers on embedded and Windows platforms.

Miao and Jiang [9] introduced a method of sharing secrets between two users using the effects of wireless channel dynamics on the data connection layer. In particular, the authors create problems in improving their goal of minimizing the eavesdropper's access to all secret sharing packets. Their contributions are: (i) authors coming up with a secret sharing method that reduces the objective function mentioned above and (ii) authors analyzing how authors find the worst chance of eavesdropper accessing all the secretly distributed packets. Simulations verify their theoretical outcomes.

Farhadi et al. [10] discussed a new way of storing integrated data in IoTs via secret sharing scheme using (t, n)-threshold in cloud storage. In this way, the actual data is divided into t blocks, where each block is treated as a share. This method is scalable and detectable; that is, it can insert new data or delete a portion of the actual data, without changing shares, and when cloud service providers find fault with sending the wrong share. Table 1 shows the related work comparison based on the security type used.

Table 1 Comparison of related work based on the type of security used

Related work	Type of security used
[1]	Cryptography
[2]	Access control
[3]	Secret sharing
[4]	Cryptography
[5]	Cryptography
[6]	Access control
[7]	Access control
[8]	Cryptography
[9]	Secret sharing
[10]	Secret sharing

3 IoT-PSKTS: Public and Secret Key with Token Sharing Algorithm to Prevent Keys Leakages

IoT network consists of three entities: (1) Admin, (2) IoT base station and (3) IoT devices. Admin is a person who responsible for forest monitoring; he can monitor forest anywhere at any time using IoT. IoT devices monitor forest and generate sensed data. Followed by, it shares sensed data to the admin through IoT base station. IoT base station is a network controller of IoT. After collection of sensed data, it outsources these sensed data to admin. IoT devices have limited energy, limited coverage area, limited transmission power (Et) and limited receiving power (Er). Each IoT devices is fixed at various locations in the forest for sensing temperature, sound, vibration, pressure, etc. This section proposed IoT-PSKTS algorithm to improve IoT network security, which is explained in Algorithm 1, and the IoT-PSKTS algorithm block diagram is shown in Fig. 1.

Demonstrated in Fig. 1, the admin generates three keys with one token to all IoT devices and base station for encryption, decryption and access control purpose (Step 2–4). They are,

1. The public key for IoT base station (for encryption) with
2. The secret key for each IoT devices (for encryption) and
3. Token for each IoT devices (for access control)
4. The private key (for decryption) for own use.

Followed by that, the admin converts public key, secret keys and tokens to n number of shares (Steps 5–7) and then forwards these n shares to IoT base station (Step 8). After receiving any number of shares ($<n$), the IoT base station reconstruct public key, secret keys and tokens based on shares (Steps 11–13). Followed by that, the IoT base station converts secret keys and tokens of each IoT devices to n number of shares (Steps 16–18). Each share will transmit to the IoT device, which is entitled

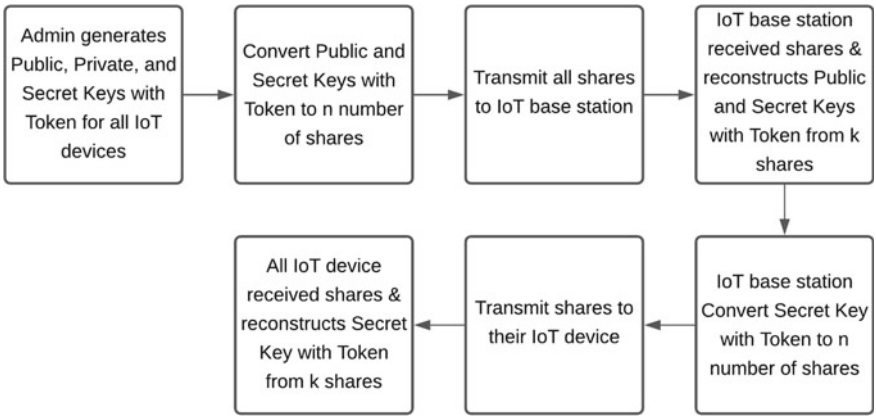

Fig. 1 Block diagram of IoT-PSKTS algorithm

to it (Step 19). After receiving any number of shares ($<n$), all IoT devices reconstruct its own secret key and token, respectively (Step 21–25).

Algorithm 1: IoT-PSKTS: Public and secret key with token sharing algorithm

Input	:	Admin, IoT base station (IBS), IoT devices (IDSs)
Output	:	The public and secret key with token sharing
		Admin Side
Step 1	:	For each IoT device ID from IDSs do
Step 2	:	Keys[] = Key_Generation() // **Algorithm 2**
Step 3	:	PubKey = Keys[0], PrivKey = Keys[1], SecKey = Keys[2]
Step 4	:	Token = Generate_Token(ID) // **Algorithm 3**
Step 5	:	AK = PubKey + "||" + SecKey + "||" + Token;
Step 6	:	Let N, k // N - no of shares generated & k - no of shares must for reconstruct
Step 7	:	SH[] = Generate_Shares(AK, N, k) //**Algorithm 4**
Step 8	:	Forward SH with k to IBS
Step 9	:	End For
		IoT Base Station Side
Step 10	:	For each IoT device ID from IDSs do
Step 11	:	IBS received SH with a k value
Step 12	:	Take k shares for reconstructing
Step 13	:	AK = Reconstruct(k shares) // **Algorithm 5**
Step 14	:	Keys[] = AK.split("||");
Step 15	:	PubKey = Keys[0], SecKey = Keys[1], Token = Keys[2]
Step 16	:	AK = SecKey + "||" + Token;
Step 17	:	Let N, k // N - no of shares to be generated & k - no of shares must for reconstruct
Step 18	:	SH[] = Generate_Shares(AK, N, k)// **Algorithm 4**
Step 19	:	Forward SH with k to ID
Step 20	:	End For
		IoT Device Side
Step 21	:	ID received SH with a k value
Step 22	:	Take k shares for reconstructing
Step 23	:	AK = Reconstruct(k shares) // **Algorithm 5**
Step 24	:	Keys[] = AK.split("||");
Step 25	:	SecKey = Keys[0], Token = Keys[1]

3.1 Key Generation

Cryptography techniques are used to convert the original text message into unreadable text format (ciphertext). Three different types of keys such as private key, public key and secret key are used in the hybrid cryptography. In encryption, public and secret keys are involved, and in decryption, private and secret keys are involved. Algorithm 2 explained the process of key generation algorithm by using two different prime numbers, and it is denoted as $p1$ and $p2$. Step 2 multiples both prime numbers. Step 3 will subtract from prime number and multiplies it with $m2$. Step 4 calculates the co-prime number which contains common factor between two prime numbers.

$$35 = 7 \times 5 \times 1$$
$$39 = 13 \times 3 \times 1 \quad (1)$$

In mod 7, the multiplicative inverse of 2 is 4. This algorithm calculates the multiplicative inverse of $e1$ with mod $m2$ (Step 5) which provides $e2$. The values $e1$ and $m1$ are taken for the public key (Step 9), and also, $e2$ and $m1$ are taken for the private key (Step 10). The AES algorithm is used to generate a secret key. Firstly, this algorithm produces an AES key generator (Step 6) which provides the functionality of a secret (symmetric) key generator. Followed by this, the algorithm launches this key generator with a 128-bit key size (Step 7). Also, this key generator creates a secret (Step 8). Following this, this algorithm encodes this secret into the secret key (Step 11).

3.2 Token Generation

This section creates a token using the HMAC-SHA-1 algorithm because HMAC-SHA-1 algorithm provides a strong message authentication code based on SHA1, which is a cryptographic hash function over the data (to be authenticated) and a secret key [11, 12]. This message authentication code is used as a token. This token is used to control unauthorized access. In this case, IoT device identity is used as data and HMACSHA1 keyword is used as the secret key.

Algorithm 3 describes the making of tokens.

To make HMAC-SHA-1 token over the IoT Device Id data, the following are executed,

1. SecretKeySpec class—This class defines the secret key in the provider-independent fashion (Step 1). It can use to build SecretKey from a byte array, without having to go through (based on the provider) SecretKeyFactory. This class is for use with raw secret keys that can be displayed as a byte array and have no key parameters associated with them, e.g. DES or triple-DES keys.

Algorithm 2: Key_Generation		
Input	**:**	Two Random Prime numbers (p1 and p2)
Output	**:**	Keys[]
Step 1	**:**	Let Keys[] = {}
Step 2	**:**	m1 = p1 * p2
Step 3	**:**	m2 = (p1-1) * (p2-1)
Step 4	**:**	e1 = getCoprime(m2)
Step 5	**:**	e2 = modInverse(e1, m2)
Step 6	**:**	keyGen = KeyGenerator.getInstance("AES") // Secret key generation based on AES algorithm
Step 7	**:**	keyGen.init(128)
Step 8	**:**	secret = keyGen.generateKey()
Step 9	**:**	PubKey = e1, m1
Step 10	**:**	PrivKey = e2, m1
Step 11	**:**	SecKey = Base64.encode(secret.getEncoded())
Step 12	**:**	Keys[0] = PubKey, Keys[1] = PrivKey, Keys[2] = SecKey
Step 13	**:**	return Keys[]

2. Mac class—This class provides the operation of the "Message Authentication Code" (MAC) algorithm (Step 2). The Mac.getInstance (HMAC_SHA1_ALGORITHM) method returns the Mac object that executes the default MAC algorithm.
3. Mac object with a given key started in Step 3.
4. mac.doFinal (data.getBytes ()) method processes a given array of bytes (rawHMAC) and terminates MAC operation (Step 4).
5. Lastly, this algorithm encodes raw HMAC to token using the encode function (Step 6–Step 17).

Algorithm 3: Generate_Token(ID)

Input	**:**	IoT Device (ID), HmacSHA1
Output	**:**	Token
Step 1	**:**	signingKey = new SecretKeySpec(ID.getBytes(), HmacSHA1)
Step 2	**:**	mac = Mac.getInstance(HmacSHA1)
Step 3	**:**	mac.init(signingKey)
Step 4	**:**	rawHmac[] = mac.doFinal(ID.getBytes())
Step 5	**:**	Token = new String(encode(rawHmac))
Step 6	**:**	return Token
		encode function
Step 7	**:**	char[] encode(byte[] bytes)
Step 8	**:**	{
Step 9	**:**	char[] HEX = {'0', '1', '2', '3', '4', '5', '6', '7', '8', '9', 'a', 'b', 'c', 'd', 'e', 'f'}
Step 10	**:**	amount = bytes.length;
Step 11	**:**	char[] result = new char[2 * amount]
Step 12	**:**	j = 0
Step 13	**:**	For (int i = 0; i < amount; i++)
Step 14	**:**	result[j++] = HEX[(0xF0 & bytes[i]) >>> 4]
Step 15	**:**	result[j++] = HEX[(0x0F & bytes[i])]
Step 16	**:**	End For
Step 17	**:**	return result
Step 18	**:**	}

3.3 Shares Generation

After key generation, the admin wants to send the public key, the secret key with a token to IoT base station. Furthermore, the IoT base station wants to send the secret key with a token to each IoT devices. But, key sharing in an IoT network is computationally unsafe and inconsistent due to its dynamic nature. The secure key sharing technique is necessary to tackle this problem. Before generating shares, all keys should be merged (AK). Then, this technique splits the merged keys into many shares and then transmits each share to the IoT base station or IoT devices. Shares generation is explained in Algorithm 4 and Fig. 2.

This algorithm takes AK, N and k for input (Step 1). Here,

N—Number of shares to be generated and

k—Number of shares must reconstruct.

$$f(x) = a0 + (a1 * x) + \left(a2 * x^2\right) \tag{2}$$

where $a0$ is the secret, and $a1$ and $a2$ are randomly chosen integers. AK converted to N shares is shown in Fig. 2 clearly.

Algorithm 4: Generate_Shares(AK, N, k)		
Input	:	AK, N, k
Output	:	Shares (SH)
Step 1	:	Let a0 = AK, SH = {}
Step 2	:	Generate Random (k-1) numbers (a1 and a2)
Step 3	:	Let f(x) = a0 + (a1 * x) + (a2 * x^2)
Step 4	:	For x=1; x<=N; x++
Step 5	:	SH[x-1] = (x,f(x))
Step 6	:	End For
Step 7	:	return SH

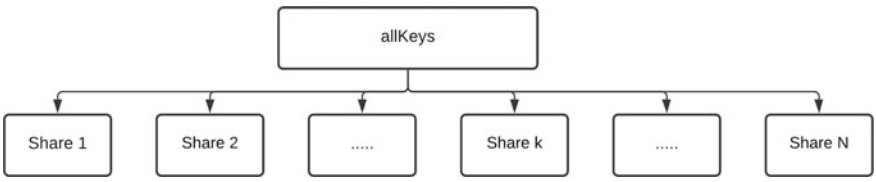

Fig. 2 Shares generation

3.4 Reconstruct

After receiving all N shares, an IoT base station or IoT device takes k shares for reconstructing the AK. It is the advantage of the proposed IoT-PSKTS algorithm. If any intermediate device turns into malicious, it may be dropping any shares. So, this algorithm takes k shares which are enough for reconstructing, which shows in Fig. 3.

Reconstruct process explained in Algorithm 5. In Fig. 3, the algorithm applies k shares into a Lagrange polynomial formula (Step 1).

$$f(x) = \sum_{j=0}^{k} (yj * lj(x)) \tag{3}$$

It provides $a0$, $a1$, $a2$ and so on. For simplicity, k values are 3 (it give while shares generation), so this algorithm provides $a0$, $a1$ and $a2$ only (Step 2). Here, $a0$ is AK (Step 3).

Algorithm 5: Reconstruct(k shares)

Input	:	k shares (x0,y0), (x1,y1), ... , (xk,yk)
Output	:	AK

Step 1	:	f(x) = $\sum_{j=0}^{k}$(yj * lj(x)) // Lagrange basis polynomial
		// If k=3 then f(x) = (y0*l0(x)) + (y1*l1(x)) + (y2*l2(x))

Step 2	:	f(x) = a0 + (a1 * x) + (a2 * x^2)
Step 3	:	AK = a0

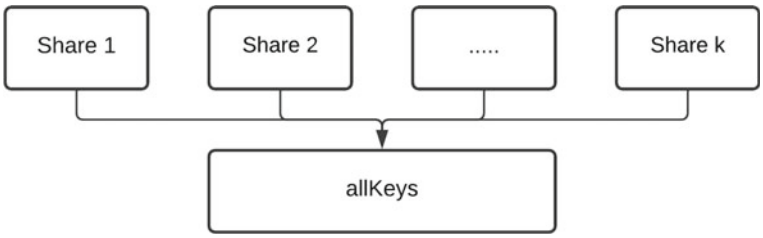

Fig. 3 Shares reconstruction

3.5 Mathematical Model of Share Construction and Reconstruction Process

Share Construction:

For instance, AK = 1234. The proposed research work attempts to split the secret into six shares ($n = 6$), where any three shares ($k = 3$) are enough to reconstruct AK. At random, $k - 1$ numbers are obtained as: 166 and 94.

($a0 = 1234$; $a1 = 166$; $a2 = 94$), where $a0$ is secret

The polynomial mentioned in Eq. (2) provides secret shares:

$f(x) = 1234 + 166x + 94x^2$

It constructs six shares from the polynomial:

$f(1) = 1234 + 166(1) + 94(1)^2 = 1494$
$f(2) = 1234 + 166(2) + 94(2)^2 = 1942$
$f(3) = 1234 + 166(3) + 94(3)^2 = 2578$
$f(4) = 1234 + 166(4) + 94(4)^2 = 3402$
$f(5) = 1234 + 166(5) + 94(5)^2 = 4414$
$f(6) = 1234 + 166(6) + 94(6)^2 = 5614$

Share Reconstruction:

To reconstruct the AK, any three shares ($k = 3$) will be sufficient.

($x0, y0$) = (2, 1942); ($x1, y1$) = (4, 3402); ($x2, y2$) = (5, 4414)

Now, Lagrange basis polynomials are applied based on Eq. (3):

$l0(x) = (x - x1/x0 - x1) * (x - x2/x0 - x2) = (x - 4/2 - 4) * (x - 5/2 - 5) = x^2/6 - 3x/2 + 10/3$
$l1(x) = (x - x0/x1 - x0) * (x - x2/x1 - x2) = (x - 2/4 - 2) * (x - 5/4 - 5) = -x^2/2 + 7x/2 - 5$
$l2(x) = (x - x0/x2 - x0) * (x - x1/x2 - x1) = (x - 2/5 - 2) * (x - 4/5 - 4) = x^2/3 - 2x + 8/3$

Thus,

$$\begin{aligned} f(x) &= (y0 * l0(x)) + (y1 * l1(x)) + (y2 * l2(x)) \\ &= \left(1942 * \left(x^2/6 - 3x/2 + 10/3\right)\right) + \left(3402 * \left(-x^2/2 + 7x/2 - 5\right)\right) \\ &\quad + \left(4414 * \left(x^2/3 - 2x + 8/3\right)\right) \\ &= 1234 + 166x + 94x^2 \end{aligned}$$

Here 1234 is AK.

4 Results and Discussions

This section provides the results of the experimental and analysis of the IoT-PSKTS algorithm on the IoT network. This simulation assumes that most IoT devices are still distributed evenly and randomly in the forest. These IoT devices measure temperature, humidity, light intensity, wind speed, rainfall and smoke [13, 14]. Following these devices, readings are transmitted to the admin via the IoT base station. Java is used to evaluate the IoT-PSKTS algorithm. Compare the proposed IoT-PSKTS algorithm with other secret sharing algorithms, such as AdiShamir's perfect secret sharing scheme (PSS), HugoKrawczyk's computational secret sharing scheme (CSS) and Rabin's information dispersal algorithm (IDA) [15]. Table 2 shows the time take in (ms) of share formation ($n = 5, k = 3$).

Figure 4 shows the graph of time taken against data sizes in share creation when $n = 5, k = 3$.

Table 2 and Fig. 4 demonstrated that IoT-PSKTS is the fastest algorithm based on the data sizes. Furthermore, Table 3 shows time take in (ms) for share recreation ($n = 5, k = 3$).

Figure 5 shows the graph of time taken against data sizes in share recreation when $n = 5, k = 3$.

Table 2 Time take in (ms) for share creation ($n = 5, k = 3$)

Algorithm	Data size (in KB)		
	16	32	64
CSS	19.45	25.03	31.80
IDA	12.82	19.59	21.19
PSS	28.78	40.01	42.89
IoT-PSKTS	10.97	17.19	19.68

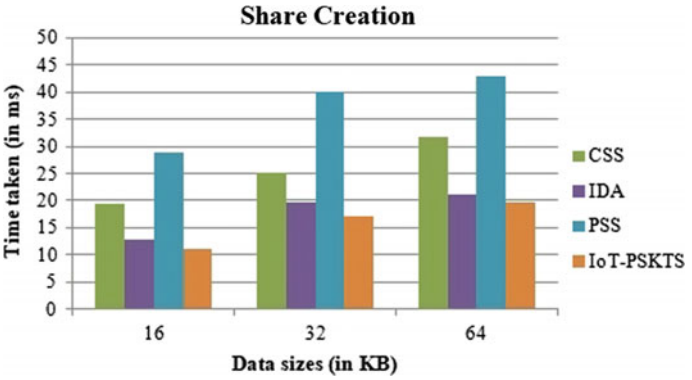

Fig. 4 Graph of data size against the time taken in share creation when $n = 5, k = 3$

Table 3 Time take in (ms) for share recreation ($n = 5$, $k = 3$)

Algorithm	Data size (in KB)		
	16	32	64
CSS	19.27	21.63	26.11
IDA	17.82	19.51	22.57
PSS	30.01	20.00	23.89
IoT-PSKTS	15.76	17.04	20.49

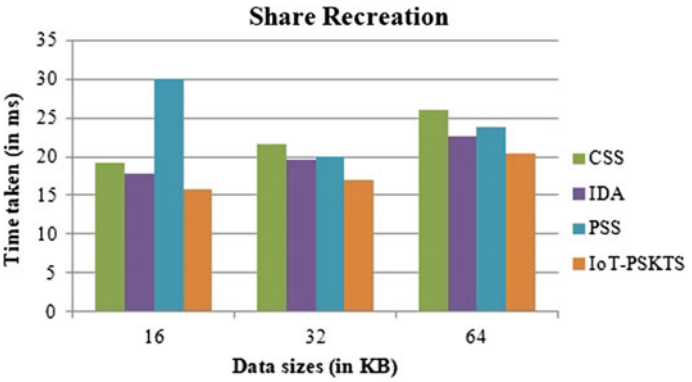

Fig. 5 Graph of data size against the time taken in share recreation when $n = 5$, $k = 3$

Table 3 and Fig. 5 demonstrated that IoT-PSKTS is the fastest algorithm based on the data size. This approach demonstrates the data size improvement to avoid the scalability compared to other algorithms.

5 Conclusion

This paper proposed a public and secret key with token sharing (IoT-PSKTS) algorithm to prevent key leaks in the IoT. In an IoT network, the admin creates a public key, a private key, a secret key and a token. Here are the public and secret key used for packet encryption, the private key used for decryption and the token used to control access. For encryption purposes, the admin shares a public and secret key with the token for IoT base station and IoT devices. Consequently, the IoT-PSKTS algorithm presents security while keys shared in a distributed way. Compared with previous key sharing algorithms, experimental results have proven that IoT-PSKTS algorithms present secure key sharing with minimal share creation and recreation time in forest monitors on the IoT network.

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Investigation and Analysis of Path Evaluation for Sustainable Communication Using VANET

D. Rajalakshmi, K. Meena, N. Vijayaraj, and G. Uganya

Abstract Today, the taskforce is getting increasing and the streets are getting more hazardous by the impact of blockage and increment of crashes. Intelligent transportation systems (ITS) are utilized to incorporate data innovation in transportation. Vehicular ad hoc networks (VANETs) are a subset of MANET which provides communication between the mobile nodes. VANET is a collection of various dynamic nodes that can change and configure. In VANET, enormous routing protocols are implemented to route the packet reliably. One of the protocols is ad hoc on-demand distance vector (AODV) routing protocol, and this protocol can only be used when the nodes are in static movement. The other protocol is destination sequenced distance vector (DSDV) in which each node maintains a table of information about the presence of the other nodes. In traditional system, only one algorithm used for the communication strategy, but in our proposed system GAD protocol (a combination of Genetic, AODV and DSDV) in which the functionalities of entire algorithms can be used based on the communication range in the network. Our proposed idea, using GAD protocol (a combination of Genetic, AODV, and DSDV) in which the functionalities of both the algorithms can be used based on the communication link in the network. Here proposed a numerical model to calculate the path duration between source and destination using GAD protocol and solve the Sybil attack, its severe attack on vehicular ad hoc networks (VANETs). The numerical model is simulated, and the GAD protocol is developed using MATLAB. The result exposes that when the transmission range increased then the path duration and numbers of hops become decreased in VANET.

Keywords FCM · GAD · KNN · MANET · VANET

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1 Introduction

For humankind, transportation is the basic mode to travel from one place to another. Nowadays, the different kinds of vehicles including transports, trucks, trains, cable cars, ships, planes, bikes, bikes, and helicopters are used for transportation. In recent days, engineers play a vital role in developing software for effective communication between source and destination [1]. When a packet is traveled from source to destination, there is a chance of congestion, which means when the message traffic is so heavy it slows down the network response time [2]. This leads to an increase in delay and a decrease in performance. At the same time, it leads to a collision.

ITS is an intelligent transportation system [3]. It pointed toward utilizing PCs and interchanges to make travel more intelligent, quicker, more secure, and more advantageous. ITS makes travel more secure and less tedious and makes it simpler to choose how you wish to travel [4]. And business has a more efficient, less costly way of moving its products to the marketplace.

1. **Routing Protocol**: To choose the correct routing protocol is very important in VANETs because the topology changes frequently.
2. **Mathematical Models**: It is a mathematical expression for identifying path duration between two vehicles through an average number of hops and connection duration.
3. **Modeling Assumptions**: Our assumption is to make connection duration for the dynamic nodes.
4. **Area of Boundary Region for Identifying the Next Hop**: The node becomes closer to the boundary region, and it reduces the number of hop distance between source and destination.
5. **Probability of Identifying Nodes in the Shaded Region**: To identify the probability of a single node in the boundary region has to increase the performance of the network [5].

    1. Number of Hop: Intermediate node between source and destination.
    2. Speed of Nodes: The mandatory field of path duration is the motion and speed of the node.
    3. Connection Duration: It calculates the time for two nodes which is active and which one is directly connected to the transmission range.
    4. Path Duration: It improves the performance and throughput of VANET.

2 VANET

VANET is an emerging technology; it leads to improving security in wireless communication [6]. It is inherited from mobile ad hoc network (MANET). The similarities of VANETs with mobile ad hoc networks (MANETs) are flat network (infrastructureless environment), self-organizing without a server configuration [7]. VANETs can be differentiated by the following parameters: (i) extremely vibrant topology; (ii)

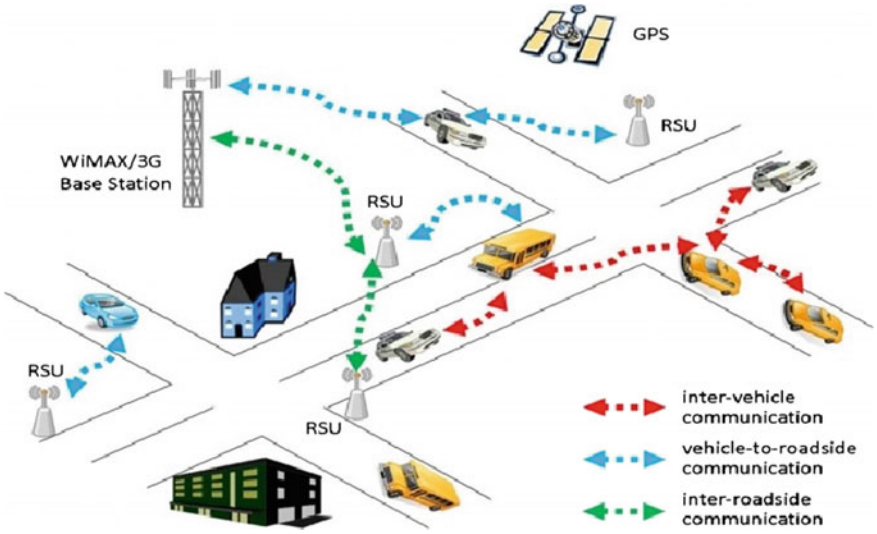

Fig. 1 Architecture of VANET

frequently disconnected network; (iii) sufficient energy and capacity gave by the vehicle; (iv) geological kind of correspondence; (v) versatility demonstrating and forecast; (vi) hard suspension limitations; and (vii) connection with onboard sensors [8]. The architecture of VANET is shown in Fig. 1.

3 Related Work

In the existing system, they used AODV routing algorithms for static movement of nodes and communication with each other. DSDV routing algorithm for dynamic movement of node communicates with each other [9]. The static and dynamic movement of node communication works separately in the existing system. Before establishing communication, Initially calculated the path duration of the routes in the network, automatically performance and throughput of the VANETs can be enhanced significantly [10].

Drawbacks in the Existing System

1. If the path time increased, the transmission range also increased; if the transmission range is increased, then it needs more power to complete the entire communication.
2. If the number of hops increased, the average path time decreased for a fixed number of nodes.
3. If there is any data loss occurs (attack) during transmission, the packet cannot be recovered automatically.

4 Proposed System

In our proposed system, the communication between the nodes is established during both static and dynamic movements of nodes using GAD protocol. GAD protocol is a combination of genetic algorithm, AODV algorithm, and DSDV algorithm. The genetic algorithm identifies which protocol to be used based on node motion whether it is static, it uses the AODV routing algorithm, or its dynamic, it uses the DSDV routing algorithm helps in deciding which protocol to be used based on node motion whether it is static it uses the AODV routing algorithm, or dynamically it uses the DSDV routing algorithm. Here, the GAD protocol is used to detect and resolve the Sybil attack and successfully transmit the packet to the other nodes.

Sybil Attack: It is a basic attack in VANET. In this attack, the aggressor sends various messages to different vehicles. Each message contains an alternate source identity. It confuses for different vehicles by sending incorrect messages like congestion messages. If there is congestion, further vehicles are compelled to take another path. The primary point of the attacker is to give an illusion of various vehicles to different vehicles so vehicles can pick another course. With the help of GAD protocol, it detects the sybil attack, without disturbing the communication it resolves the attack more effectively going to detect and resolve these attacks.

Advantages of the Proposed System

1. Simulation results depict that the identification of reliable path time is very low for all circumstances.
2. The communication range is increased, and then the path time is low.
3. Genetic algorithm provides reliable communication and reduces path failure.

In our proposed work, the implementation was divided into three sections:

1. Section 1 explains the concept of creation of nodes and finds the best route to communicate in both static and dynamic movements of vehicles separately.
2. Section 2 includes the combination of both static and dynamic movements of vehicles using the GAD protocol and with simulation result and graph.
3. Section 3 depicts the concept of how a Sybil attack occurred and recovered.

5 GAD Protocol

GAD stands for genetic AODV DSDV algorithm. Generally, genetic algorithms are used to find the reliable path between the nodes. In the GAD protocol, the genetic algorithm chooses the functionality of the AODV algorithm if the nodes are connected in a static link; otherwise, it chooses the functionality of the DSDV algorithm if the nodes are connected in a dynamic link. For clustering to the nearest nodes, the fuzzy C-means (FCM) algorithm is used when AODV is selected and K-nearest neighbor (KNN) algorithm is used when DSDV is selected. Using GAD protocol, the functionalities of both the algorithms can be used based on the link in the network.

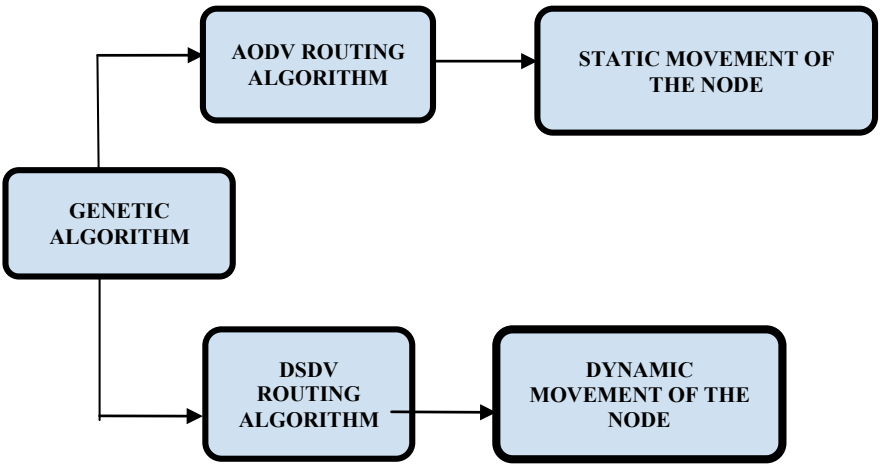

Fig. 2 System architecture

In the GAD protocol, the genetic algorithm decides which algorithm to be used. The proposed system architecture is depicted in Fig. 2.

6 Algorithm for GAD

Algorithm: Genetic algorithm for determining the "i" reliable path.
buffer_size, gen, Bm, Bc, a0, the destination nodes Y, X.
1. Create the initial buffer_size
2. max $\leftarrow$ 1
3. While (max <= max) do
4. $B \leftarrow 1$
5. While (B <= buffer_size) do
6. Getting chromosomes of the new buffer, select two chromosomes from the parent buffer based on Bc. Apply crossover, and then alter the new child according to Bm parameter.
7. Calculate the bandwidth of the new child (Band(B))
8. If $X(B) \geqslant X$ then
Save this child as a contestant solution.
9. $B \leftarrow B + 1$
10. End if
11. End
12. Print all determined solutions
13. End

7 Genetic Algorithm

GA is an irregular pursuit strategy dependent on the development rule of science (natural selection), which was proposed by J. Holland in 1975 to streamline total NP issues [11]. The genetic algorithm imitates the cycle of Normal Choice (NS) hereditary calculation mirrors the cycle of normal choice (NS), which implies a focal idea of advancement. These attributes will be given to the future, which is additionally named as natural selection. GA can be viewed as a abstract representations of candidate solutions to resolve the optimization issues [12]. Hereditary calculations can be seen in the recreation where a populace of dynamic portrayals of up-and-comer arrangements to take care of an advancement issue [12]. GA solves a problem using an evolutionary approach by creating mutations to the current solution by selecting the better methods from this new generation and then using these improved methods to repeat the process. Since the genetic algorithm calculations are randomized hunt and improvement strategies, following the standards of development and common genetic qualities, have a lot of verifiable parallelisms. Hereditary calculations are randomized hunt and improvement strategies following the standards of development and common hereditary qualities, have a lot of verifiable parallelisms. Thusly, GA might be a piece of the more extensive class of organic cycle calculations that might be implemented to the streamlining of convoluted calculations, the instructing of text arrangement frameworks, and the development of smart counterfeit specialists that will decide the conditions randomly [13–17]. With these perceptions, genetic calculations perform a search in muddled, huge, partner proclaimed multimodal scenes and gracefully close ideal answers for target or wellness performance of an enhancement disadvantage. The essential module cycle of GA delineates in detail as follows [18]:

(i) Initially, build up a GA for a streamlining issue. So, the arrangement is a series of pieces that comprise a similar number of components.
(ii) An underlying populace is produced unexpectedly which ought to be spread over the inquiry space to speak to a wide assortment of arrangements.
(iii) The determination duplicates the string to be remembered for the future.
(iv) By choosing an irregular position, the hybrid is applied and it makes two new chromosomes.
(v) Determination and hybrid can create a surprising measure of contrasting strings.
(vi) The end model can be set by the number of development cycles, the measure of the variety of people of various ages.

8 Sybil Attack

Sybil attack is a genuine danger as it decreases the usefulness of VANET. Here, an attacker hub sends messages with various phony personalities to different hubs in the

organization. The attacker mimics a wide range of various hubs in the organization [19]. The hub forcing the characters of different hubs is called a malevolent hub, whose personalities are vanquished called Sybil nodes. Moderately, every other attack can be dispatched on an organization within the sight of Sybil attack. The chance could be thought of as a gridlock or mishap with the goal that different vehicles change their steering way or leave the street to serve the aggressor. Sybil attackers can likewise motivate false data in the organizations through some manufactured non-existing hubs [20]. For instance, on account of a mishap on an expressway, the main vehicle noticing the mishap is sending a change course/deceleration ready message to all the encompassing vehicles. The agents may advance this message to caution the supporters by assuming anything. This sending cycle can be disturbed by Sybil vehicles by not sending the admonition message. This may lead the travelers in the harmful way.

9 Result and Discussion

The source and destination are selected by the black dot that represents the vehicle. The lines joining them represent the path between source and destination. By clicking the go button on the right side, possible routes will be shown in Fig. 3.

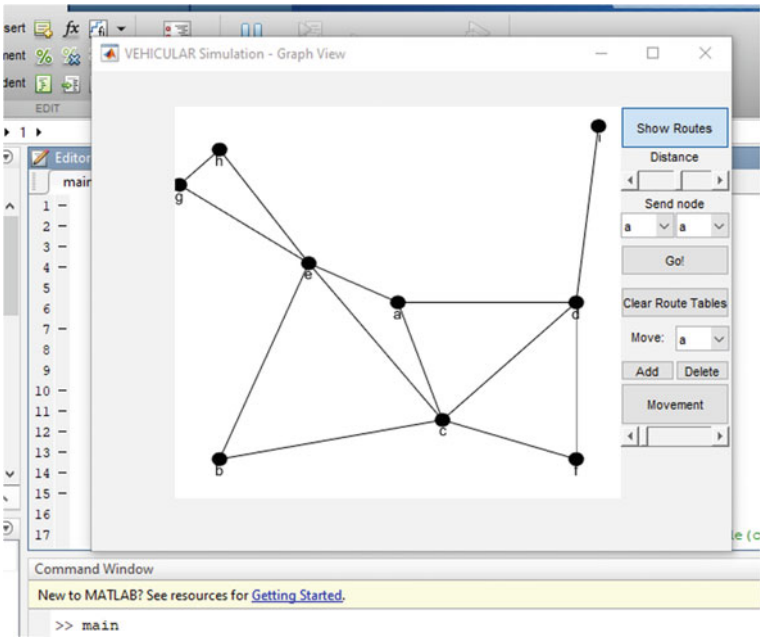

Fig. 3 Initial configuration of VANET

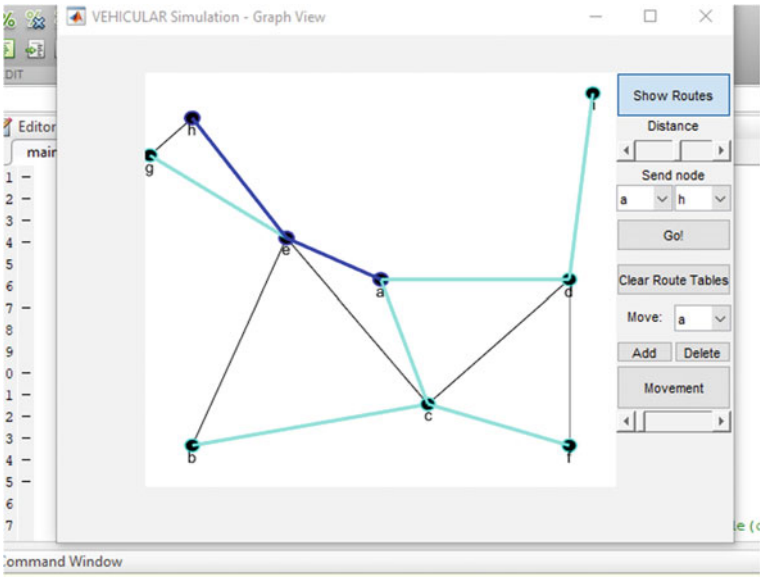

Fig. 4 Identifying different routes for vehicles

From source to destination, the different routes are determined. The routes are established by using the AODV routing protocol. Initially, it will find all possible nodes between the source and the destination. Then, it selects the source and destination nodes. Both static and dynamic motions of vehicles are identified, and the path is established. From source to destination, different routes are determined and identify the reliable path using FCM. It is denoted in Fig. 4.

Using the DSDV algorithm, a table is created which holds the source node, destination node, packet sequence number, and hop distance. Identify the source and destination node to perform the desired communication. By clicking the movement button on the right side of the window, the nodes will dynamically change. It automatically chooses the shortest route identified by DSDV algorithm through which the message is to be transferred will be identified by using the DSDV algorithm. Finally, the table was automatically updated with the corresponding details, and it is represented in Fig. 5.

In Fig. 6, a total of 60 nodes, sink node, indicate as yellow color and it finds the cluster head, which is ready for attack. The cluster head node is indicated in white square color. The routing path is shown in magenta color. The routing path shows communication via source to destination. The test case performance is analyzed with different sensor radii like $R = [100, 120, 150, 170]$ m.

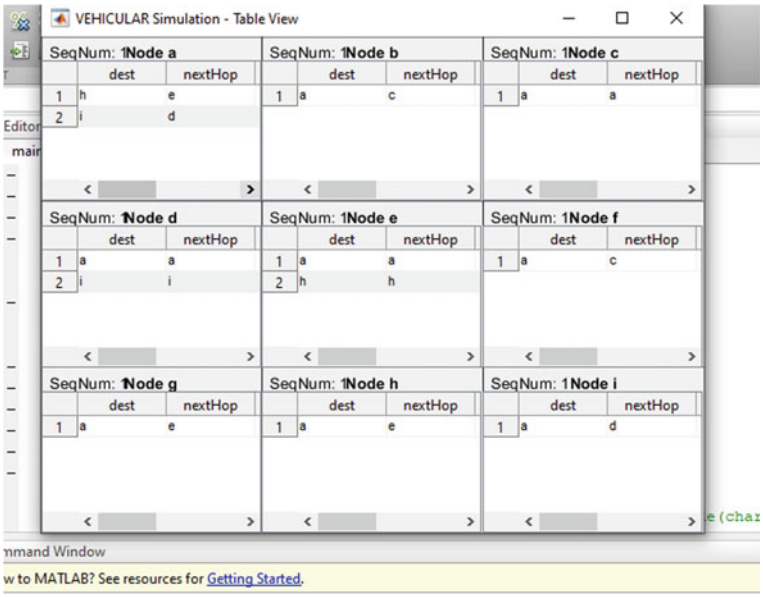

Fig. 5 Determining hop count details

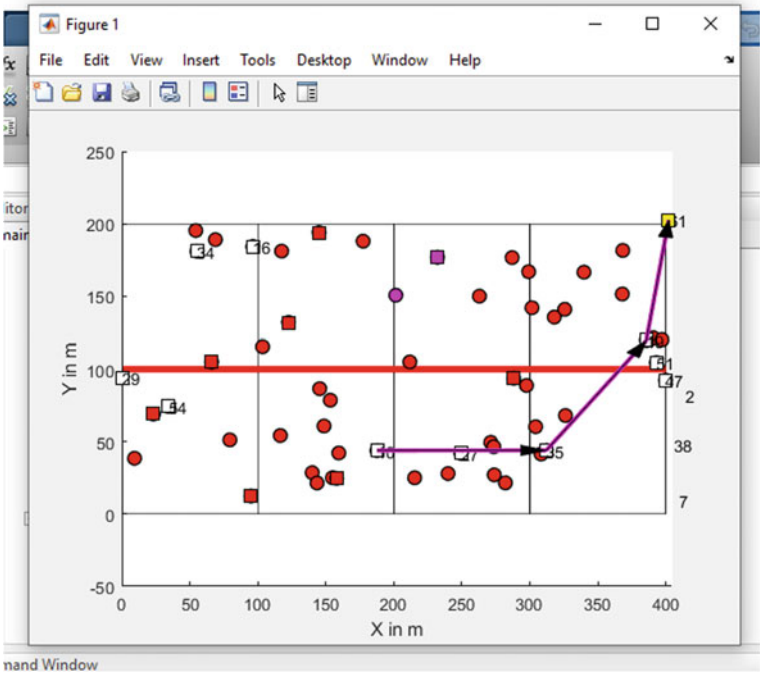

Fig. 6 Clustering of nodes

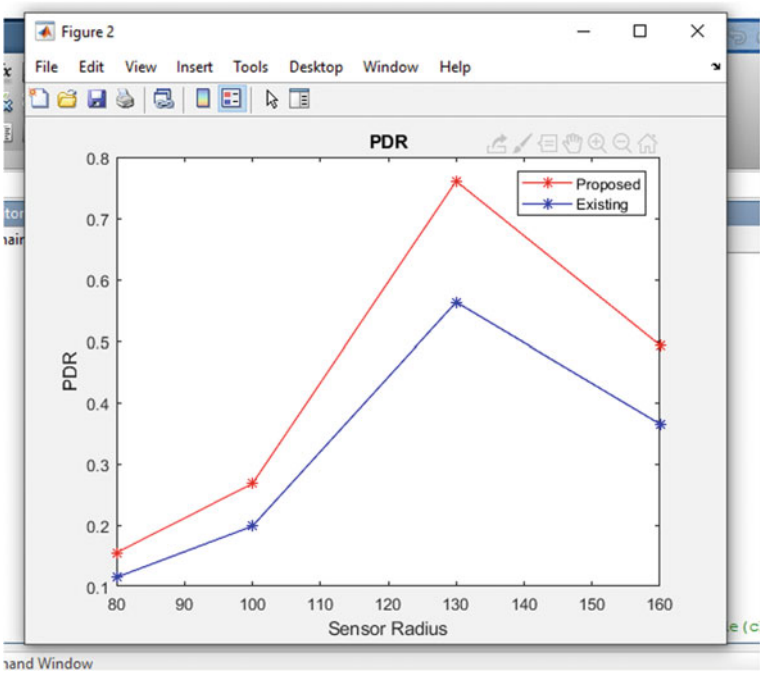

Fig. 7 Packet delivery ratio

9.1 Packet Delivery Ratio

The ratio of how many packets is successfully received by destination from the source node. A graph that compares the existing model with our proposed model is shown in Fig. 7. In this, the sensor radius is taken on the *X*-axis, and PDR is taken on the *Y*-axis. If the sensor radius is low, the communication path breakage may happen, so it automatically reduces the PDR; if the sensor radius increases more and most of the communication data from the source to sink with a low number of hopes in this time due to packet congestion, the PDR may decrease. But compared to the existing method, the proposed method has a high PDR.

9.2 Average End-to-End Delay

The time taken for a communication across a network from source to destination is calculated difference b/w communication the data from source to the destination is calculated. The data transfer between source and destination may get lost due to node coverage area or their position, represented in Fig. 8.

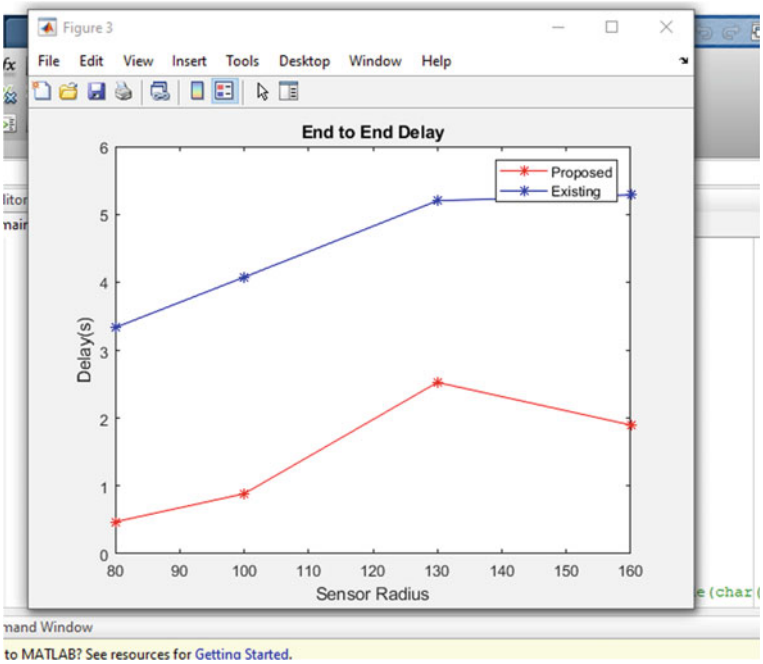

Fig. 8 Average end-to-end delay

9.3 CH Formation Delay

Initially, CH selection is based on a clustering algorithm, after the *t*-time slot CH update validates based on the neuro-fuzzy prediction. This time duration of CH update is called CH formation delay, represented in Fig. 9.

In Fig. 10, vehicles are moved in two lanes. Usually, the road side unit (RSU) is a wave device fixed along the road side for dedicated short-range communication. Every vehicle node communicates with the RSU. When the attacker spoof's multiple identities for one vehicle, 2 lanes mobility leads to Sybil attack to one vehicle, thus in 2 lanes mobility of vehicles leads to Sybil attack. Here, the attack is detected using the genetic algorithm, the node with the attack is cleared, and an encrypted message is safely sent to the required destination vehicle node.

10 Conclusion

In this article, the proposed algorithm called GAD is the combination of genetic, AODV, and DSDV algorithm for an effective vehicle-to-vehicle communication. The genetic algorithm determines the reliable route between the source and destination

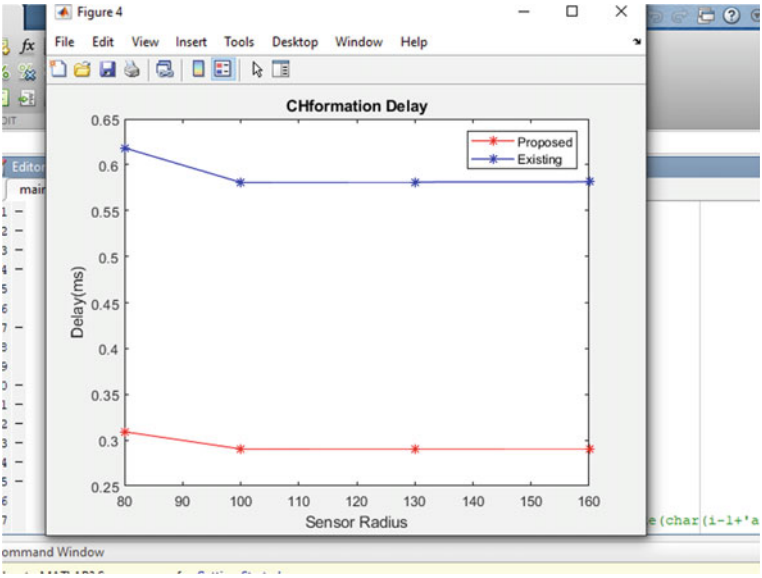

Fig. 9 Channel selection

node routes by either AODV or DSDV. In the first part, the nodes are created, the communication links are established, and the shortest path between the nodes is found. In the second part, the messages are successfully sent to the receiver. And finally, in the third part, the Sybil attack was implemented and it was recovered using GAD protocol. The GAD protocol simulation results depicted that the efficiency is improved by following performance metrics, Packet Delivery Ratio (PDR), End-to-End delay and Cluster formation delay, and these metrics are compared with existing protocols AODV and DSDV represent that the efficiency is improved in the following performance metrics of PDR, End-to-End delays and cluster formation delay all are efficient compared to the existing method.

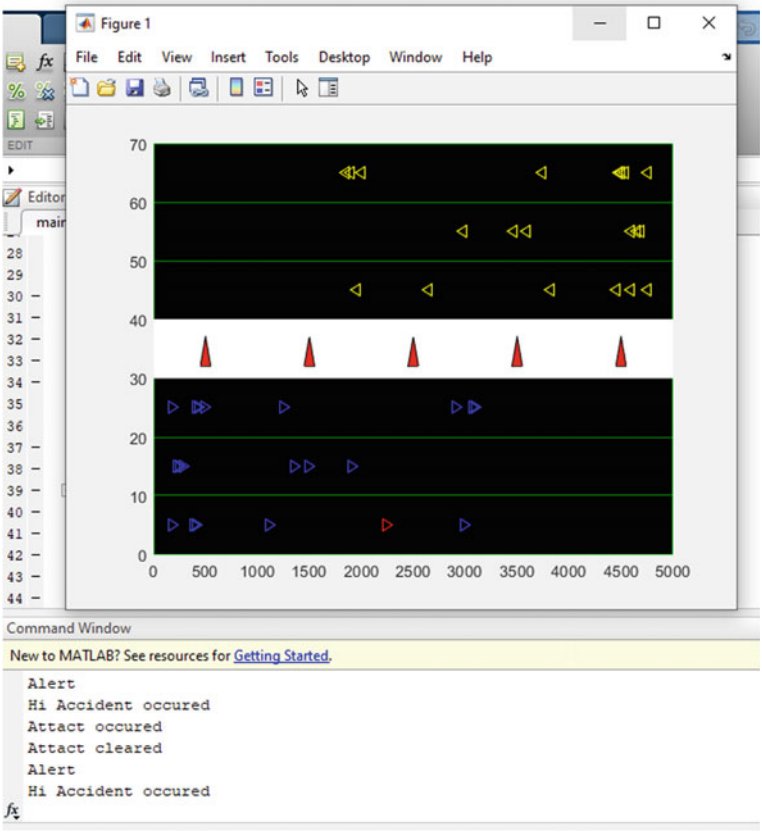

Fig. 10 Effective communication using GAD protocol

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Performance Study of Free Space Optical System Under Varied Atmospheric Conditions

Hassan I. Abdow and Anup K. Mandpura

Abstract In this paper, the performance study of free space optical (FSO) systems is completely analyzed, when the atmospheric channel is affected by atmospheric conditions such as haze and fog. Comparison of the FSO system's performance with semiconductor optical amplifier (SOA) and erbium doped fiber amplifier (EDFA) under the influence of haze and fog is studied. The received power, eye diagram, and quality factor (Q-factor) are the performance metrics taken into consideration in this paper. Through simulations, it is demonstrated that the fog has a detrimental effect on FSO system performance, when compared with the haze. Further, the distance over which the FSO system can work reliably will be improved by using EDFA in the place of SOA for performing pre-amplification and post-amplification.

Keywords Free space optical (FSO) · Atmospheric channel · Erbium doped fiber amplifiers (EDFA) · Quality (Q) factor · Semiconductor optical amplifiers (SOA) · Fog and haze

1 Introduction

In the past few decades, there has been an ever-increasing demand for high bandwidth along with the popularity of live streaming applications for work, social interaction, entertainment, and infotainment purposes. Various research studies will leverage research significance to improve the spectral efficiency of the existing cellular system and accommodate these demands [1–5]. The strategies in [1–5] are promising; however, an alternative solution for decongesting the cellular spectrum is to shift from the existing radio frequency carrier range of 300 MHz to 3 GHz to optical frequency range of 300–3000 GHz. The main advantage being that, licensing of spectrum in the optical domain is not required. Therefore, the optical domain offers a large bandwidth that is economical and helps increase the capacity of the communication system [6]. Recently, free space optical (FSO) communication has been widely studied in

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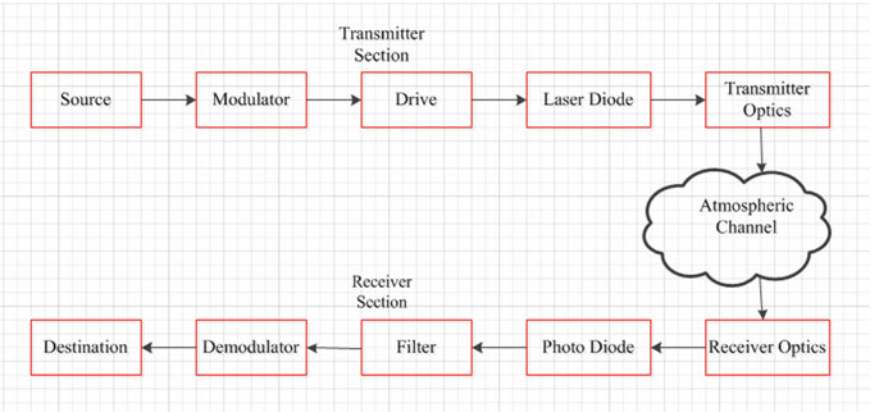

Fig. 1 FSO communication system

[7–11] due to the dual advantages of optical spectrum (large bandwidth), licensed free operation, security, ease of implementation, absence of electromagnetic interference, and wireless transmission channel. Due to the scarcity of spectrum for radio frequency (RF) transmission, these features offer an important solution for wireless access [12]. FSO is communication technology where information is exchanged by sending a beam of light from the transmitter to the receiver. Figure 1 block diagram of the FSO communication system is presented. The information is transmitted from the source to the receiver through the atmospheric channel. The source data is sent to the modulator, and the modulated carrier signal, with the information, is transmitted through the FSO channel. The information at the receiver is sent to the photodetector, filter, and demodulator for decoding at the destination [13]. This technology finds applications where the laying of physical cable is impossible due to the terrain of the area, for example, in a hilly location. The transmission of information in FSO is similar to that in optical fiber communication, i.e., the transmitted data is modulated by a laser light. However, transmission medium in FSO is the atmosphere, unlike the optical fiber where the light travels through a fiber. FSO communication system performance is adversely affected by the environment through which it propagates. The fluctuations of pressure and temperature variations lead to the refractive index which results in atmospheric turbulence. This atmospheric turbulence leads to an increase in the systems errors, therefore, degrading the FSO system performance [14].

The FSO communication system performance largely depends on weather factors such as fog, rain, and haze [15]. These atmospheric disturbances attenuate and scatter the light beam, thereby hindering the direct path of the laser light from the transmitter to the receiver [16]. These disturbances therefore significantly affect the performance of FSO communication, thus, reducing the overall range and capacity of the system. It is therefore of interest to study the performance of FSO system when the transmission channel is affected by atmospheric disturbances such as fog and haze. Free

space optical communication link performance is also degraded due to turbulence in atmospheric conditions and other parameters such as distance and optical power. Due to the loss in signal strength caused by atmospheric disturbances and obstacles, it is difficult to attain a high performance in a free space optical network [17]. In real-life scenarios, the availability of FSO communication link is limited during fog and haze. The intensity of the FSO signal is subjected to random fluctuation due to atmospheric turbulence. Scintillation causes performance degradation and potential loss of signal connectivity. These shortcomings pose the main challenge to FSO communications system deployment. Therefore, different channel modeling and diversity techniques have been studied to improve system performance [18]. The quality factor, received power, and span of the system (distance) are the performance metrics for a FSO system.

In this work, FSO communication system's performance under atmospheric conditions such as fog and haze are studied. FSO suffers from signal degradation due to external and internal impairments, therefore, to compensate for the attenuation caused by atmospheric conditions; pre-amplification and post-amplification of the signal are performed. Before the advent of optical amplifiers, the signal amplification was performed by optical to electrical and then to optical conversion for a single wavelength and moderate data rate requirements. However, this amplification process is not preferable for high data rate and multiple wavelengths [19]. Moreover, this technique increases equipment cost and introduces delay and noise due to large numbers of regenerators for long haul transmission. With the introduction of optical amplifiers, the delay and congestion issue can be overcome by simultaneous amplification of various wavelengths [20]. The repeaters have been replaced with amplifiers, in order to have a cheaper alternative for optical amplification and transceivers in [21]. Erbium doped fiber amplifiers (EDFA) and semiconductor optical amplifiers (SOA) are the most commonly used optical amplifiers. Among these amplifiers, EDFA is conventionally used for long haul optical transmission over fiber. EDFA's main benefits over other amplifiers are high-power efficiency, low-noise figure, and commercial availability in the C-band and L-band [22]. SOA is used as a preamplifier before the signal reaches the receiver to boost the signal level. One of the feature of SOA is low-noise value of 5–8 dB as compared to EDFA of 4 dB. However, it is hard to obtain power levels above 10 mW due to the relatively small output saturation power values of around 5 mW. Parameters such as polarization, nonlinear effects, sensitivity, and high losses at the junction make these amplifiers more challenging to use than the inline amplifiers. EDFA has proven to be best for signal amplification [23]. EDFA can amplify different channels without reducing its bandwidth. The difference between EDFA and SOA is an active region where the gain generation occurs. EDFA generates directly within the glass fiber, while SOA is directly within the structure of the semiconductor [24].

There have been studies on multiple transceivers and channel modeling to reduce the effect of atmospheric conditions. Diversity techniques are used to transmit the information and enhance system efficiency [25]. In [26], the FSO communication link performance is analyzed under foggy weather conditions employing different transmitters/receivers pairs and an EDFA amplifier using OptiSystem software for

simulation. Free space optical link analysis is carried out and evaluated based on Q-factor for various modulation techniques and weather conditions. In [27, 28], by using log-normal and Gamma–Gamma scintillation models, the authors analyzed the value of Q-factor versus proposed distance of FSO link for varying range of index of refraction. Therefore, in this work, the objective is to study the FSO system performance with pre-amplification and post-amplification using EDFA. The system performance is evaluated using a received power, eye diagram, and Q-factor.

The paper is organized as follows: Section 1 discusses the introduction to FSO and the performance metrics used in the paper. Section 1.1, discusses the FSO system model with EDFA at both ends. Section 2 presents results and compares an FSO system's performance with EDFA and SOA. Section 3 provides conclusions.

1.1 The System Model

Figure 2 shows a system model of free space optical communication. It comprises of a transmitter, atmospheric channel, and a receiver. The transmitter comprises of a light source, modulator, data source generator, and an amplifier. The main function of the transmitter in FSO is to convert the data into an optical signal that can propagate through the atmosphere to the receiver. The characteristics of a transmitted signal are affected in FSO channel due to the various weather conditions. The receiver comprises of an amplifier, photodetector, low-pass filter, and an analyzer. The optical signal at the receiver is amplified by the amplifier, then the photodetector is used to convert the received optical signal into an electrical signal, and then the low-pass filter is used to remove the unwanted high-frequency noise signal.

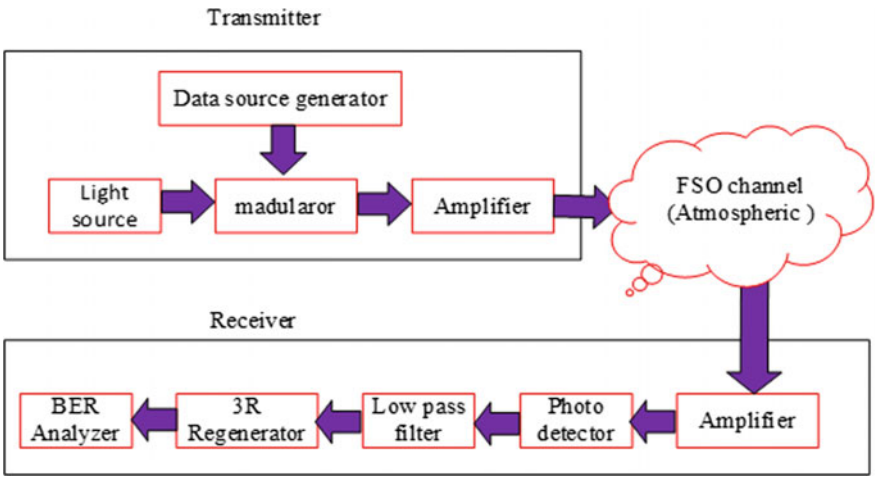

Fig. 2 FSO system model

Table 1 Parameters of FSO used for the simulations

Parameter	Values
Data rate Modulation format	**EDFA** 40 Gbps, **SOA** 0.5 Gbps Non-return to zero (NRZ)
CW (continuous wave) laser source	25 dBm
Aperture diameter transmitter	2.5 cm
Aperture diameter receiver	20 cm
Operating frequency	193.414 THz
Responsivity	1 A/W
Attenuation-very clear	0.1 dB/km
Attenuation-haze	4.2 dB/km
Attenuation-light-fog	15.5 dB/km
SOA-parameters Injection current	0.087 A
Width	3e−006
Height	6e−007
Confinement factor	0.15
Enhancement	5

This paper studies the FSO communication system's performance for different weather conditions as follows: very clear weather, haze, and fog. The performance metrics used in the study are Q-factor, received power, and eye diagram for the above different weather conditions. The FSO system simulation is modeled using OptiSystem software. The system parameters and different values of attenuation of each of the atmospheric conditions are listed in Table 1 [29, 30].

2 Result and Discussion

This section discusses the impact of using EDFA as a preamplifier and post-amplifier in free-space optical system for different atmospheric conditions. The free space optical system was simulated using OptiSystem as shown in Fig. 3 and analyzed under different atmospheric conditions. The system parameters are given in Table 1. The pseudorandom binary sequence generator is used to generate the data bits, which are fed to Mach–Zehnder modulator for conversion to an optical signal. A light source of wavelength 1550 nm transmits power of 25 dBm. The modulator's output is fed to an optical preamplifier (EDFA or SOA) and transmitted through the FSO channel as shown in Fig. 3. The received optical signal from the receiver is converted into an electrical signal using a photodetector. The low filter rejects the high-frequency noise.

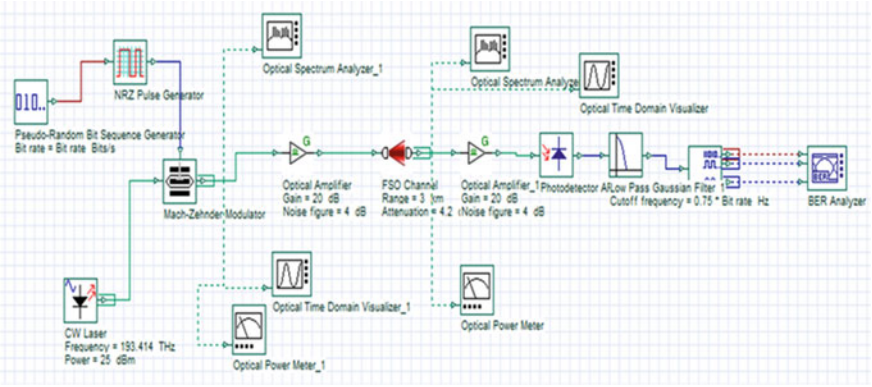

Fig. 3 Model of a FSO system in OptiSystem

Figure 4 compares Q-factor versus distance of FSO system with EDFA and SOA for different weather conditions, i.e., very clear weather, haze, light fog, and moderate fog. It can be observed from the figure that FSO with EDFA has a better Q-factor over a large distance in comparison to SOA. This is due to the fact that the noise figure of SOA is greater than 5 dB whereas the noise figure of EDFA is less than 5 dB [31]. The typical gain of EDFA is also greater than 40 dB, while that of SOA is greater than 30 dB [32, 33]. The FSO system with EDFA has a better performance in comparison to SOA for all different weather conditions. As the distance is increasing, the quality factor is decreasing for both amplifiers. Very clear weather has the least

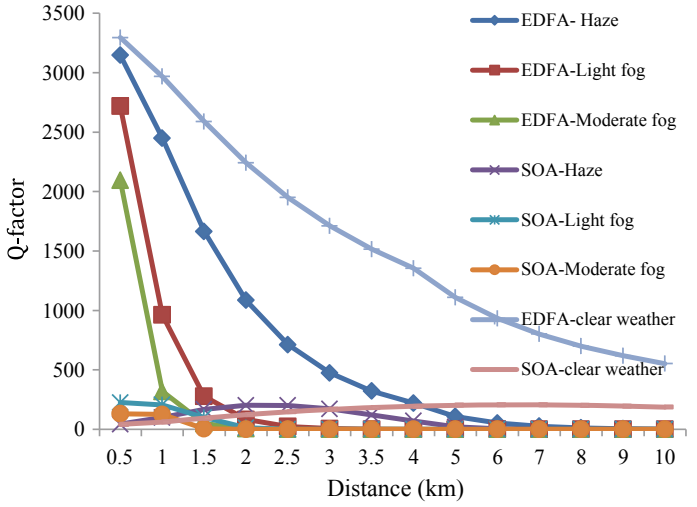

Fig. 4 Q-factor versus distance for different atmospheric conditions (haze, light fog, moderate fog and very clear weather)

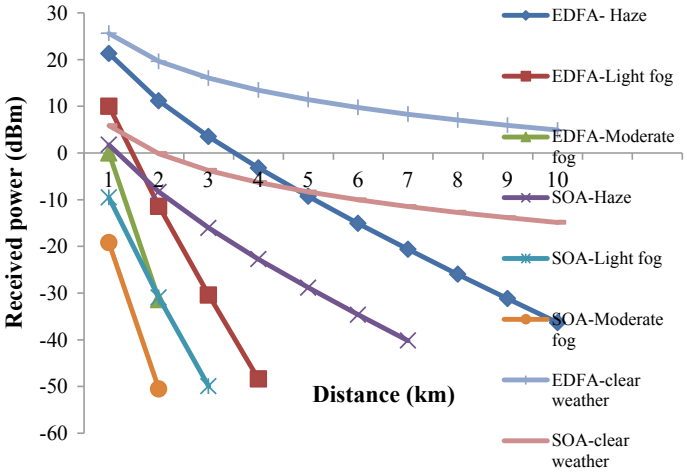

Fig. 5 Received power versus distance for different atmospheric conditions (light fog, haze, moderate fog, and very clear weather)

effect on the performance of FSO as compared to haze and fog. Moderate fog is the worst among all different weather conditions for FSO system.

Figure 5 shows the relationship between the received power and transmission distance for different weather conditions by using EDFA and SOA. Comparing between the two amplifiers, EDFA has a better received signal power than SOA under the similar weather conditions. It can be observed from the figure that the received power of an FSO system with EDFA is larger in comparison to an FSO system with SOA for a distance of 10 km for very clear weather conditions, and the received power with EDFA is 4.692 dB, whereas the received power with SOA is −14.852 dB. From the figure, it is evident that the received signal power decreases with increasing distance. The gap between the received powers of FSO with EDFA and FSO with SOA is nearly 19.544 dB for a distance of 1–10 km for haze weather conditions. The difference in received power of FSO with EDFA and FSO with SOA for haze is approximately 19.544 dB for communication over short distances. Again, it is observed that very clear weather conditions have the least affected on FSO system performance in comparison to haze and fog for all the cases.

Figures 6, 7, and 8 show eye diagrams of FSO link for haze at 9 km, moderate fog at 2 km, and clear weather at 70 km, respectively. The eye opening signifies the performance of an FSO system; if the opening is wide, the system performance is good, and if the opening is narrow, the performance is poor. The qualitative analysis of digital signal transmission can be studied using the eye diagram. In Fig. 8, the system has a large eye opening between the upper and lower levels as compared to Figs. 6 and 7. The height of the eye opening determines the noise margin of the system at a specified time interval. It can be concluded from the three figures that very clear weather conditions have wider opening and hence a better performance than the fog and haze weather conditions. The simulation results show that both

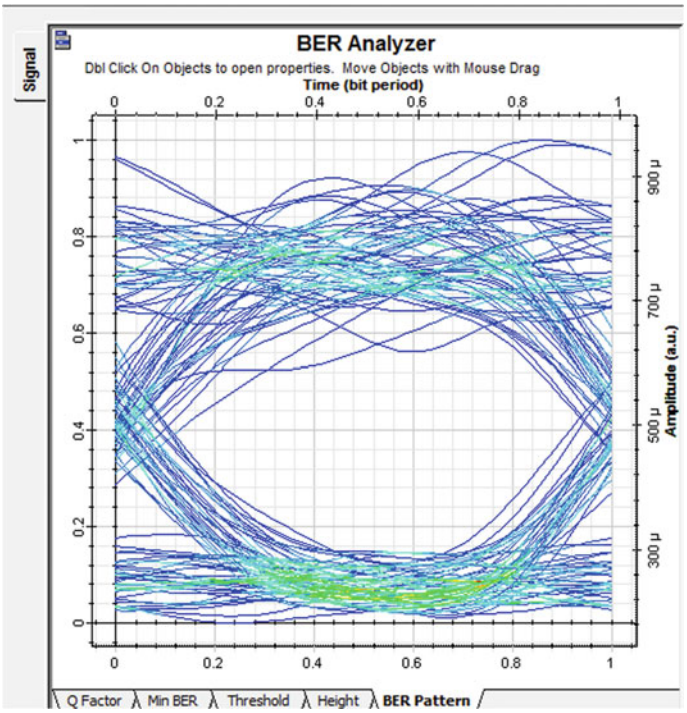

Fig. 6 Eye diagram for haze at 9 km

distance and attenuation affects the FSO link. The opening of the eye for haze at 9 km is 2.3e−04 while it is 2.769e−04 for moderate fog at 2 km.

3 Conclusion

In this paper, the performance of free-space optical (FSO) communication system with EDFA in the presence of haze and fog is studied. The FSO system performance was compared using received power, Q-factor, and eye diagram for different weather conditions. From the comparison of the results, it is concluded that fog has a detrimental effect on FSO system performance in comparison to haze.

Under clear weather conditions, the FSO system with EDFA has a range of 67.1 km, whereas for haze and moderate fog conditions, the range is 9 km and 2.5 km, respectively. Also, from the results presented, it can be summarized that FSO system performance is enhanced by using EDFA amplifier in comparison to a SOA amplifier.

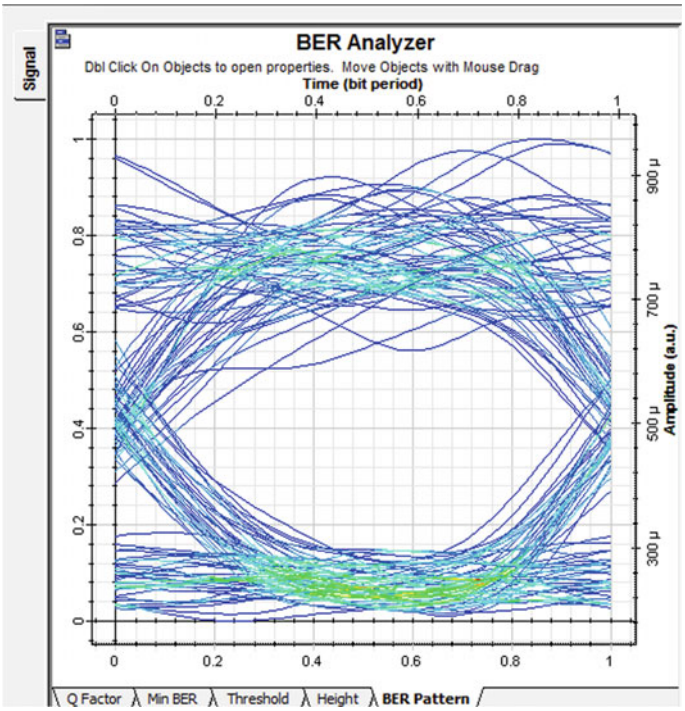

Fig. 7 Eye diagram for moderate fog at 2.5 km

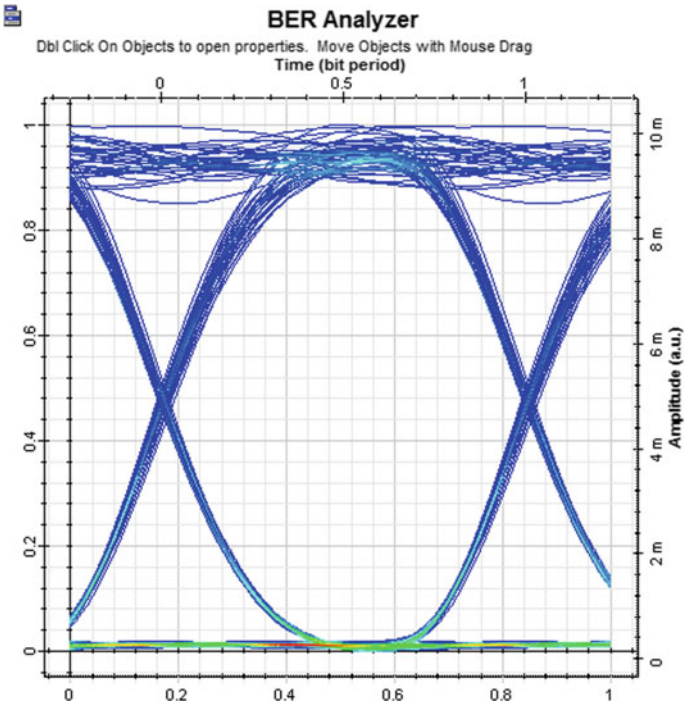

Fig. 8 Eye diagram at 70 km for very clear weather

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Malicious URL Detection Using Machine Learning and Ensemble Modeling

Piyusha Sanjay Pakhare, Shoba Krishnan, and Nadir N. Charniya

Abstract Websites are software applications that allow us to connect and interact with the data located in the web servers. Websites allow the user to capture, store, process, and exchange sensitive data like banking details and personal details. Web pages are accessed by merely entering the required URL in the browser. To prevent sensitive information from users, the attackers/hackers make duplicate websites and send them to victims through phishing emails. In this article, the machine learning framework is used to find malicious URLs. Here, five different machine learning algorithms such as the logistic regression algorithm, K-nearest neighbor algorithm, decision tree algorithm, random forest algorithm, and support vector machine algorithm have been used. An ensemble modeling has been done using these algorithms, and the performance of each algorithm has been compared.

Keywords Cyberattacks · Malicious URLs · Supervised learning · Machine learning · Ensemble models

1 Introduction

The epoch of big data where data in quintillions is generated every single day [1]. With more and more data on the Internet that included user's data, credit card details, phone numbers, etc., hackers are trying to obtain those data by stealing it from the user unknowingly. This is done by sending various phishing e-mails, creating duplicate websites, sending attachments via e-mail, and SMSs. Phishing uses e-mails as a weapon. The attacker dissembles as a trustworthy person or organization and sends a

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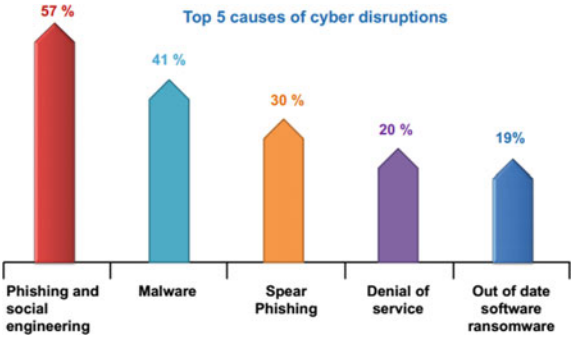

Fig. 1 Causes for cyber disruptions [3]

message to be from the bank, asking for details or some note from companies tricking the recipient to open attachment or website links. The spreading of coronavirus across the world has caused people to work remotely from their homes. URL is the entry point of most cyber-attacks. If the attacker has control of the malware-hosting server, he/she can easily change the URL address making it point toward the malicious content [2]. As a result, it will risk the entire organization's privacy. URLs are classified into two (binary) categories—malicious and legitimate.

There are various domains on the Internet that have words like "covid19", "coronavirus", etc., cybercriminals are creating hundreds or even thousands of new websites every day to carry out phishing, fraud, and malware. The percentages of major cyber-attacks are shown in Fig. 1.

From Fig. 1, it is evident that phishing and malware attacks are the most common attacks and these attacks are spread using links and e-mails. Apart from these, URLs are host to cross-site scripting (XSS) attacks and URL injection attacks. According to Data Breach Investigating Report (DBIR), 32% of the confirmed data breaches involve phishing. Approximately 80% of the email attacks are malware-less, the attackers use spear-phishing and impersonation tactics. Wandera's 2020 Mobile Threat Landscape Report showed that more than 50% of all surveyed organizations have experienced a minimum of one mobile phishing incident [4]. Barracuda researchers [5] detected 467,825 spear-phishing attacks through email between March 1, 2020, to March 23, 2020, out of which 9116 were related to coronavirus.

For detecting these malicious attacks, machine learning (ML) is the most popular approach used. ML is a partial application of artificial intelligence. It is used to develop algorithms that can access the data and can use it for self-learning [6]. These algorithms work efficiently when huge data is involved. ML is often categorized into three, viz. supervised learning, unsupervised learning, and reinforcement learning [7]. All the ML algorithms are labeled training data with specific inputs, outputs, and system parameters. The proposed system uses supervised learning algorithms where past data is utilized to train the model to predict future outcomes. In unsupervised learning, the data used to train the model is neither labeled nor classified. Apart from these two categories, there is a semi-supervised learning algorithm that uses both unlabeled and labeled data for training. There are various ML algorithms, viz.

Regression, Classification, Clustering, Recommendation System, etc. Classifying the malicious URLs requires classification algorithms mentioned below.

This article deals with detecting the malicious URLs using various machine learning algorithms, namely [8],

(a) Logistic regression-It gives a probability as if a particular event will occur or not using a logistic function based on the input.
(b) Decision tree-The data is split at various nodes and the end decision (good/bad) is given by the leaves of the tree.
(c) Random forest-It is a group of decision trees and the final output is selected by majority voting.
(d) K-nearest neighbors-This algorithm will classify the sample point based on the classification of its k-neighbors. The best way to find the optimum value of k is using the elbow method. Usually, k's value should be odd for a classification problem.
(e) Support vector machine (linear, RBF, and sigmoid kernels)-for classification, a hyperplane/decision boundary is defined which separates the data and classifies them into two categories—good (legitimate) and bad (malicious). If the problem cannot be separated linearly, then kernels are used. Kernels are complex mathematical functions.

Further, an ensemble method is used to improve the accuracy of the algorithms. Ensemble modeling is the process where various algorithms are used to predict an outcome. It is a combination of individual classifiers that helps in the classification of new test samples. Ensemble learning in supervised learning has become one of the in-depth areas of study among machine learning researchers [9]. The majority voting method of ensemble models is utilized. Finally, these algorithms were tested completely on a new data to find which algorithm gives better classification. The motivation for using ensemble modelling is that it reduces the generalization error. Even though it consists of multiple algorithms, it acts as a single model.

This article is organized as follows: In Sect. 2, some literature review is done. In Sect. 3, our approach, methodology, and flowcharts used for URL classification are shown. In Sect. 4, the results of the experiments are shown and finally, in Sect. 5, the conclusion for the research work is presented.

2 Literature Review

Various studies have been conducted to find a solution to this problem using different techniques.

Vanhoenshoven et al. [10] have used a public dataset having 2.4 million URL instances to classify good and bad URLs. Having around 3 million features, they divided the features into 3 sets. Set A contains real and binary values, Pearson's correlation was found and values having more than 0.2 coefficient value were selected. Set B has only binary values and attributes having more than 0.1 coefficient are selected.

Set c has only real-valued data which are binary having non-zero values. They have classified the performance of the algorithms, viz. Naive Bayes, k-nearest neighbors, support vector machines, multi-layer perceptron, decision trees, and random forest. The algorithms were evaluated based on accuracy, precision, and recall. The random forest classification method showed maximum accuracy, recall, and precision.

Tan et al. [11] have addressed the problem of concept drift. Concept drift is the phenomenon where the distribution of data changes, i.e., malicious URL may turn into benign URL. If it happens, then the trained model cannot accurately tell the classification of such a URL. Three features have been selected which are IP blocks, destination port, and domain. Their system framework consists of four modules—Feature Extraction, Training, Prediction ad Concept Drift Detection. The functioning of the concept drift algorithm is evaluated by comparing the WRST algorithm with the CUSUM algorithm. The WRST algorithm had the highest accuracy and minimum delay over the CUSUM algorithm.

Feroz and Mengel [12] have developed a method that will automatically classify the URLs based on their host-based and lexical features. They have combined clustering and classification method. The results are divided into three categories—severe, moderate, and benign. Additionally, an internal scale is given to each classification—Severe—red, moderate—yellow, benign—green. Their classification accuracy is 98.46%.

Manjeri et al. [13] have experimented on classifying the URLs for two cases—class imbalance and without class imbalance. Recursive Feature Elimination technique is used to narrow down to eight features for classification and further ranking them according to their priority. Random forest algorithm gave the maximum accuracy of 96%. Finally, association rule mining was performed to find the relation between variables in data using three algorithms—Apriori, FP Growth, and decision tree.

3 Experiment

3.1 Url Structure

Figure 2 shows the structure of a URL.

Fig. 2 Structure of URL [14]

1. Protocol/Scheme

   This indicates the webserver which type of server to utilize when it accesses the page on the website. Nowadays, Hypertext Transfer Protocol Secure i.e., HTTPS is the commonly used protocol.

2. Hostname

   Hostname consists of Top Level Domain (.com, .net, .org, .uk), Domain Name (google.com, urlinfo.com) and Subdomain (www)

3. Port

   Port number is used to access a server application that is running on the machine. By default, HTTP uses port 80 and HTTPS port 443.

4. Path

   The path describes the specific source in the host that is accessed by the web client

Hackers/Cybercriminals will change certain parts of the URL to carry out attacks like phishing.

3.2 Dataset

The dataset is obtained from GitHub [15]. It contains 344,821 good URLs and 75,643 bad URLs. To avoid imbalance classification problems, the dataset ia made even by eliminating random good URLs. So, the new dataset has 75,643 good URLs and 75,643 bad URLs.

3.3 Pre-processing

As the dataset contains text data, it is first pre-processed by using tokenization, where the URLs are divided into tokens. Since the data is a URL, the URLs are first divided wherever there is a forward slash (/) and hyphen (-). Next, the domains, sub-domains, and extensions are separated by splitting wherever there is a dot (.). Lastly, the stop words are removed which is www and.com. The words in URLs are then assigned weights using TfidfVectorizer. TfidfVectorizer converts the text into feature vectors that is used as an input. TfidfVectorizer computes the word count, idf values and tf-idf score. If the words are unique, the score is high and common words have a low score.

3.4 Methodology

Different steps involved in methodology are given below:

1. Get the dataset.
2. Preprocess the data.
3. Divide the dataset into a training set and testing set.
4. Use different machine learning algorithms for training the model.
5. Get the evaluation matrices.
6. Get predictions on completely different data.
7. Make a classification table.

By default, the dataset is split into 75% training and 25% testing, and the further training set is converted into 75% training and 25% validation. The training set contains 85,098 samples, having 42,549 good and bad samples respectively, validation set consists of 28,366 samples divided into 14,183 good and bad samples, whereas the testing set has 37,822 samples of equally good and bad, respectively. In this experiment, initially, train the model using five supervised machine learning algorithms, viz. logistic regression algorithm, K-nearest neighbor algorithm, decision tree algorithm, support vector machine algorithm with 3 of its kernels, and random forest algorithm. Flowchart for designing individual algorithms is discussed in Fig. 3. Next, consider 10 models, each having 3 algorithms together to check the performance of those models. For ensemble models, the model is trained using three different algorithms of any combination. For calculating the accuracy and for generating the classification report for validation data, majority voting is calculated using the mode function. Each model makes predictions (votes) for every test event and the final outcome prediction is more than half the votes. If more than half of the votes were not cast in any of the predictions, it is not possible to predict a stable prediction for this event in a combined manner. Lastly, the model is given test data for prediction, and in a similar way, the accuracy and classification report for test data is obtained. The flowchart for the ensemble model is described in Fig. 4. After designing the algorithms, the classification based on four parameters namely, accuracy, precision, recall, and Fl-score was analyzed.

3.5 Performance Evaluation

3.5.1 Confusion Matrix

To get the idea about classifications and misclassifications, generate a confusion matrix for each algorithm. Confusion matrix is the m x m matrix, where m is number of variables. Table 1 shows the confusion matrix. Diagonal elements represent the true values and non-diagonal elements represent false values. There are four parameters inside the table, viz. False Positive (FP), True Negative (TN), True Positive (TP), and False Negative (FN).

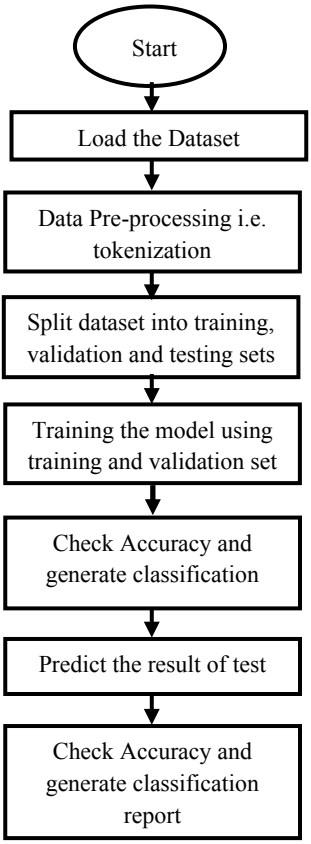

Fig. 3 Flowchart of individual model

3.5.2 Accuracy

Accuracy is determined as the ratio of rightly predicted good and bad URLs to total prediction.

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{1}$$

3.5.3 Precision

Precision is determined as the ratio of literal good URLs out of total predicted good URLs.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{2}$$

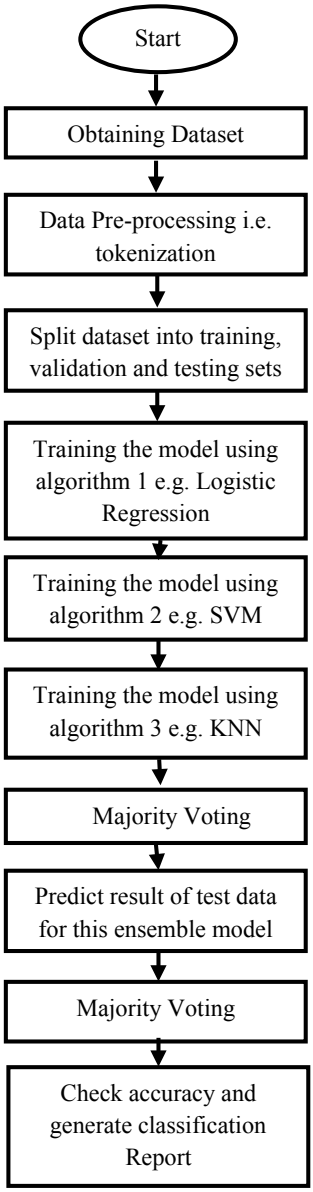

Fig. 4 Flowchart of individual ensemble model

Table 1 Confusion matrix

Actual value	Predicted values	
	Negative	Positive
Negative	True negative	False positive
Positive	False negative	True positive

3.5.4 Recall

The recall is defined as the ratio of actual good URLs over total actual good URLs.

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{3}$$

3.5.5 F1 Score

F1 scores are the harmonic mean of recall and precision. It is computed by the given formula:

$$\text{F1 Score} = \frac{2}{\frac{1}{\text{Precision}} + \frac{1}{\text{Recall}}} \tag{4}$$

4 Results

All the individual algorithms were tried on different values of the random state. After implementing all the algorithms, the classification report of each algorithm is shown in Table 2, and the training–testing accuracy plots are depicted in Figs. 5 and 6.

From Figs. 5 and 6, it can be clearly seen that there is not much difference between training and testing accuracies which indicates that the models are not overfitted. Logistic regression algorithm has given the maximum accuracy 94.31%, and random forest algorithm has given the minimum accuracy of 87.34%. Precision, recall, and F1-score shown in Table 2 for each algorithm are above 80% indicating good classification between good and bad URLs.

Table 2 Classification report of individual models

Algorithm	Precision		Recall		F1-score	
	Bad	Good	Bad	Good	Bad	Good
Logistic regression	0.93	0.95	0.95	0.94	0.94	0.94
K-nearest neighbor	0.97	0.82	0.84	0.96	0.90	0.89
Decision tree	0.91	0.87	0.88	0.90	0.89	0.89
Random forest	0.80	0.95	0.94	0.83	0.86	0.88
SVM (linear)	0.92	0.96	0.96	0.92	0.94	0.94
SVM (rbf)	0.90	0.97	0.96	0.91	0.93	0.94
SVM (sigmoid)	0.93	0.96	0.96	0.93	0.94	0.94

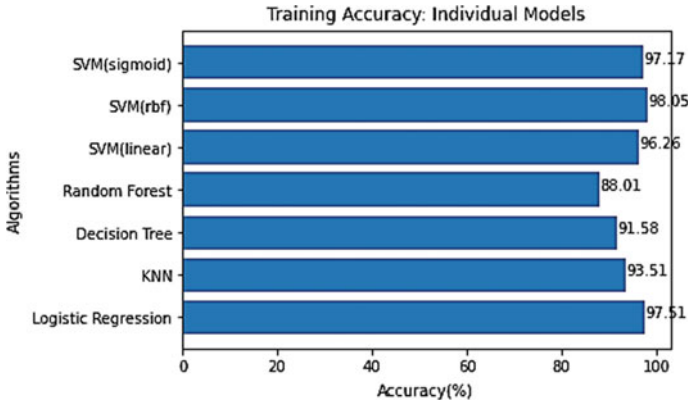

Fig. 5 Training accuracy: individual models

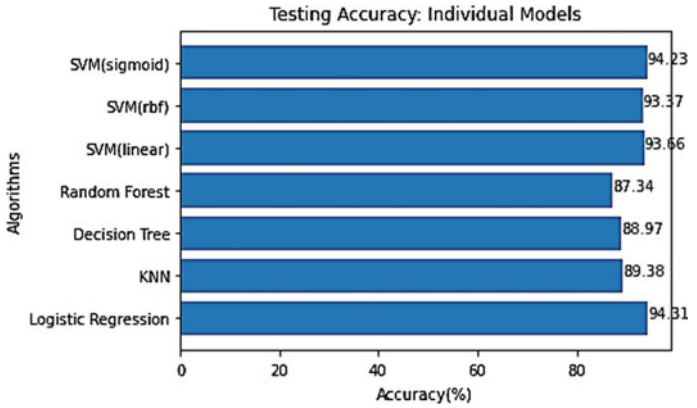

Fig. 6 Testing accuracy: individual models

Next, combined all these three algorithms at a time. Since SVM (sigmoid kernel) gave a good result, this algorithm is selected instead of all the SVM kernels. The classification report of these algorithms is shown in Table 3, and the accuracies are depicted in Fig. 7.

From Fig. 7, it is clear that the eighth ensemble model (K-nearest neighbor, decision tree, and support vector machine) gives a maximum accuracy of 94.93%. The accuracy of all the ensemble models lies in the range 93–95. Also, the high (above 90%) precision, recall, and F1-score are shown in Table 3 which indicate that all of the ensemble models have performed well.

Table 3 Classification report of ensemble models

Algorithm	Precision		Recall		F1-score	
	Bad	Good	Bad	Good	Bad	Good
LR-KNN-DT	0.95	0.95	0.95	0.94	0.95	0.95
LR-KNN-RF	0.96	0.93	0.93	0.96	0.94	0.94
LR-KNN-SVM	0.96	0.94	0.94	0.96	0.95	0.95
LR-DT-RF	0.95	0.92	0.92	0.95	0.94	0.94
LR-DT-SVM	0.97	0.94	0.94	0.97	0.95	0.96
LR-RF-SVM	0.96	0.93	0.93	0.96	0.94	0.94
KNN-DT-RF	0.94	0.93	0.93	0.94	0.94	0.94
KNN-DT-SVM	0.95	0.95	0.95	0.95	0.95	0.95
KNN-RF-SVM	0.96	0.93	0.93	0.96	0.94	0.95
DF-RF-SVM	0.95	0.92	0.92	0.96	0.94	0.94

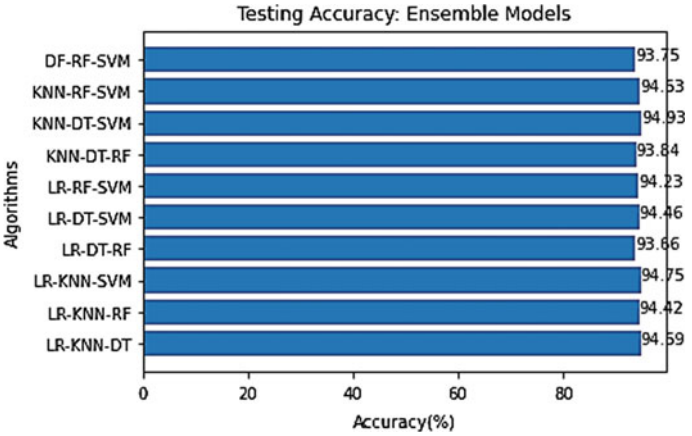

Fig. 7 Testing accuracy: ensemble models

5 Conclusion

Malicious URL detection plays a significant role in cybersecurity applications. In this article, various ML algorithms are utilized to classify the URLs into malicious (bad) and legitimate (good). In the experiments, the performance accuracy of five different machine learning algorithms was compared. To get better results, the algorithms were implemented by changing different parameters like the kernel (in SVM algorithm), criterion and number_of_trees (in the decision tree and random forest algorithms), neighbors (in KNN algorithm), and random state for each individual algorithm. The same parameters were used to evaluate each ensemble model. By analyzing the experimental results, it is shown that our model has effectively classified the URLs.

Logistic regression and KNN-DT-SVM ensemble model have outperformed other algorithms. Overall, the accuracy of the individual model is above 85%, and the accuracy of each ensemble model is also above 92%. The major limitation of the proposed work is that the DT, RF and especially SVM takes hours for training. Future scope of this includes increasing the number of algorithms in the ensemble model and change parameters considering different features.

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Review on Energy-Efficient Routing Protocols in WSN

G. Mohan Ram and E. Ilavarsan

Abstract Recently, wireless sensor networks (WSNs) incorporate their prominent role in various applications like monitoring and tracking remote environments. WSN exhibits a distributed nature and dynamic topology which increases the challenge of designing an energy-efficient protocol for routing. Enhancement of energy efficiency in WSN is considered as the primary goal of the routing protocol. This review mainly intends to discuss the hierarchical-based energy-efficient routing protocols to maximize a lifetime of network and energy efficiency. The objectives, challenges, and issues of the WSN routing protocols are also discussed in this review. Finally, the performance analysis for each energy-efficient routing protocol is also summarized in this article. In this, the systematic literature survey from 2010 to 2020 for hierarchical-based energy-efficient routing protocol has been carried out. From these reviewed details, the researchers can obtain a valuable technical direction while emerging an energy-efficient routing protocol. The information available in this review is helpful for various researchers to acquire significant information about the current status of WSN's energy-efficient routing and the various potential concerns that need to be discussed. Finally, the future aspects and research gaps for the reviewed protocols are also discussed.

Keywords WSN · Routing protocol · Energy-efficient routing protocols · Hierarchical routing · Network lifetime

1 Introduction

As an evolving technology field for ad hoc networks, WSNs have been gaining extensive coverage. WSNs contain a variety of sensor nodes with wireless processing as well as communication proficiencies that are low cost, multi-functional, and low

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power. Such sensors connect within a small distance through a wireless intermediate and combine to achieve the common task, such as environmental detection, target management, and industrial process control [1]. The sensor network intends to use the collection of stationery, cheap, and tiny sensors for sensing the physical characteristics of the surrounding environment and to transfer such sensed information to its associated sink node [2]. However, WSN performs a variety of tasks among the most essential tasks like data sensing, data handling, and transferring the sensed data back to sink.

The routing protocol defines the information that allows the nodes to select the routes between the available nodes. In WSN, the routing process aims to send information to an acknowledged destination sensor node from a sensor node. The development of the efficient routing protocol achieves this objective by setting a path between the sensor and destination nodes. Few constraints in network resources such as link failures during communication, bandwidth, energy, meta-heuristic optimization problems, storage, and several other network constraints increase the complexity of designing an efficient routing protocol for WSN [3, 4]. The design of a routing protocol closely depends on the architecture model of an entire system.

During a network design process, energy conservation is a big cause of concern since sensors are fabricated with non-rechargeable batteries. When sending messages from source to destination, route selection is a crucial operation. During data transfer, vast amounts of energy are absorbed. The problem of unnecessary energy consumption is solved by using the extremely successful hierarchical routing architecture. The network is broken into many clusters in the clustering process. A middle sensor helps the source node to send information to an endpoint via routing tracks during the data transmission process [5, 6]. The principle of data aggregation helps in the successful utilization of available WSN resources.

The rest of the article is structured as follows. Section 2 describes the taxonomy of routing protocols in WSN. The energy-efficient routing protocols of WSN are described in Sect. 3. Section 4 explains the performance evaluation metrics of routing protocols. Section 5 describes the future enhancement of energy-efficient routing protocols. Finally, Sect. 6 represents the conclusion of routing protocols.

2 Classification of Routing Protocols in WSN

In modern decades, WSNs apply various routing protocols during data transmission to increase an entire network lifetime. Taxonomy of routing protocol is shown in Fig. 1. These protocols are categorized into two based on network structure and properties. Based on the node uniformity, the network structures are categorized. The primary feature of these protocol types is how the data is connected and exchanged by nodes depending on the interconnection mechanism.

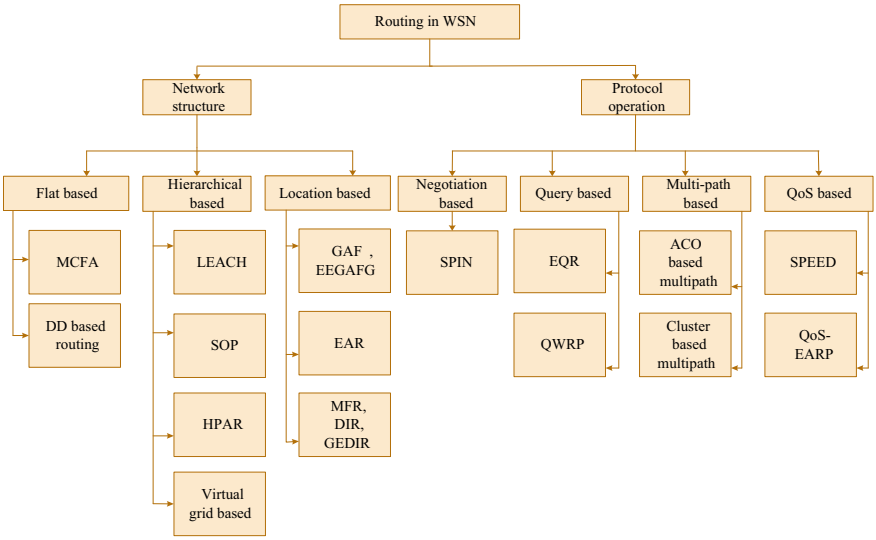

Fig. 1 Taxonomy of routing protocols

2.1 Network Structure-Based Routing Protocols

The hierarchical-based, location-based, and flat-based protocols come under the network structure-based routing protocols in which they are briefly explained in the given subsection.

2.1.1 Flat-Based Routing

This routing is necessary when massive numbers of sensor nodes are needed, where every single node performs a similar role. Therefore, it is not probable to allocate a special identifier (Id) for every single node if the number of nodes gets increased. Data-centric routing is led by this method in which the sink node forwards the information to a group of nodes for an answer. The nodes are treated impartially and have similar roles in this routing.

Minimum Cost Forwarding Algorithm (MCFA)

MCFA [7] takes advantage of the fact that the routing path is still remembered. For gradient-based routing, a sensor node does not need to have a specific ID. As an alternative, every node retains the smallest cost estimation from itself to the drain.

Any data sent by a sensor is sent to its neighbours. When the data is sent by a node, it checks if it is on a minimum expensive path between the source and the sink. It rebroadcasts the data to its neighbours if the path is least expensive. Before the sink is hit, this step occurs.

Directed Diffusion-Based

The hybrid energy balanced routing protocol (DCRP) and the diffusion clustering scheme (DCS) are proposed to avoid creating isolated CHs in the clustering process. Routing and clustering process are included in DCRP. DCS is projected in [8] to establish contact among neighbouring CHs without relay nodes during the clustering period. Clusters are created by diffusing hop by hop outward from the sink, while new CHs are picked from established clusters' member nodes. Besides, to minimize the number of clusters and transmission delays, the residual capacity, width, and number of neighbouring nodes outside the clusters have been taken into account. The hybrid energy balanced routing protocol (HEBR) is used in the routing process.

2.1.2 Hierarchical Cluster-Based Routing Protocol

In a hierarchical architecture, small-energy nodes may be utilized to measure the nearness of the destination node whereas higher energy nodes are utilized to route and relay signal facts. As a consequence, hierarchical cluster-based routing protocol strategies are reasonably effective for the sensor nodes within a cluster to consume fewer resources. Data aggregation and data fusion can also be achieved by these methods with a limited number of transferred messages to sink [9].

Low-Energy Adaptive Clustering Hierarchy (LEACH)

Energy is a main area of concern in WSNs due to lack of power supply. The highest capacity is required for data transfer. To maximize the lifespan of a sensor network, many experiments are performed. Among them, the solution focused on clustering is well established to accomplish energy efficiency. LEACH hierarchical routing protocol [10] has been proposed where clusters are regularly refreshed based on residual energy as well as space. Re-clustering distributes a capacity from numerous nodes, and in turn, the CH increases network lifespan. During its transmission slot only, the sensor nodes remain active. It lives in a sleepy state the majority of the time to conserve electricity.2.1.2.2 Self-Organizing Protocol (SOP).

SOP has been utilized to construct design to help diverse sensors [11]. These sensors may be stationary or mobile. Any sensor may measure the atmosphere and transfer the information to a specified group of nodes that serves as routers. Composed information is sent to the more efficient sink through the routers. A routing model has been suggested that involves the addressing of every single sensor. Sensing nodes may

be recognized by the address of the router node they are attached to. Local Markov loop (LML) algorithm was performed to promote fault tolerance and transmitting path. There are four stages in the algorithm for consolidating the router nodes and fabricating the routing tables, namely the exploration process, the organizational process, the management phase, and the self-reorganization phase.

Hierarchical Power-Aware Routing (HPAR)

Growth in wireless connectivity has made the development of low-cost WSNs feasible in recent years. An efficient topology management strategy is clustering sensor nodes. A new routing algorithm that can maximize the lifespan of the network was suggested in [12]. Each node will approximate its residual energy and then suggest a new form of clustering to maximize the existence of the network. This inference is identical to several other suggested WSN routing algorithms. Based on particular threshold values, the pre-defined numbers of nodes with the highest residual energy are initially chosen in the current algorithm as CHs and the representatives of every cluster are calculated based on the distance between the node and CH as well as between the CH and sink.

Virtual Grid Architecture

Since it has a basic and hustle-free design, the wireless network holds a special place in networking, less costly to save time and resources in numerous ways. But as they are human un-attended, therefore this resource-scare network needs special management. WSN still required modern routing and new technical developments in which energy in the network is used for data transmission. The two main problems in the WSNs are the utilization of wireless transmission energy and coverage. [13] proposes a routing algorithm that retains network coverage as well as reduces energy consumption, contributing to increased network life.

2.1.3 Location-Based Routing

Sensor nodes are uniformly distributed in the interesting regions in this form of network architecture and are often identified by the geographical location. They are mainly found by way of GPS. The separation between nodes is determined by the signal intensity generated from those nodes, and the coordinates are measured by the information exchange among adjacent nodes. Location-based routing protocols are utilized to identify nodes about their current location. The position is derived from GPS or by collaboration between nodes.

Geographical Adaptive Fidelity (GAF)

GAF is a routing protocol based on positions and energy focused. It was previously recommended for ad hoc networks, but now this protocol can also be used for WSNs. It is based on the principle that the perspective of routing is equal to all adjacent nodes. The entire network in GAF is broken into a virtual grid. Grid size is based on the idea in which every node can connect with the other node's adjacent grids. Each node utilizes GPS-based position information to link itself within the grid. This protocol depends on location, but is often utilized as a hierarchical protocol in which clusters are generated based on the location data [14].

Geographical and Energy-Aware Routing (GEAR)

For WSNs, a centralized clustering of regional energy-conscious routing (GEAR-CC) was introduced in [15]. It has the superiority of both hierarchical routing and geographic routing of spatial energy. It takes full advantage of the adequate capacity of the base station as a centralized algorithm to execute any transmission in the WSN. The base station can easily devise the optimum transmission schemes for all sensor nodes in GEAR-CC, based on global topology and energy details. The optimization is accomplished by generating trade-offs between the expense of electricity and the remaining capacity of the node.

MFR, DIR, GEDIR

Both the neighbours of the sender node are involved in routing decisions with directional routing protocol (DIR), most forwarded within range (MFR), and geographic distance routing (GEDIR) techniques [16]. Owing to the presence of the nodes lying in a backward direction, this adds to needless overhead and excessive energy consumption. This extra energy consumption minimizes the reduction of network lifespan. A new approach is recommended in [17], and a forward search area is added where a large number of sensors engage in routing decision-making.

2.2 Protocol Operation-Based Routing Protocols

It is a different routing functionality. It is categorized into 4 types; they are QoS-based routing, query-based routing, multipath routing protocols, and negotiation-based routing protocols.

2.2.1 Multipath Routing Protocols

These protocols utilize multiple paths for network throughput improvement. It comprises two different ways for performing the transmission between the base station and source sensors.

(i) Disjoint paths
(ii) Braided paths.

For WSN, Yang [18] developed an ant colony optimization (ACO)-based multi-path routing protocol. CH is designated from the cluster of sensors based on residual energy. After that, a multipath between sink and CH is discovered by the ACO procedure. Based on the energy consumption parameter, CH dynamically chooses the route to convey the information with a probability. Cluster-based multi-path routing protocol was developed by Sharma and Jana [19] for WSN. Minimization of energy consumption as well as maximization of reliability is obtained by this clustering and multipath routing method. The major objective of this article is to minimize a load of the sensor by applying more accountability to the sink node.

2.2.2 Query-Based Protocol

Query-based protocol utilizes target node broadcast query for information. These queries are explained in terms of directed diffusion and rumour routing protocol.

Ahvar et al. [20] developed a new energy-aware query-based routing (EQR) for WSN. This EQR protocol provides a good transaction among the energy-saving objects as well as traditional energy balancing methods. The total energy consumption is decreased with the help of learning automata together with the zonal broadcasting method. For WSN with mobile sink, Jain et al. [21] developed query-based routing protocol. For query-driven scenarios, this paper developed a query-driven virtual wheel-based routing protocol (QWRP) method which creates a virtual structure with the aim of confining the sink node location. To improve the data delivery performance, a novel packet forwarding mechanism is developed under QWRP and an angle-based forwarding algorithm.

2.2.3 QoS-Based Routing Protocol

This protocol maintains a perfect balance between energy consumption and data quality. Few of its types are SPEED and energy-aware QoS routing.

Fonoage et al. [22] developed a QoS-based routing protocol. To forward packets in the network, this article developed a geographic routing mechanism combined with QoS support. The data is routed to other nodes based on the type of data packet. Here, multiple transmission queues are used to route packets with different significances. The node with high link quality, low load, and high residual energy is designated as a next-hop node which is nearer to sink node.

In WSN, Masruroh and Khadijah [23] developed a QoS-based and emergency-aware routing protocol (QoS-EARP). This article is developed based on the initial network design. Sensor network's emergency awareness, QoS, and energy efficiency are considered for algorithm design.

2.2.4 Negotiation-Based Routing Protocol

High-level descriptors are used by negotiation-based routing protocol for removing the redundant data transmissions via negotiation.

Sensor Protocol for Information Negotiation (SPIN)

Data transmission is considered as one of the main tasks in WSN. Several routing protocols were suggested to conserve energy during data transmission. In this sense, data-centric-based routing methods are ideal for conducting in-network data aggregation to generate energy-saving data propagation. In [24], an updated variant of the SPIN protocol called M-SPIN was introduced and equates its efficiency with the standard SPIN protocol using broadcast communication, which is a well-known benchmark protocol. In the TOSSIM setting, the M-SPIN protocol is tested using simulation. M-SPIN has major efficiency benefits relative to conventional SPIN routing.

3 Energy-Efficient Routing Protocols in WSN

In the case of wireless networks, battery-operated devices try to achieve heuristic energy efficiency. Conversely, this is not the optimal strategy for multi-hop routing, which would be typical for sensor and ad hoc networks. In this review, the following types of energy-efficient routing protocols were analysed and established out in Fig. 2.

3.1 Opportunistic Routing

Opportunistic routing is a new revolution for WSN routing that decides the sensor closest to the target sensor for data transmission. It utilizes the nature of the transmission of wireless communication. It enhances the effectiveness, presentation, and dependability of a network. So, this section presents a brief explanation of the opportunistic routing protocol in WSN (Table 1).

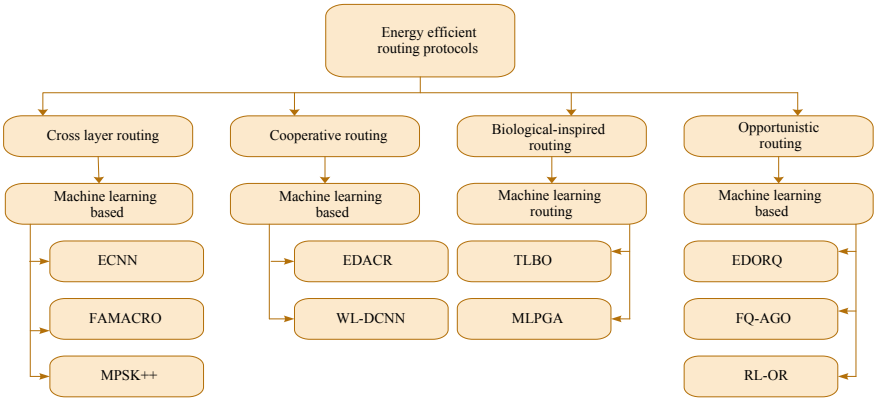

Fig. 2 Classification of energy-efficient routing protocols

Table 1 Survey on opportunistic routing

Author name and year	Protocol name	Objectives	Advantages	Disadvantages	Metrics	Future scope
Zhu and Don Towsley [25]	E^2R	To deliver control messages and data packets in a multi-hop wireless network	Node failure percentage is less	Causes poor end-to-end performance due to unavailability of preselected routing paths	Packet delivery ratio, control overhead, packet delivery delay	–
Hung et al. [26]	EFFORT	To maximize the amount of data gathered in WSNs	Improves transmission reliability	Cannot adopt per-hop communications due to the end-to-end data transmission	Network lifetime, end-to-end delay, energy cost, error percentage	–
Devi et al. [27]	EESOR:	To reduce delay in transmission and to prolong the network lifetime	Increase reliability and improve the sensing range of the sensor	More number of hops increases the delay in data transmission	Network lifetime and end-to-end delay	Analyse this routing protocol for throughput and turnaround time parameters
Chithaluru et al. [28]	AREOR	An energy-efficient optimal forwarder node selection	Using the sensor's for energy while assuring the QoS parameter	Due to the sub-optimal selection of routes, there is a loss in throughput	Message success rate, energy consumption, end-to-end delay, and packet delivery ratio	Fine-tuning of the adaptive method to decide the node rank quickly

3.2 Cross-layer Routing

In WSN, there is a need for cooperation among the various layers in the protocol stack for routing problems to conserve energy and to improve application performance. Cross-layer architecture accomplishes this kind of routing. This architecture enables different layers to collaborate and share network position data and guarantees the best route which is chosen for better energy enhancement purpose (Table 2).

3.3 Cooperative Routing

Cooperative routing is a kind of cross-layer routing that uses cooperative communication technology in the physical layer and routing selection in the network layer. This routing is mainly performed to decrease the energy consumption in the overall network (Table 3).

3.4 Biological Inspired Optimal Routing

The self-organization and self-association characteristics are more desirable by swarm intelligence (SI)-based protocols, and besides it contributes to organizing both the negative and the positive feedbacks. The routing behaviour is mainly carried out by certain different SI-assisted meta-heuristic algorithms such as bee colony optimization (BCO), ACO, and particle swarm optimization (PSO). In ACO, indirect coordination called stigmergy is followed by ants, and this approach helps to solve the combination issues. Stigmergic communication is completely fulfilled due to the compound substances gained from the ants called pheromone. Besides, such pheromones from the ants also act as a real feedback tool, so more ants are enrolled to attain their ultimate destination by following the pheromones which are sequenced on the shortest path (Table 4).

3.5 Machine Learning (ML)-Based Routing Techniques Under Opportunistic, Cross-layer, Swarm Intelligence, and Cooperative Protocols

This section briefly explains the machine learning algorithm which comes under the opportunistic, cross-layer, swarm intelligence, and cooperative routing protocols. In next-generation network, machine learning-based routing algorithms show great

Table 2 Survey on cross-layer routing

Author name and year	Protocol name	Objectives	Advantages	Disadvantages	Future scope	Metrics
Singh and Verma [29]	Adaptive threshold-based routing protocol	To perform routing in heterogeneous networks	Increase the lifetime of the whole network	Data overhead is high	–	Network lifetime and number of alive nodes
Ward and Younis [30]	Distributed beamforming-based routing	Balances the relay recruitment energy and the number of recruited relays	Improve the energy efficiency of the whole network	Data traffic is not limited	Enhancing the non-distributed approach in the WSN field	Average communication energy
Han et al. [31]	Geographic node disjoint multipath routing protocol	To optimize the whole network	Optimize all the parameters to achieve routing	Limits the useable links for exploring possible routing paths	Selecting path with minimum inter-interference	Residual energy, sum rate, and available path length
Abazeed et al. [32]	CLMR	To ensure QoS and minimize energy consumption	Reliability, security, energy efficiency, fault tolerance	Due to the memory constraint, the neighbour table is limited with few numbers of nodes	Integration of CLMR with Internet	Packet delivery ratio, PSNR, end-to-end delay

Table 3 Survey on cooperative routing

Author name and year	Protocol name	Objectives	Advantages	Disadvantages	Future scope	Metrics
Hung et al. [33]	EERH	To reduce the energy consumption of the whole network	Reduce the energy consumption of the whole network	Limited packet size	Security of EERH to be achieved	Average residual energy
Rani et al. [34]	CBCCP	To minimize the transmission distance	Improve network lifetime	Communication gets delayed due to limited power	Security must be considered	Delay and number of dead nodes
Manfredi [35]	Cooperative routing protocol	To guarantee a good performance trade-off between reliabilities	Energy efficiency enhancement	The limited capacity of the wireless medium network	To adapt a cooperative strategy for particular applications	Energy consumption and time delay
Habibi et al. [36]	Mixed-integer optimization framework	To obtain minimum energy transmission policy	Reduces energy consumption	Less amount of computational capability	Security must be considered in future studies	Bit error rate and normalized transmission power
Razzaque et al. [37]	DACR	To reduce delay and energy	Provides reliability of the network	Lack of understanding about the dynamics of several estimation tuning parameters	The analytical model must be performed in future	Energy consumption, packet delivery ratio, end-to-end delay

Table 4 Survey on biological inspired optimal routing

Author name and year	Protocol name	Objectives	Advantages	Disadvantages	Future scope	Metrics
Helmy et al. [38]	AFSA	To lower down network energy consumption	Achieves better network lifetime	Energy consumption is somewhat high	Limiting the energy of the nodes that have little or no energy is another area of future research	FND, energy consumption per round, network lifetime, data received by BS
Liu et al. [39]	QoS-PSO	To enhance the QoS level	Improvement in the QoS measure	Due to limited resources, maintenance of data structure was affected	Improvement to effectively handle high mobility	Packet loss, average residual energy, QoS, mean delay
Kuila and Jana [40]	PSO	To extend lifetime of WSNs	Energy consumption is balanced, and network lifetime is improved	Overhead of data routing in the CH formation phase	Enhancement to deal with dynamic network scenarios	Network lifetime, energy consumption, delivery of total data packets
Rao et al. [41]	PSO-ECHS	To achieve improved network lifetime by conserving the energy of SNs	Better performance in terms of success rate, network lifespan, and total energy consumption	Inappropriate cluster formation	Fault tolerance in heterogeneous networks	Total energy consumption, network lifetime
Shankar et al. [42]	HSA-PSO	To attain balanced energy consumption among SNs	Achieves better search, convergence, energy-efficient operation	Inappropriate cluster formation	Scalability enhancement for very large-scale networks	FND, LND, residual energy, mean throughput, standard deviation

prospective conversely, and researches on artificial intelligent routing are still on a very beginning stage. So, this section briefly explains the machine learning concepts in routing protocols (Table 5).

4 Performance Evaluation Metrics of Routing Protocols

For performance analysis, this section shows the various performance metrics of routing protocols. Some of the parameters were selected to make an adequate approach to the technical specifications of the routing protocols.

1. Throughput: The amount of bit transmission per second is defined as throughput, and it is measured by Kbps. Such type of calculation provides a fast response about system productivity boosted by every group.
2. End-to-end delay: It is a period taken by the standard data transmission system from the source node to the target node.
3. Normalized overhead routing: It is described as the number of packets transmitted per data packet.
4. Packet delivery ratio: It is defined as the ratio of several packets received by the destination node to the number of packets sent. It is measured in terms of percentage.

The given Tables 6, 7, 8, 9, and 10 represent the various performance parameter values of different types of energy-efficient routing protocols.

5 Future Enhancement

In the proposed work, future studies should focus on the design and implementation of unique routing protocols for particular applications. To develop routing protocols for applications needing QoS services such as real-time applications, video, imaging, and surveillance monitoring, careful attention is required. In this field, some of the research processes are performed so far to explore a vast. The survey revealed that protocol expectations on SNs and sinks are typically stationary. It is typically not a real-environment scenario, though. Applications such as goal detection and analysis of surveillance serve as a mobility prerequisite. Further study is needed to explore the effectiveness of routing protocols to accommodate volatility of sink/source nodes, the overhead due to complex topology, QoS constraint in an area of energy restriction. It is important to facilitate the algorithm experimentation on actual testbeds so there could be some elements of a protocol that can be discovered there and not discovered on the simulator. It is expected to inspire researchers to consider different characteristics of the protocol when designing and improving energy-efficient routing protocols that are energy efficiency, application area, statistical modelling, QoS calculation, and implementation of simulation/real testbed.

Table 5 Survey of machine learning-based routing methods in energy-efficient routing protocols

Author name and year	Type of routing	Protocol name	Advantages	Disadvantages	Future scope	Metrics
Sumalatha and Nandalal [43]	Cross-layer	ECNN	Reduces faults in routing	Packets are misrouted	To find the various kinds of attacks with different parameters	Throughput, energy consumption
Gajjar et al. [44]	Cross-layer	FAMACRO	Reduces collision among the clusters	Limited hostile environment	–	Energy consumption and residual energy
Mydhili et al. [45]	Cross-layer	MSPK + +	Eliminates the corrupted data	Energy consumption is high	Optimized the ML through the heuristic approach	Accuracy, computational time
Yongjie Lu et al. [46]	Opportunistic routing	EDORQ	Improves network performance	Overhead of data	Minimize the average packet delay	Network overhead, packet delay, packet delivery ratio, energy consumption
Alshehri et al. [47]	Opportunistic routing	FQ-AGO	Selects the best candidate set towards the destination	Large overhead	–	Packet delivery ratio, throughput, delay
Tang et al. [48]	Opportunistic routing	RL-OR	Improves transmission reliability	Limited wireless resources	–	End-to-end delay, throughput
Wang et al. [49]	Cooperative routing	EDACR	Adjusts the weight for three metrics	Non-supportive behaviour for real-time traffic	–	Average QoS, percentage of surviving nodes
Huang et al. [50]	Cooperative routing	WL-DCNN	Determines the reliability of target links	Not sensitive to data with spatial displacement	Apply this technique to improve the resilience of the network	Average routing length, number of dead nodes

Table 6 Comparison values of opportunistic routing protocol

Reference no.	Method	Parameters	Values
Chithaluru et al. [28]	AREOR	Packet delivery ratio	97.78%
		End-to-end delay	36.6 s
		Message success rate	230 bits/s
		Consumed energy (CE)	72 J
Zhu and Towsley [25]	E^2R	Packet delivery ratio	100%
		Control overhead	0.4
		Packet delivery delay	1.4 s
Hung et al. [26]	EFFORT	Network lifetime	2 MB
		Energy cost	0.012 mJ/bit
		End-to-end delay	20.5 s
		Error percentage	0.12%
Devi et al. [27]	EESOR	Average end-to-end delay	500
		Maximum end-to-end delay	800
		Network lifetime	127.5

Table 7 Comparison values of cross-layer routing protocol

Reference no.	Method	Parameters	Values
Singh and Verma [29]	Adaptive threshold-based routing protocol	Energy consumption	66%
		Number of alive nodes	10@80 rounds
Ward and Younis [30]	DiCLR	Average communication energy	3 μJ
		Belief metric	0.01
Han et al. [31]	Geographic node disjoint multipath routing protocol	Average residual energy	490
		Average length of paths	24
Abazeed et al. [32]	CLMR	Delivery ratio	0.94%
		Energy per packet	0.065

Future studies will help researchers to attain reasonable decisions and to set targets based on better options for investigations.

6 Conclusion

WSN becomes more common in recent years; therefore, it is extensively used in various applications like volcano or earthquake prediction, health care, structural health monitoring, target tracking, remote sensing, intruder detection, surveillance, and military. Due to the restricted battery capacity of source nodes, energy usage

Table 8 Comparison values of cooperative routing protocol

Reference no.	Method	Parameters	Values
Hung et al. [33]	EERH	Average residual energy	95 mJ
		Average notified event	13.5×10^4
Rani et al. [34]	CBCCP	Average number of alive nodes	50@5000 rounds
		Number of dead nodes	1100@5000 rounds
Manfredi [35]	Cooperative routing protocol	Delay	3.6 s
		Reliability	68%
Habibi et al. [36]	Mixed-integer optimization framework	BER	0.038
		Normalized transmission power	37.5
Razzaque et al. [37]	DACR	Average end-to-end delay	0.3 s
		Network lifetime	400

Table 9 Comparison for optimization-based energy-efficient routing protocol

Reference no.	Method	Parameters	Values
Helmy et al. [38]	AFSA	Number of alive nodes	45@100 rounds
		Residual energy mean value	42 J
Liu et al. [39]	QoS-PSO	Mean delay	3.2 s@100 nodes
		Packet loss ratio	0.38 @100 nodes
		QoS	0.58@100 nodes
		Average residual energy	0.9 J for 100 nodes
Kuila and Jana [40]	PSO	Network lifetime	600 nodes @ 650 rounds
		Inactive rate of sensor node	135@2500 rounds
		Energy consumption	1650 J@3000 rounds
		Packet received by BS	7.56×10^4 for 90BS
Rao et al. [41]	PSO-ECHS	Total energy consumption	450 J@ 5000 rounds
		Packet received by BS	540 for 15 CHs
Shankar et al. [42]	HSA-PSO	Mean residual energy	98 J
		Mean throughput	17 Mbps for 200-100 sink positions

is a big issue for these devices. Hardware constraints are required for designing an energy-efficient hierarchical routing protocol. This article highly attempts to review the classical- and hierarchical-based routing protocols that intend to progress the efficiency of network energy. In-depth empirical comparison for various hierarchical-based routing protocols is provided in this article. Further, the performance can be measured by the comparing the various parameters such as QoS, energy consumption,

Table 10 Comparison of machine learning-based energy-efficient routing protocol

Reference no.	Method	Parameters	Values
Sumalatha and Nandalal [43]	ECNN	Throughput	0.1034 bps@5.4 s
		Energy consumption	9.90 J@10 s
Gajjar et al. [44]	FAMACRO	Average energy consumption	20.240 J@250 rounds
		Number of dead nodes	1000@250 rounds
		Sum of residual energy	270 J@250 rounds
Mydhili et al. [45]	MSPK + +	Residual energy	85.56 J@100 nodes
		Computational time	0.3 s@100 nodes
Yongjie Lu et al. [46]	EDORQ	Total energy consumption	7.8 kJ@800 nodes
		Packet delivery ratio	0.98@800 nodes
		Average packet delay	1.8 s@800 nodes
Alshehri et al. [47]	FQ-AGO	Throughput	1600kbps@30 m/s
		Delay	0.4 s@30 m/s
		Packet delivery ratio	0.75%@30 m/s
Tang et al. [48]	RL-OR	End-to-end delay	0.1 s@5Mbps
		Throughput	5 mbps@10 s delay
Wang et al. [49]	EDACR	QoS	0.38@3000 rounds
Huang et al. [50]	WL-DCNN	Accuracy	0.986 for yeast, 0.971 for power

fault tolerance, question regarding multipath, scalability, position knowledge, and data aggregation were also analysed. The classical routing techniques that stress the load balancing evolutionary techniques and optimal clustering are mainly reviewed in this work to find out a strong correlation between the network lifetime and energy efficiency. Through proposing architecture, algorithmic level improvements by biologically driven meta-heuristic methods that provide better solutions for optimization issues, hierarchical routing in terms of swarm intelligence enhances a reasonable contribution. This study provides a better solution for the problems related to energy consumption for hierarchical-based routing protocols; further, it contributes to the better network lifespan. Finally, the open challenges and issues that are encountered while designing an energy-efficient routing protocol are also outlined in this work.

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Intelligent Machine Learning Approach for CIDS—Cloud Intrusion Detection System

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Abstract In this new era of information technology world, security in cloud computing has gained more importance because of the flexible nature of the cloud. In order to maintain security in cloud computing, the importance of developing an eminent intrusion detection system also increased. Researchers have already proposed intrusion detection schemes, but most of the traditional IDS are ineffective in detecting attacks. This can be attained by developing a new ML based algorithm for intrusion detection system for cloud. In the proposed methodology, a CIDS is incorporated that uses only selected features for the identification of the attack. The complex dataset will always make the observations difficult. Feature reduction plays a vital role in CIDS through time consumption. The current literature proposes a novel faster intelligent agent for data selection and feature reduction. The data selection agent selects only the data that promotes the attack. The selected data is passed through a feature reduction technique which reduces the features by deploying SVM and LR algorithms. The reduced features which in turn are subjected to the CIDS system. Thus, the overall time will be reduced to train the model. The performance of the system was evaluated with respect to accuracy and detection rate. Then, some existing IDS is analyzed based on these performance metrics, which in turn helps to predict the expected output. For analysis, UNSW-NB15 dataset is used which contains normal and abnormal data. The present work mainly ensures confidentiality and prevents unauthorized access.

Keywords Cloud intrusion detection system · Machine learning · Feature selection · UNSW-NB15 dataset · KLS framework

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1 Introduction

Cloud computing is a rising technology that becomes an essential service in the entire IT world. Nowadays, because of the tremendous amount of dataflow in the network, it is necessary to maintain a storage system that should organize the data in a well-structured manner. The major benefits like scalability and pay has increased the popularity of cloud computing drastically. Although, security in cloud computing becomes a serious issue in this modern IT world because of the exchange of highly confidential information. In 2020, ransomware threat will contribute a serious hazard to the entire cyber world [1]. To overcome this challenge, many traditional systems have already been established and developed. Despite most of them were incapable of detecting the advanced type of attacks and opened the door for hackers. To complement these traditional systems, an intrusion detection system comes into the picture which can effectively detect intruders and prevent them from all the threats. Attacks can occur in the network as well as in the host system. There are two types of IDS based on network-based and host-based system [2]. In this digital world to compete with the intelligent attackers, many AI based IDS have already been proposed by integrating machine learning with IDS. Machine learning is a learning technology that learns from experiences and trains the model and makes some predictions based on the situations. While comparing with traditional intrusion detection mechanisms, the ML based IDS is more effective in detecting and reporting even unknown attacks to the network administrator [3]. Even though the underlying ML based IDS framework aims to detect the anomalies, the major drawback with these ML based IDS is to handle highly complicated datasets. Therefore, to increase the performance of these types of IDS based architecture, it is very important to perform feature engineering for highly complicated datasets. Therefore, to increase the performance of these types of IDS based architecture, it is very important to perform feature engineering for highly complicated datasets. This data monitoring and extracting features is a big challenge in this untrusted IT network. To overcome this problem, many machine learning-based techniques for extracting the features and reduction of features come into play. Feature reduction is an important step that comes under feature engineering which plays a vital role in machine learning. In feature engineering after extracting all the features, it is necessary to perform feature reduction to handle these huge volume data. The primary motivation of this paper is to propose an efficient ML based IDS incorporating an effective feature reduction technique to handle complex datasets.

The proposed method gives an expected output of high accuracy and highly effective detection rate comparing with the IDS technique without feature reduction. The work here focuses on contributing the following:

- An effective machine learning-based intrusion detection system for cloud is proposed which incorporates AI agent and KLS feature reduction techniques to handle complicated datasets.
- Fuzzy C-means clustering algorithm is followed for attack detection and random forest machine learning algorithm to classify the attack.

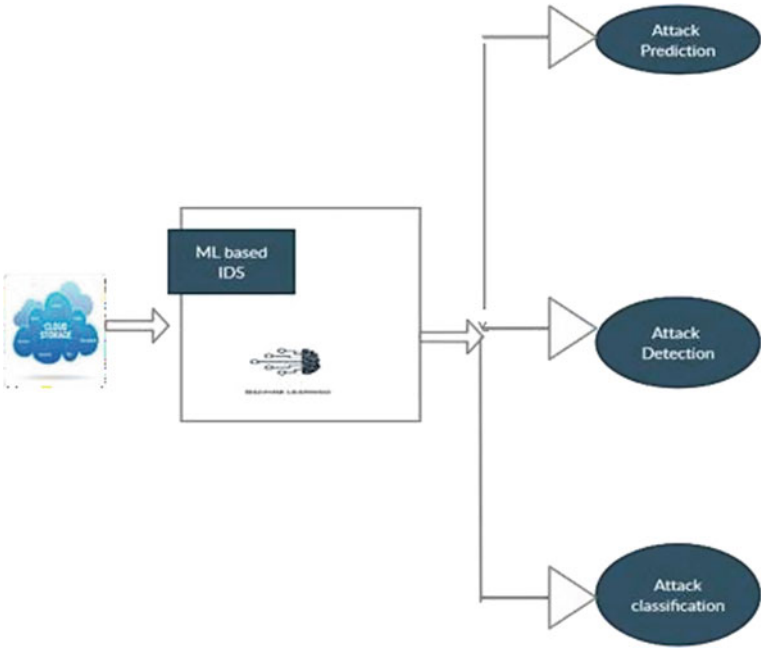

Fig. 1 ML based IDS

- Our approach is to design a feature reduction framework that will select the best features to achieve better performance.
- Our proposed CIDS mechanism can detect all the attacks and protect the data from intruders.

Figure 1 explains the basic machine learning-based IDS that can detect, predict, and classify the type of attack. The primary motivation of this paper is to propose an efficient ML based IDS incorporating an effective feature reduction technique to handle complex datasets.

The paper is structured as follows: In Sect. 2, background of IDS and related work are introduced, and in third section, proposed methodology is discussed. Results and discussions are elaborated in Sects. 4 and 5 which covers the conclusion with further enhancements.

2 Background and Related Work

Since cloud security is a main issue for the entire IT world, cloud intrusion detection system monitors the traffic based on the data and selected features. In order to predict the anomalous behavior of a cloud, IDS monitors the traffic in a better way [4]. To

overcome the challenges present in the existing IDS, soft computing-based IDS is one of the measures to identify the intrusions in a better way. In [5], machine learning is a technology that models the system based on the experience. Machine learning-based IDS predicts the presence of intruders in the system by using different classification and regression algorithms.

The challenges faced by the existing IDS are given as follows:

(1) *Time complexity*
Every day along with the information technology world, data is also growing drastically. Hence, a mechanism is required to handle this data efficiently by selecting the best attributes from the entire attributes. So that it will train the data within a short period of time.

(2) *Space Complexity*
Due to this huge volume of data, interpretation of the output will increase the complexity. So in order to handle this huge volume of data, a feature reduction algorithm is necessary which will select only the relevant features.

(3) *Accuracy*
Accuracy can be achieved by reducing the volume of data; hence, an efficient feature selection method will increase the accuracy of the model.

(4) *Overfitting*
A powerful feature selection algorithm is needed to deal with the problem of overfitting. Complex data will always lead to overfitting, which gives an erroneous output.

Many researchers have already proposed ML based IDS to deal with all the challenges in cloud security. ML based IDS is also capable of ensuring security measures confidentiality, integrity, and availability.

Mukherjee and Sharma [6] propose an intrusion detection system with a feature reduction technique called feature vitality-based reduction method (FVRM) and naive Bayes algorithm for the classification of attack. Here, the author considers the performance criteria accuracy, true positive rate, and false positive rate; and investigation was conducted on NSL-KDD dataset. During the first phase of the implementation, FVRM based feature reduction is performed that reduces the features to 24, and for the next phase, intrusion detection is developed using naive Bayes classifier. Here, the author focuses mainly on DOS, Probe, R2L, and U2R attacks. These methods show an improvement in accuracy while comparing with CFS, IG, and GR feature reduction methods.

According to Nguyen et al. [7] an automatic feature selection method called correlation-based feature selection which will automatically select the features and reduces the complexity. They experimented using NSL-KDD benchmark dataset and investigated with best-fit CFS and genetic algorithm CFS.

In that, proposed method achieves higher accuracy and better performance while comparing with the above feature selection methods. In [8], an enhanced support vector decision function algorithm is proposed which is based on mainly two important steps. During the first step calculation of the weights from the functions takes place and for the next step ranking of the features takes place.

An approach based on a PCA combined [9] with random forest algorithm for classification of attacks reduces the complexity of the dataset. A dimensionality reduction technique called principle component analysis is used in the initialization step. Then, for the classification of the attacks, random forest algorithm is used. The proposed model shows better performance with respect to accuracy and detection rate.

Natesan and Balasubramanie [10] propose a multistage filter for network intrusion detection using random forest and PSO. Here, the method is composed of two stages, feature selection using PSO and classification of attack using random forest algorithm. Performance is evaluated with KDDCup 99 dataset, and the output is generated with high detection rate and low false alarm rates.

Hasan et al. [11], authors built two models using SVM and random forest for intrusion detection. They compared the performance metrics with respect to accuracy, precision, and false negative rate. In order to select the best intrusion detector, KDD CUP 99 is used. In [12], an feature selection algorithm is introduced which selects the features using filter and wrapper method with firefly algorithm. The selected features are subjected to C4.5 and Bayesian networks. For performance evaluation, KDD CUP99 dataset was used. The proposed model shows the highest accuracy while comparing with other models with the ten selected features.

3 Proposed Methodology

The work focuses on proposing an effective machine learning-based IDS in the cloud by using an intelligent agent-based KLS combinational framework for feature reduction and machine learning models for attack detection. This section begins with the data collection phase and later proceeds with the detailed step by step procedure of the system.

3.1 Data Collection

In the proposed system, benchmark dataset UNSW-NB15 uses a labeled dataset characterized with 2 million records and 49 features for each record [13]. This dataset is publicly available for the researchers and established by UNSW cybersecurity laboratory records are classified as label ‘0’ for normal and ‘1’ for attacks. Attacks are further classified with nine latest attack types, namely Reconnaissance, Backdoor, Exploits, DoS, Analysis, Fuzzers, Worm, ShellCode, and at last Generic. The training and testing dataset has all the attacks and normal data (Table 1).

Table 1 UNSWNB15 dataset classes

No.	Type of attackers	Train UNSW-NB15 No. of record	Test UNSW-NB15 No. of record
1.	Analysis	2000	677
2.	Backdoor	1746	583
3.	Dos	12,264	4089
4.	Exploits	33.393	11,132
5.	Fuzzers	18,184	6062
6.	Generic	40,000	18,871
7.	Reconnaissance	10,491	3496
8.	ShellCode	1133	378
9.	Worms	130	44
10.	Normal	56,000	37,000
Total		175,341	82,332

3.2 Preprocessing of the Dataset

Preprocessing is an important step in machine learning to increase the quality of the data since UNSW-NB15 is categorical data. In order to deal with this categorical data, one hot encoder is used for encoding the data during the first step. During the next step, in order to achieve better results, the Gaussian distribution standardization method is used to rescale the data.

3.3 Intelligent Agent Based Feature Reduction Method

This section describes an intelligent agent system which uses two modules: data reduction agent and feature reduction agent. Feature reduction agent will select only the relevant features corresponding to the attack class. This research work uses UNSW-NB15 dataset for analysis. The proposed method expects to give better performance in terms of accuracy and detection rate. Here, the novelty introduced in the proposed architecture is the introduction of data selection agent which is a new approach which will filter the data that promotes the attack. The main objective of agent-based KLS framework is to reduce the complexity of UNSW-NB15 dataset. Here, this research work uses the intelligent agent-based KLS framework that integrates agent algorithm by using K-means clustering as the first stage and a combinational framework that combines SVM and linear regression algorithm in the second stage. The proposed model is expected to give a promising output in terms of feature reduction.

A strategy called an intelligent agent-based KLS framework is introduced to deduce the features from the entire subset of attributes. Even though UNSW-NB15 is already having classified data which corresponds to all the attacks, in a view to

increase the performance, the attack dataset is deployed to an unsupervised algorithm. In this section during the initial step, it uses K-means clustering algorithm, which clusters the training data into nine attack classes and a normal class. Since, K-means clustering is an unsupervised algorithm that can compute the centroids of each class and use them to join the training data from UNSW-NB15. Here, during the evaluation, the attack label should be dropped and normal from the training dataset. After partitioning the data into the attack and normal data using an intelligent data selection agent, the attack data is only filtered out and subjected as an input for the next step. For the next step, a combination of linear regression and SVM will help to extract only the features that provoke the attack and help to remove the irrelevant features

3.3.1 Intelligent Data Selection Agent

In our current literature, the agents work as an administrative tool which selects the attack data efficiently. Thus, during the feature reduction process, the novel data reduction agent will select only the data that provokes the attack.

Algorithm1: Agent Based Data Selection Algorithm
Input: A set of training data having 175,431 records from UNSW- NB15 dataset. Let it be' D'

Expected output: A set of reduced data's that contains only attack promoting data. Let it be 'R'

Intelligent data selection agent performs the following steps

Step 1: Initialize the cluster value with k=10

Step 2: Place centroids C for each cluster at random locations of D *Step 3*: for each centroid C, assign each data from D which is closer to C.

Step 4: for each centroid C, recompute C by calculating its mean value of all the data points.

Step 5: If no change in the centroid position, go to step 3

Step 6: Intelligent data selection creates 10 clusters with 9 attack data cluster [A1…A9] and 1 normal data cluster 'N'

Step 7: store the attack data cluster points [A1…A9] into R and output it.

Algorithm 1 explains the data selection process which employs K-means clustering algorithm which collects only the abnormal data in UNSW-NB15. After calculating the distance between the randomly selected centroids and data points, if the distance from the centroid 'C' and data points 'D' is minimum, then assigns the data point to the centroid 'C'. Repeat the calculation until there will be no reassigned data points. The purpose of this agent is to generate ten clusters with nine attack clusters and one normal data cluster. This allows the intrusion detection module to report the attacks easily. The present work aims to reduce the time complexity and to increase performance. When there is abnormal data, the data agent module expects to give a relatively efficient output.

3.3.2 Agent Based KLS Feature Reduction Method

UNSW-NB15 is having a total of 49 features, so it is very important to reduce the features to make the observations easy. Thus, a powerful feature reduction technique is proposed that can reduce the features only to relevant features. Here, the output from the previous step is taken as an input for this step. The selected attack data is passed as an input to linear regression and SVM algorithm. The two algorithms parallelly select the relevant features with the help of selected data from the previous step. During the final step, the output is generated by concatenation of the selected features from LR and SVM. The proposed KLS feature reduction method expects to give a high yield output in terms of accuracy and detection rate. The feasibility of the proposed intrusion detection system can be increased to a level higher than the earlier systems which are currently available. In addition to this, proposed model uses UNSW-NB15 dataset for evaluation which has all the latest attacks. Future researchers can use this model for feature reduction and can increase the performance of the system.

Algorithm 2: KLS Algorithm
Input: selected data 'R' and 49 features of the dataset Output: Set of reduced features 'F'

for each data and features of UNSW-NB15

(1) Extract the features from Linear regression algorithm, 'L'
(2) Extract the features from SVM algorithm, 'R'
(3) Concatenate the outputs of step 1 and 2, [L, R]
(4) Store the output of step 3 in' F'

In algorithm 2, a detailed overview of the agent-based KLS feature selection algorithm has been mentioned. The above-mentioned algorithm selects the best feature from the 49 features, and it has been expected to give a reduced number of features. Since SVM and linear regression are combined here, this strategy selects only the dominant features. It reduces the chance of overfitting, which will automatically lead to a highly accurate output. This agent-based method will increase the performance of our random forest classifier which in turn will increase the performance of the intrusion detection system.

3.4 Proposed Cloud Intrusion Detection System

CIDS is a system that can monitor the traffic by detecting the attack and should report to the system administrator to prevent the attacks. Even though many traditional authorization mechanisms have been used, our cloud storage is still vulnerable to attacks. This section presents a CIDS framework to detect and classify the attack effectively. Here, KLS approach is used to build our IDS which accustoms the novel

data selection agent and feature selection agent. The CIDS framework is shown in Fig. 3 which comprised of two major steps, attack detection and attack classification. The attack detection phase detects whether an attack happens or not, and for the next phase, attack classifier detects the type of attack.

The CIDS application is used to achieve main functions feature reduction where KLS frame work is used for deducing the features as well as attack recognition. When structuring predictors, combining feature reduction methods can lead to high accuracy and detection rate by decreasing the false positive rate. Note that KLS is employing K-means, linear regression, and SVM. Data intelligent agent filters only the attack data, and the selected data is deployed as an input for the feature selection agent. The feature selection agent collects the selected data from the data selection agent, and based on the attack data, SVM, and LR together can reduce the features. By reducing the features, the complexity is reduced which in turn increase the accuracy and detection rate. Once the features are deduced, it will be used by the fuzzy C-means clustering algorithm to detect the attack in cloud by clustering process. When the data is transferred to fuzzy C-means clustering algorithm, an output is produced which indicates whether the data is normal or attack. Finally, if the output generated is attack, then the testing data's are transported to the random forest classifier, which classifies the attack based on the training data.

3.4.1 Attack Detection

After the agent-based feature reduction, the entire trained data is used to monitor the traffic. Here for distinguishing normal traffic and abnormal traffic, fuzzy C-means clustering algorithm is used. Fuzzy C-means algorithm divides the data into normal and attack. Even for the detection of unknown attacks, fuzzy C-means [14] clustering proved to be effective. As we are using agent-based feature reduction algorithm, performance expects to be significantly high.

3.4.2 Attack Classification

The efficient classification of attack is a major problem in the intrusion detection system. The next major phase of intrusion detection is to classify the attack using a major classifier, random forest. After detecting the attack, the trained data is transported through random forest classifier which is based on a voting method. Random forest along with agent-based feature reduction helps to develop effective intrusion detection by achieving high accuracy and detection rate than the existing algorithms.

The proposed CIDS framework (Fig. 3) combines the agent-based KLS feature selection algorithm using feature reduction agent (Fig. 2) to detect normal and abnormal data.

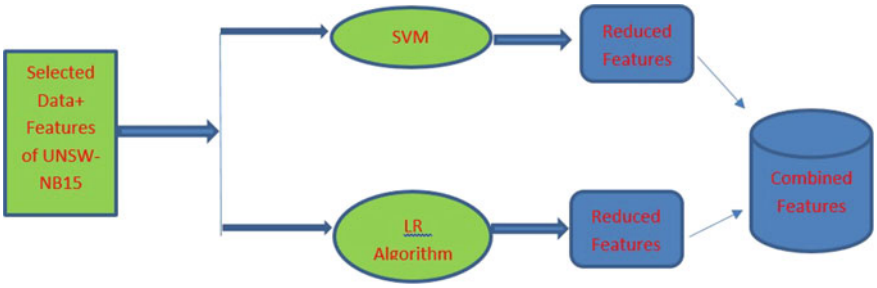

Fig. 2 Feature reduction framework

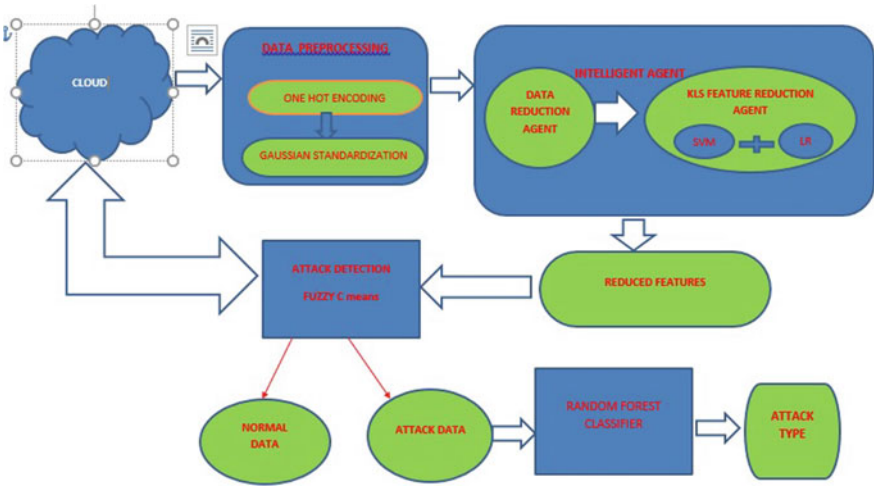

Fig. 3 CIDS framework

4 Results and Discussions

To determine the performance of the intrusion detection system, UNSW-NB15 dataset has been used. This dataset is the latest dataset that has been widely used in intrusion detection strategy. Dataset has four major csv files, which is a combination of normal and attack data. An effective IDS should be capable of detecting all the attacks, and the performance metrics rate also should be high. The proposed agent-based IDS, which incorporates intelligent agents which use K-means clustering, linear regression, and SVM algorithm, expects to reduce the 41 features to relevant features. It helps to take the best features out of that 41 features by using the concatenation function in the KLS framework. For detection purposes, we are using fuzzy C-means clustering, which is an effective algorithm that detects the attack by clustering normal and abnormal data. Here, the classifier is random forest which classifies the type of attack by employing the majority voting method.

Table 2 Performance analysis table

Author name	Dataset used	Feature reduction method	Measurement analysis
Shone et al. [15]	NSL-KDD, K DD CUP 99	Non-symmetric deep auto-encoder	Accuracy-98.81%
Xiao et al. [16]	KDD CUP 99	PCA, AE	Accuracy-94.0%
Fangjun Kuang et al. [17]	KDD CUP	Genetics algorithm	Accuracy-99.69%
Li et al. [18]	KDD CUP	GFR	Accuracy-98.62%
Lin et al. [19]	KDD CUP	SVM	Accuracy-99.96%

4.1 Performance Analysis

To evaluate the accuracy and detection rate of machine learning algorithms, we used the intelligent agent mechanism for data selection and feature selection. It is expected that the present work shows a high detection rate and high accuracy as the combined approach of data selection and feature selection is employed. In addition to that for training purposes, we used the public dataset UNSWNB-15 dataset which in turn increases the accuracy and rate of detection.

4.1.1 Effect of Intelligent Agent

The results in Table 2 show the feature selection methods applied for intrusion detection. The following studies highlight how feature reduction methods affect the accuracy measure and detection rate. Even though researchers have already proposed eminent feature selection mechanisms, but still we need more investigations. Our proposal on UNSW-NB15 expects to reduce the features and recommends to implement a CIDS with high accuracy and detection rate.

The above performance analysis table focuses on different feature selection algorithms, and our current work expects to give promising results in terms of detection rate and accuracy. In an aim to increase the accuracy and detection rate, we used two-stage process for data selection. Our proposed model will show a very high accuracy rate comparing with the above-mentioned models. Since we are using an intelligent agent-based feature reduction mechanism, the time taken to model the IDS also will be less. In this current paper, we provided a solution to reduce the time taken to train the model with the reduced features. From Fig. 4 graph, it is clear that SVM shows the highest accuracy in feature reduction; hence, the proposed model is expected to show better accuracy.

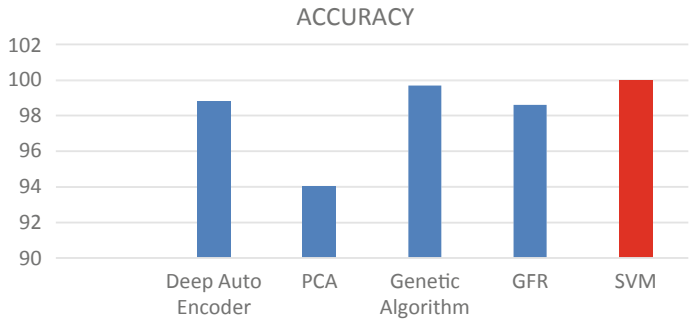

Fig. 4 Performance comparison of feature reduction algorithms

5 Conclusion

The proposed research work used robust CIDS which uses an eminent feature reduction technique that will detect the attacks with high accuracy and high detection rate. Many traditional intrusion detection techniques are already available in the information technology world, our cloud data is still vulnerable to attacks, so it is necessary to provide security efficiently. The aim of the paper is to incorporate intelligent agent for feature reduction and the use of classifiers for the efficient intrusion detection system. From our current architecture, the proposed intelligent agent expects to be faster and can reduce the features. Randomly selecting the centroid data and computing the minimum distance between the data point and centroid makes the K-means clustering algorithm which makes the feature reduction process easy. Moreover combined approach of SVM and linear regression facilitates the feature reduction process by selecting the features corresponding to the selected data. Even for the detection of attacks, fuzzy C-means algorithm is used, and the robust random forest classifier classifies the attack efficiently. The above explanations provide clear justifications of why our proposed architecture expects to yield better results while comparing with the earlier methods. The current literature will serve as a base for further studies to develop an efficient cloud intrusion detection system (CIDS). Furthermore, the presented architecture can be implemented and can be extended for intrusion detection in the network. The proposed method on UNSW-NB15 dataset will give high performance by means of accuracy and detection rate. Further investigation is needed to enhance security in the cloud using machine learning and deep learning models.

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In-network Data Aggregation Techniques for Wireless Sensor Networks: A Survey

T. Kiruthiga and N. Shanmugasundaram

Abstract A sensor network consists of the random deployment of large numbers of tiny sized sensor nodes in a region of interest to detect the physical/environmental events and transmit the relevant data to the sink node through multihop communication. The nodes have many physical constraints like energy, memory, processing power, and hence the result is the limited or insufficient network lifetime of a network. To solve this problem, data gathering in an energy-efficient manner is an important task in the wireless sensor network to enhance network lifetime. Data aggregation is one such energy-efficient data gathering technique that reduces the data traffic and thereby the energy consumption substantially. The prime idea of the data aggregation is to gather, combine, and compress the data from various sensor nodes during transmission to the sink node. Among the available aggregation methods, in-network processing plays a major role to reduce the amount of data to be transmitted in the network. This article analyzes the various in-network data aggregation algorithms in detail and provides an insight into the techniques utilized.

Keywords Wireless sensor network · Data aggregation · In-network aggregation · Algorithms · Redundant data · Energy efficiency · Network lifetime · Aggregation rate

1 Introduction

In wireless sensor networks (WSNs), the sensor nodes are deployed in numerous applications. The sensor node performs the activities like sensing the information and communicating with one another and with the base station through the wireless network. To execute the behavior of all sensor nodes in the network is equipped with

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the battery power for energy consumption [1]. Data aggregation plays an important role in combining the data from different sources which in turn is used as a powerful energy-saving mechanism and on the way after extracting the unnecessary data by reducing the energy consumption [2].

Based on the network structure, data aggregation is categorized into a tree-based aggregation technique, cluster-based aggregation technique, centralized aggregation technique, in-network aggregation technique, and hybrid structures. This article is prepared to furnish an organization of in-network aggregation by denoting the prime conception and overlaying the predominant and present specialization in the area of in-network data aggregation [3]. This article focuses on the comparative study of in-network aggregation of data in the networks. In-network aggregation is projected for resource constraint wireless sensor networks (WSNs) [4].

The essential scheme of in-network aggregation is that superfluous and inappropriate information is eliminated, and the significant information is merged into an aggregation consequence at intermediate nodes along the communication paths [5]. A communication cost is usually several times of level greater than the cost of processing the data [6]. Thus, the input range and congestion are decreased, which will conserve significant power [7]. This article intends to enhance the outlook of the in-network data aggregation and furnish an initiative and outset for the analyst who focused on these difficulties.

2 Data Aggregation

Data aggregation is the unique technique used in wireless sensor networks to extend its lifetime for saving energy by the nodes in communication. Data from different sources of nodes are aggregated at the intermediate from a source to sink based on some operation as shown in Fig. 1. Energy is wasted in the process of data gathering at a base station.

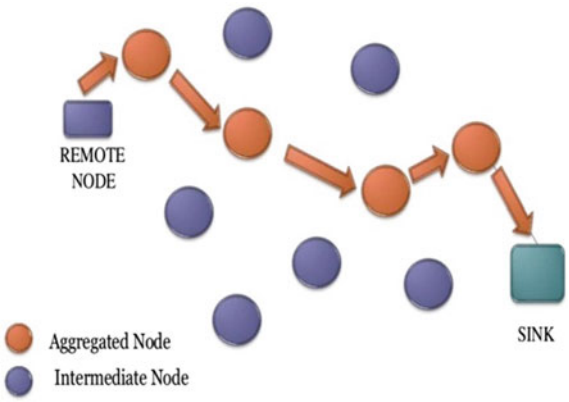

Fig. 1 Data aggregation process

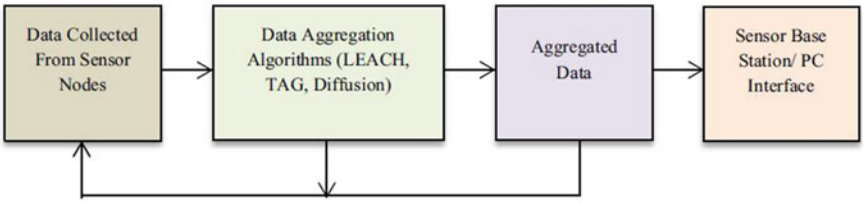

Fig. 2 Block diagram of data aggregation

In the data aggregation method, instead of sending data out of all nodes to the sink node, a node called a data aggregator collects the information from its nearest nodes and aggregates them and finally transmits it to the sink node [1]. This method of aggregation includes the data packets transferred which contain only the needed information without redundant data [2]. When developing a new aggregation algorithm, few parameters to be thought-out namely the energy level of the sensor, resource constraint, and mathematical ability. The purpose of the data aggregation approach is to aggregate the sensed data in the node as shown in Fig. 2.

The different types of the algorithm such as hybrid energy-efficient distributed clustering approach (HEED), clustered diffusion with dynamic data aggregation (CLUDDA), power-efficient data gathering protocol for sensor information systems (PEGASIS), and a centralized approach is like to aggregate the observed input value from various sensor nodes in the network. A successful path from the aggregated data node to the sink node is selected for reliable transmission.

In the sensor networks, data aggregation consists of replacing each node of the individual sensing readings. For example, an aggregate function like MIN, MAX, AVERAGE (AVG), etc., can be used which allows the function of summarizing the n number of data obtained from all the intermediate nodes and send to the base station as only a single message from these n numbers of data [8].

This minimizes the excess of message forward to the base station and saves energy which is shown in Fig. 3. There are two classifications of data aggregation types namely data aggregation with range limiting and data aggregation without range limiting.

(A) **Data aggregation with range limiting**: This procedure combines and compresses the input value accepted from various motes to decrease the information delivered in the system. (e.g., for manipulating the overall n number of accepted data subsequently sends that information into a distinguished packet as an alternative for transmitting the n number of received data).

(B) **Data aggregation without range limiting**: This process compresses the received data from various nodes in a single packet without processing. (e.g., habit monitoring and disaster management cannot be processed simultaneously, but they can be sent in a distinguished packet which in succession to minimize the header).

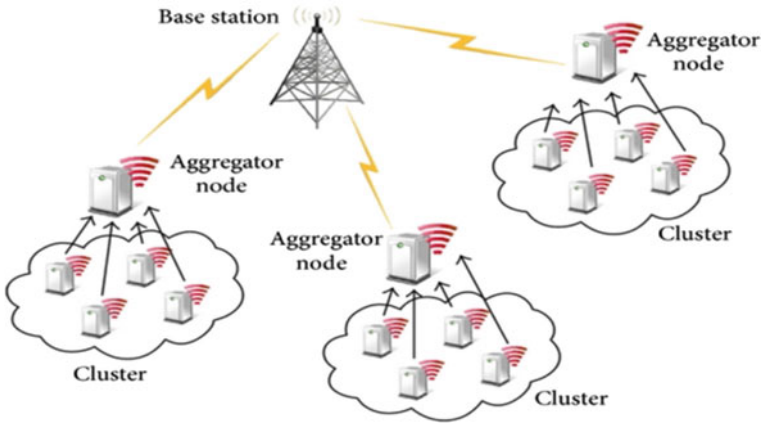

Fig. 3 Data aggregations in sensor network

3 Taxonomy on Data Aggregation

The different data aggregation methodologies are grouped as a centralized aggregation technique, tree-based aggregation technique, cluster-based aggregation technique, and in-network aggregation technique are displayed in Fig. 4.

3.1 Centralized Aggregation Technique

In this aggregation technique, one and all nodes in a network can convey the sensed data value to the mid node, which is considered as a strong node given power and bandwidth, etc., it is also called aggregator node. The purpose of the mid node is to aggregate the sensed data from various nodes in the network and then convey

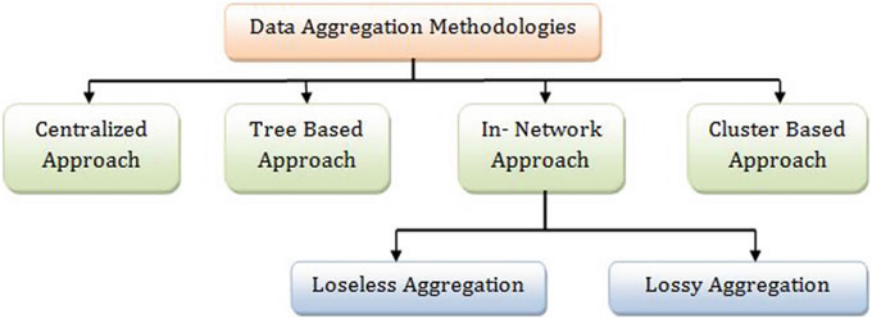

Fig. 4 Organization of data aggregation

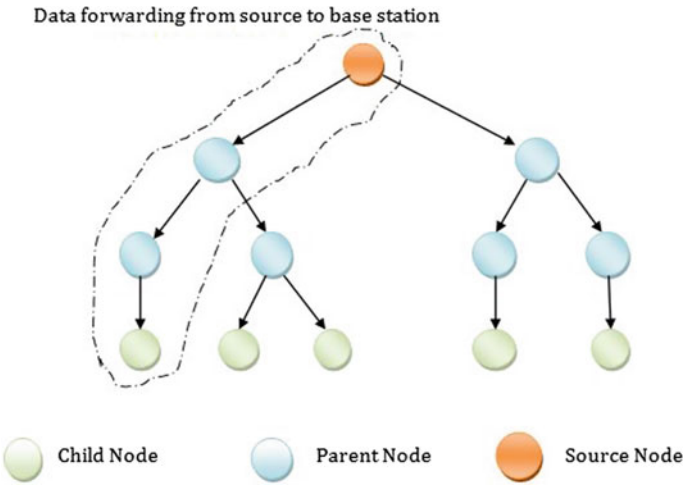

Fig. 5 Structured tree technique

the information to the base station. This aggregation technique affects heavy traffic because of the huge number of data being transmitted [2].

3.2 Tree-Based Aggregation Technique

In this aggregation technique, an aggregation tree is constructed at first with a minimum spanning tree. Here, root nodes act as a base station, terminal nodes act as a source node, and central nodes acts as parent nodes [2, 3, 9, 10]. Here, the leaf node transfers their observed data packets to their parent's node in a route found in the middle of the terminal node and base station is displayed in Fig. 5.

This aggregation technique has undergone some difficulties. In case, a packet loss occurring at any line of the tree will lose the entire data from the subtree, for the reason this approach needs a response mechanism to direct the aggregated data. Hence, the greedy incremental tree was recommended. It is formed by direct diffusion which initiates an effective path and grasping a new source to the initiated path. On noticing the first event, the data are directed using the shortest path for all new events [5].

3.3 Cluster-Based Aggregation Technique

In this aggregation technique [2, 3, 5, 9, 10], the network is subdivided into several clusters. Within a cluster, a cluster head is selected, the process is to aggregate the data packet. Any other nodes in the network sense the data and transfer to the cluster

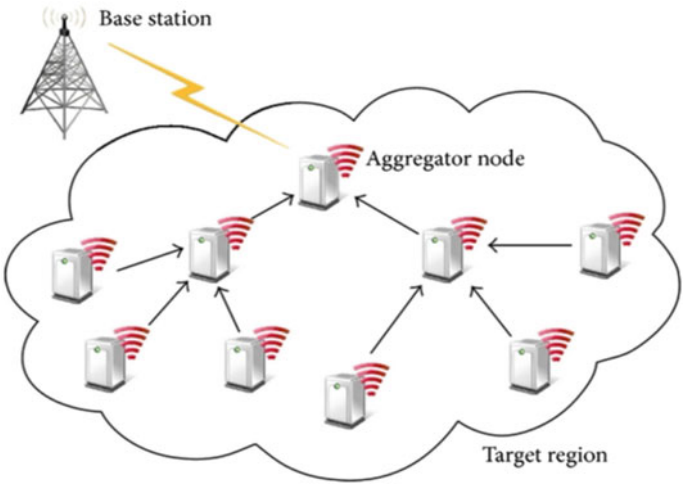

Fig. 6 Cluster-based approach for data aggregation

head of the identical cluster in behalf of forwarding directly to the mid-station as shown in Fig. 6. This technique associates data fusion close to the specific nodes, and it can decrease the size of the data packet transferred to the sink. Hence, it saves the energy of the system [11].

3.4 In-network Aggregation Technique

In this aggregation technique, sensed input values are aggregated at mid nodes to decrease the energy depletion. It also improves the network lifetime by decreasing the power depletion at each node [2]. Types of the proposal for in-network aggregations are:

(i) ***Lossy aggregation***: Data are sensed and collected from different nodes in the network and then a few aggregate tasks are involved on the sensed data such as SUM (), MIN (), MAX (), and AVG (). The range of the data packet is reduced. Individual purposive value is transferred to the base station instead of sending the whole packet of every node.

(ii) ***Lossless aggregation***: Lossy aggregation is necessary as it replies sensibly to the base station. Here, each packet is combined with a single packet without compression. For instance, in a jungle fire alarm, the lowest or highest thermal readings are needed promptly.

4 In-network Aggregation

In-network data aggregation permits the gradual processing of partial accumulation along with the separate way as for the routing tree to the root, thus the node is accountable to accumulate the entire outcomes of the aggregation. Such a thing decreases the amount of data packets to swapping in the middle of the adjacent nodes and therefore the energy depletion on the network is minimum and prolonging the duration of the node in the sensor network[12].

Usually, data aggregation is utilized to conserve power and energy efficiency. It is the action of arranging the various input values into one. WSNs may have redundant data because of more than one sensor; it can observe the same information when they are close together. Thus, the data aggregation eliminates unnecessary data in both transmission and reception.

In other cases, the number of communications can be reduced by aggregate queries. The queries are computed, based on the received data from every node in the network (e.g., if a query is asking for temperature in a particular region, then each sensor value should be averaged by aggregate function to the base station). Hence, there is no need for the base station to receive all the sensed values. Instead, the average value can be calculated within the network while the packets are transmitting via the base station. Aggregation is done by the intermediate nodes and then it routes to the base station; it is mention as in-network data aggregation.

In-network aggregation explores the circulation processing of data packets inside the network. It can be observed as a difficult process, because of this distributed network. Consequently, it needs cooperation between the nodes for excellent performance. The advantages of in-network aggregations are.

1. The number of packets that must be sent through the networks is decreased.
2. The likelihood of packet collisions is reduced.
3. The amount of redundancy received at the host nodes is decreased.
4. An improvement in the accuracy of results.

4.1 Routing Protocols

A routing protocol is an important factor to be considered for in-network aggregation. When compared to classic routing, data aggregation requires various forwarding mechanisms [8, 13]. In a classic routing protocol, the data are forwarded on the short route to the destination. These data are accumulating to reduce the energy depletion level while the nodes should direct the packets based on the fulfillment and then it may select the next hop for in-network aggregation [3]. This way of data redirect is called data-centric routing.

5 Types of In-network Processing

In-network processing helps to minimize the size of data to be broadcast and helps to maintain the energy of the network. The techniques included for in-network processing are sensor fusion, sensor compression, sensor filtering, and sensor elimination [14].

5.1 Sensor Fusion

Sensor fusion is a widespread technique which specific the aggregation of data as a partial action and its priority of information in place of data with the use of the approach such as signal processing, statistical analysis, machine learning, and probability. Sensor fusion processes all the sensed input values inside the network intending to get additional error-free data. To rise the value of the data collection, contributing the bandwidth, and expanding the network duration, sensor fusion is used [15]. Data fusion takes multiple sensed data and resulting sensed information is often outlined and consequently, the data are turned down.

5.2 Sensor Compression

Squeezing is one of the most essential techniques to minimize data size. The power consumed will be more in executing the compression technique due to enormous data. Generally, the scheme of sensor compression includes the compression of the entire data packets from the sensor node before they are ready to transmit in the network and then the sink node will decompress the data packet while receiving it in the network [15].

This will end up with some energy depletion when compared to transferring the original data. Identifying the ratio of energy that makes use of both compression and transmission is the main issue. Usually, squeezing is the technique that generates the data close to the original data. The discrete cosine transform used in JPEG and MPEG is mathematically determined and it is problematic that energy-constrained sensors can operate it.

5.3 Sensor Filtering

Data filtering is mentioned as the elimination of incorrect values or unknown values or noisy values. Data filtering is the part of data fusion that has been used to eliminate redundancy and noise. The goal of this approach is to duplicate the sensor value by

using methods such as Gaussian distribution and Bayesian-based approximation to handle the imprecision. It qualifies the future evaluation, elimination of prolongations and finally, it reduces the numerous broadcasts.

5.4 Sensor Elimination

The way to eliminate the packets is to perform temporal aggregation or to decrease the data sampling rate of the sensor nodes. In temporal aggregation, a node caches the reading and compares it with the next sensing data. If there is not a major difference between the readings, it might not make sense to send it again. In this way, the data from the sensor can be reduced.

6 Algorithms of In-network Aggregation

In-network aggregation plays a major role in collecting, accumulating, and aggregating applicable data in WSNs. There are different in-network data aggregation classification techniques available which are shown in Fig. 7 and Tables 1 and 2 give out the comparison of those algorithms found on their common factor.

(A) ***DRINA*—**Data routing for in-network aggregation research is proposed by the subsequent authors. Thirumoorthy et al. [5, 13, 16–18] proposed an algorithm that reduces energy consumption and saves network lifetime by constructing

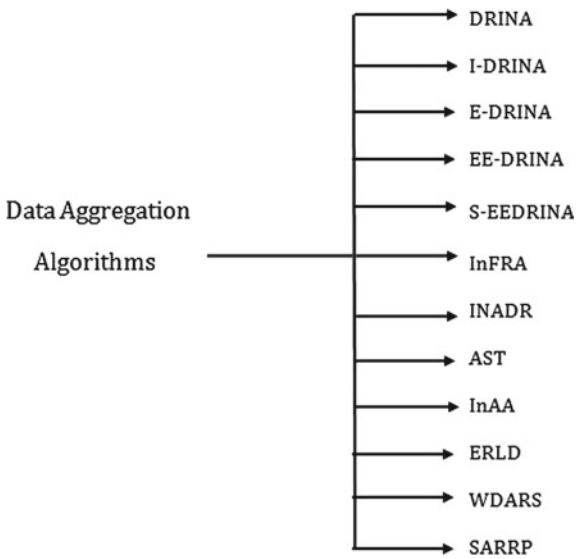

Fig. 7 Various data aggregation algorithms

Table 1 Summary of fundamental features of in-network aggregation

Parameters/algorithm	DRINA	IDRINA	EDRINA	EEDRINA	SEEDRINA	InAA
Aggregation method	Cluster	Cluster	Cluster	Cluster	Cluster	Tree and graph
Energy consumption	Low	Medium	High	Medium	Medium	Low
Aggregation rate	–	Moderate	Min	Moderate	Moderate	Max
Network lifetime	High	Low	Low	Low	Low	High
Checking of alive nodes	No	No	No	No	Yes	No
Energy-saving mechanism	–	–	Periodic and timing strategy	Route redirection	–	–
Scalability	Medium	Medium	No	No	No	No
Query based	No	No	No	No	No	Yes
Route overlap	Max	Max	No	Max	No	No
Delivery rate	High	High	High	Moderate	Moderate	Low
Throughput	High	Moderate	High	Moderate	Moderate	Low
Security	Yes	No	No	No	Yes	No
Communication cost	Low	Low	Low	Low	Low	Low
Route repair mechanism	Yes	No	No	No	No	No

the routing tree and increases the number of overlay routes and eliminates the redundancy data and thus it reduces the communication cost. DRINA will invariably increase data integration by the fault-tolerant method. It has four phases:

1. Hop tree construction
2. Cluster formation
3. Updating of hop trees
4. Route repair mechanism.

In the first phase, the hop tree is made by sending of hop configuration message (HCM) with initial value 1 from source to neighbor nodes. Each node verifies this value with the stored hop to tree value and updates it with the condition (i.e., stored value > received value) else it discards the message. In the second phase, aggregation points are selected. In the third phase, a new link is fixed by the coordinator with an establishment message to its next-hop node, and being updating node is reached. In the fourth phase, an acknowledgment ACK-based route repair mechanisms occur. When the node fails to get an ACK message, immediately it can select the new node, and thus the qualified link is formed.

Table 2 Comparison of detailed parameters on in-network aggregation

Parameters/algorithm	InFRA	AST	INADR	SARRP	ERLD	WDARS ara>
Aggregation method	Cluster	Tree	Cluster	Cluster	Cluster	Cluster
Energy consumption	Low	Low	Low	Medium	Medium	Low
Aggregation rate	Max	Max	Max	Moderate	Moderate	Max
Network lifetime	High	High	High	Low	Low	High
Checking of alive nodes	No	Yes	No	No	No	Yes
Energy-saving mechanism	Periodic scheme	–	–	–	–	–
Scalability	No	No	No	No	No	No
Query based	No	No	No	No	No	No
Route overlap	Max	No	Max	No	No	Max
Delivery rate	Moderate	Moderate	High	Moderate	Moderate	High
Throughput	Moderate	Moderate	Low	High	Low	High
Security	No	No	No	Yes	No	No
Communication cost	Low	Low	Low	Moderate	Low	Low
Route repair mechanism	No	No	Yes	No	No	No

(B) ***IDRINA***—Ameya et al. [19] presented improved data routing for in-network aggregation (IDRINA), which is focused on in-network aggregation and data management in WSNs. This technique is a hybrid method of routing efficiency and energy efficiency and allows for trade-off communication complexity.

(C) ***EDRINA***—Mankirat Kaur et al. [9, 20–22] proposed enhanced data routing for in-network aggregation (EDRINA) is a cluster-based network. The primary goal of the algorithm is to increase network fulfillment and also recover the link failure problem. This algorithm makes use of the timing strategy for data aggregation and aggregates all the incoming packets into one packet as a result of aggregation.

In this algorithm, an intermediate node is attached outward on the clusters. The node in the cluster has an add-on battery backup when compared to the remaining nodes, subsequently the cluster node query about the battery backup of the pre-established link. The cluster head is adopted by the node which contains the highest priority of battery backup. At this moment, the adopted cluster head will take part in the connection and recover the link failure problem in the network.

This algorithm has three phases:

1. Setup phase
2. Initialization phase
3. Steady-state phase.

In the first phase, the task is initiated and performed by the sink. In the second phase, the cluster heads (CH) are selected from k nodes based on the probability of the node being CH. In the third phase, aggregated data are sent to the sink/base station by alive nodes within the network through CH.

(D) ***EEDRINA***—Shinde et al. [23] presented the energy-efficient data routing for in-network aggregation (EEDRINA) algorithm supported on route redirection. The route will increasingly meet to an alternate node disjoint the path with this following local redirection operation. Consider three successive nodes A, B, and C on the trail on the P-S connection. Node D is a neighbor node of all three nodes. Consequently transmitted data packets by three nodes can easily hear by node D. Node D can hear identical packets three times. By identifying this case, node D realizes that it can replace node B, therefore the subpath A-B-C are often redirected to A-D-C. Node D will do that process as long as the power level is quite that of B.

(E) ***SEEDRINA***—Sujatha et al. [24] proposed secure energy-efficient data routing for in-network aggregation (SEEDRINA) algorithm and offers safety for EEDRINA and has the accurate capacity to store the electricity to provide it for alive nodes. SEEDRINA has an eminent upgrade in average throughput and energy-efficient aggregation features.

(F) ***InFRA***—Nakamura et al. [25, 26] presented an information-fusion-based role assignment (InFRA) algorithm to classify the network by fixing roles to the nodes whenever the events are detected in the network. It initiates a hybrid group in which the source node is structured into clusters. The communication between the cluster and the sink node occurs only in a multihop manner. The primary goal of InFRA is to provide a logical estimation balance with tolerable service costs. The role assignment algorithms carry out the subsequent events:

1. Node detecting actions are conveyed to the collaborator and coordinator to form the cluster.
2. Routes are formed by connecting the clusters to the sink node where the relay is assigned to other nodes.
3. Service costs are decreased by information fusion.

(G) ***INADR***—Keerthishree et al. [10] proposed the in-network aggregated data routing (INADR) algorithm which is referred to improve the aggregation rate besides the relay pathway in stable through a fault-tolerant routing technique. This method has a minimum for setting up a routing tree. This algorithm aims to connect each node in the network to the sink node by creating the routing tree with the shortest path. When stably increasing the aggregation rate, the energy utilization will decrease in the network.

This method required only a minimum number of data packets from source to sink node and increases the number of overlay routes if there are excess events occur. High data aggregation is attained by stable data communication.

(H) ***AST***—Yi Zhang et al. [7] presented an adaptive spanning tree algorithm (AST), which can flexibly form and adapt an aggregation spanning tree. This algorithm has two phases:

1. Construction of a tree
2. Maintenance of the tree.

In this phase, one and all node sets a casual delay time to decide its father node via particular criteria. By this approach, it can ignore the good node which has more number of child nodes, and then it becomes congested. Asynchronously, a new node can replace any father node only by the use of the setting up a strategy. Constructions of the new tree with updating features are called AST.

WDARS—Mahdi et al. [27] proposed a weighted data aggregation routing strategy (WDARS) which focuses on increasing the overlay routes for effective data aggregation and connection rate problem in cluster-based networks synchronously. The proposed technique is analyzed for energy conservation, network lifespan, throughput, and packet delivery ratio.

The suggested protocol creates a scattered cluster and effective routing tree with the most energy saving and delay from overcrowding. When increasing the data aggregation, an event is detected, and the connection is established between all sensor nodes and the sink node.

The proposed algorithms contain three steps:

1. Hop tree establishment
2. Cluster formation and head selection
3. Route establishment by node weight.

In the first phase, a hop tree between the sensor node and sink nodes is organized. In the second phase, the formation of the cluster and cluster head selection starts when an event is sensed by the sensor node. In the third phase, events like path creation, data aggregation, and packet routing procedures occur.

ERLD—Du et al. [28] presented an efficient and real-time algorithm based on the dynamic message list (ERLD) algorithm which is formed by individual data array and dynamic list in which details of the data packets are stored.

The concept of ERDL has all cluster heads in the cluster equally react like filtering nodes. Rather than slow down the process of checking the redundancy in every transmission, a dynamic list is created and upgraded in all filtering nodes to save the record of data packets communicated by this node in certain intervals. The data packet is compared to all the records in the dynamic list when it reaches the filtering node. If the data packet is available in the list, then it will be rejected or else it will be communicated at once and the record of the list will be upgraded.

Based on the dynamic list, ERDL can be real time and conclude the message of whether imitated with the high ratio of filtering. There are three steps in ERDL:

1. Creating an initial list by setting filtering nodes
2. Transmitting messages after filtering
3. Dynamic updating list.

Firstly, a dynamic list is fixed by the filtering nodes which are employed in cluster heads. Then, the sensor receives the query packet and then the analysis is made to know the number of sensors included in this query and record the number of queries and send out all. At last, the range of the list would be logically powerful according to the list contained in the updated state.

(K) ***InAA***—Hua Yan et al. [29] proposed in-network aggregation algorithms (InAA), which can be used to discover the best aggregation node for various sensors from their fixed ancestor node in a particular multisensor query. To find the best aggregation node, it can also be used in both tree-based and graph-based structures. InAA contains three main procedures.

1. Establishing of sensor nodes in a stable form
2. Sending query packets to the sink node to the next hop
3. At the ancestor node data, packets are aggregated.

Initially, the sink node sends a stable level request packet with its level (0) to the neighbor. On receiving this, it will update its value (1) as a new level. Secondly, the sensor receives the query packet and then the analysis is made to know the number of sensors included in this query and record the number of queries and send out all. Finally, data packets get to the sink node. Concerning the query packets, if the level of the packet number is equal to the stored value, then it requires to direct the same packet. If the level of the packet number is lesser than the stored value, then it requires holding back the other data packets for aggregation.

(L) ***SARRP***—Anuradha et al. [30] presented the secure aggregated reliable routing protocol (SARRP) algorithm which is developed to combine clustering and aggregation techniques to build the best routing hierarchy with the most number of constructive lines that attach all the sensor nodes to the base station while making the best use of the available system resources in WSN. The SARRP algorithm can be divided into four modules.

1. Deployed nodes form special clusters using node energy levels and their neighborhood data.
2. Concentrates on data management and it provides exact data aggregated results for decreasing energy consumption and increasing throughput.
3. Focus on network connectivity.
4. Responsible for both setting up a reliable route among any sensor node to the base station and sink node with improved security features involving public key excess N cryptosystems.

7 Parameters for Analyzing In-network Aggregation

The effectiveness of the aggregation algorithms is assessed using the following parameters: quantity of alive nodes, throughput, energy efficiency, aggregation rate, network lifetime, scalability, security, packet delivery ratio is used in this survey are described below:

(A) ***Checking of Nodes Alive***: The capacity to sense and store the data in an exceedingly WSN depends on the group of alive nodes or there are the big qualities of nodes that could be operating well [24, 31]. At this moment, the effectiveness of the network is estimated by computing the variability of alive nodes within the network beyond a given duration. Checking of alive nodes in the aggregation process is used to define the network failure and storage occupancy per node per round [7].

(B) ***Average Throughput***: Average throughput is the ratio of variance among the large choices of data packets acquire at the destination node and the amount of value lost among the overall time required from the first data packet to the final records packet [24]. The throughput permits to regulate the perfect servicing of the device by estimating the efficient transmission during the periodic interval [32].

The purpose of throughput in data aggregation is to understand the data rates that are delivered to all the terminals in a network.

(C) ***Energy Efficiency***: Each sensor in a network consumes similar energy during the data collection but in a real situation, one and all nodes will ingest a different amount of power for data communication. Energy efficiency is defined as the percentage of the quantity of perfectly conveyed data in a network to the entire energy consumption for data to transmit. In data aggregation, energy efficiency is measured to enhance the network's lifetime.

$$\text{Energy efficiency} = \frac{\text{Quantity of successfully conveyed data}}{\text{Entire energy consumption to transmit those data}} * 100$$

(D) ***Network Lifetime***: The duration of the initial sensor node or collection of nodes in the network drain out of battery supply or the number of cycles gets disconnected due to defeat of more sensors.

(E) ***Data Aggregation Rate***: It is an action of fetching and gathering beneficial data value in a specific area. Data aggregation is a fundamental process to decrease energy consumption and to save resources. The aggregation rate is described as the percentage of the sum of aggregated data to the entire sum of sensed data. The main aim of this data aggregation rate is to denote the compressing capability of sensor nodes in the network during the aggregation process.

$$\text{Data aggregated data} = \frac{\text{Sum of aggregation data}}{\text{The entire sum of sensed data}} * 100$$

(F) ***Scalability***: Scalability is defined as the capability to hold a rising number of users in a network. A routing protocol is observed flexible concerning the network size.

(G) ***Security***: The security services in a WSN should protect the data communicated over the sensor network and save resources from attacks and misbehavior of nodes.

(H) ***Packet Delivery Ratio***: It is defined as the number of packets sent by the source node to the number of packets received by the destination node [24].

$$\text{Packet delivery ratio} = \frac{\text{Number of packets sent}}{\text{Number of packets received}} * 100$$

8 Comparison on In-network Data Aggregation Algorithms

Comparison of different in-network aggregation algorithms is a hard assignment because of the contrasting types of aggregation mechanisms and the lack of specifications. Hence, collation of the algorithm is important to realize the effectiveness of the in-network data aggregation technique which based on the fundamental characteristics of a parameter such as quantity of alive nodes, throughput, energy efficiency, aggregation rate, aggregation method, network lifetime, scalability, security, based on query approach, communication cost, energy-saving methods, packet delivery ratio, route overlap, and route repair mechanism are examined and briefly summarized in Tables 1 and 2.

As per the analysis in Tables 1 and 2, the main factors such as aggregation rate, energy consumption, and network lifetime are compared to different algorithms and the performance of the compared algorithms has been evaluated in Figs. 8 and 9.

The InAA, InFRA, AST, INDAR, WDARS algorithms recorded the highest data aggregation rate when compared to other algorithms. On the contrary, the algorithms like DRINA, InAA, InFRA, AST, INDAR, and WDARS consume less energy by in the view of energy nodes to steady the energy conservation between the nodes in the network.

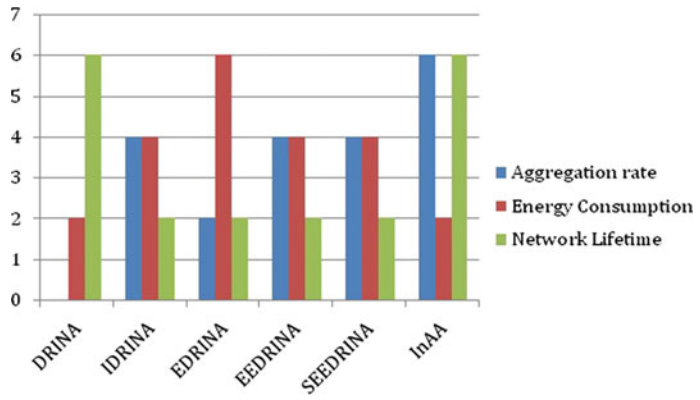

Fig. 8 Comparison of DRINA-based algorithms

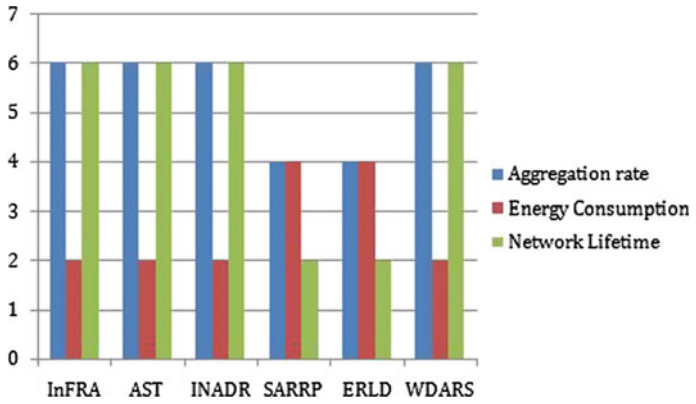

Fig. 9 Comparison of various parameters on a different algorithm

Next, on considering the network lifetime the algorithms like DRINA, InAA, InFRA, AST, INDAR, WDARS show the best result out of all the remaining algorithms.

9 Conclusion

Data aggregation is one of the predominant techniques used for reducing power conservation and enhancing network lifespan in wireless sensor networks (WSNs). The motive behind in-network aggregation is to reduce the redundant data during sensing and thereby reducing the traffic in data transmission. This review article focuses on analyzing various in-network data aggregation algorithms for their efficiency based on important parameters like energy efficiency, aggregation rate, and network lifetime. Other factors such as the number of alive nodes, throughput, energy-saving techniques, scalability, network security, route overlap, and route repair mechanisms are also taken into consideration for analysis and summarized. This article will give a deeper insight into data aggregation based on in-network processing and motivate the researchers to develop more efficient data aggregation algorithms in the future.

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Comparative Analysis of Traffic and Congestion in Software-Defined Networks

Anil Singh Parihar, Kunal Sinha, Paramvir Singh, and Sameer Cherwoo

Abstract The different methods used for classifying traffic along with the prediction of congestion and performance in software-defined networks were discussed. Although congestion prediction has foreseen many challenges, the algorithms did not give very accurate results. But over a period of time, several methods have been discovered to identify and predict the performance and congestion in software-defined networks (SDN). In this article, various techniques of classification were compared and predicted through tables and graphs.

Keywords Software-defined networks · Traffic classification · Performance prediction · Machine learning · Congestion

1 Introduction

The evolution of the Internet has made it easier for people to access anything from anywhere in the world. This has led to a new era of digitalization or Digital India. However, despite being used and accepted everywhere, traditional Internet networks (IP-based) are pretty complex and very hard to manage. With the discovery of new communication techniques like 4G upcoming 5G, it has become really important for the carrier service providers and operators to manage a high volume of load and data over their limited capacity network bandwidth since more and more users are getting added to the list and usage is increasing day by day [1].

So companies cannot afford to provide poor quality streaming services to their customers, and hence, there is a necessity at the moment to deal with the problem of over congestion of the network.

Software-defined networking is comparatively a new concept, which helps to fix the shortcomings of conventional networks which include storage needs and various environments of scalable computing. It is dynamic, financially savvy, versatile, and ideal for the high data transmission and dynamic nature of the present organization

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applications. These particular abilities make it deployable in many service network environments, from home and venture organizations to servers in cloud organizations.

1.1 Concept of SDN

The SDN architecture consists of different layers that describe the way the network devices in the data plane interact with the controller through a southbound API. The API provides an interface for interaction between the planes. For this purpose, there are many protocols available, but the OpenFlow is preferable in the project. The control plane of SDN consists of controllers like POX and OpenDaylight. The northbound API is an interface between the control and application layer (management plane). The statistics about the data plane such as the flows are gathered through REST API [2] (Fig. 1).

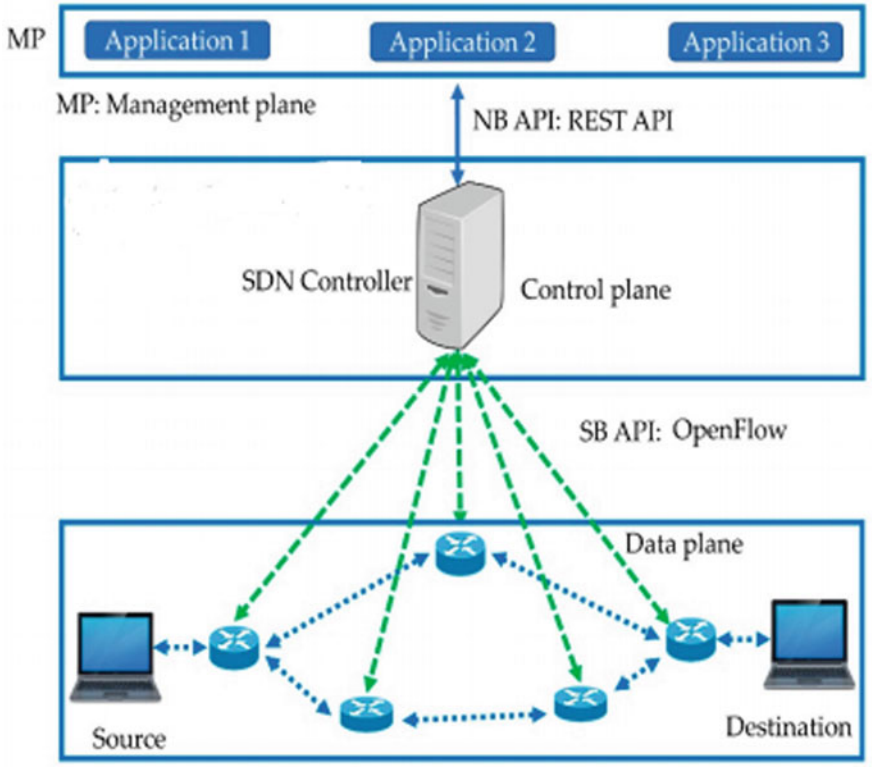

Fig. 1 Architecture of SDN

1.2 SDN Over Traditional Networks

There is an enormous recovery delay in traditional IP networks inferable from the flooding of packets, the expanded time for congestion prediction, calculation of substitute ways, and updating the routing table. Nonetheless, in SDN, the controller has global control of the network. Along these lines, it chooses ideally while scanning a proficient substitute way for the disrupted flows. Also, the controller screens the end-to-end connectivity, and accordingly, when a network is congested, the controller can reconfigure the network to restore the end-to-end availability for all paths. As opposed to conventional networks where each node floods it with packets to discover a substitute way, the SDN furnishes the arrangements with less intricacy and adaptability. The programmability and adaptability can be utilized to dynamically apply arrangements in the network through the control plane, according to the changing QoS prerequisites when the connection disconnects. Consequently, the time, cost, and workforce are decreased.

The major problems faced by the present network systems are fault issues, security issues, and congestion issues [3–5]. However, network congestion has always been an area of concern for networks since it reduces the quality of service for the users. This situation usually arises when a link between two nodes has a capacity (bandwidth) less than the data load which it is carrying. The congestion of the flow table is also a major problem. There are some approaches to solve it by compressing the table [6] when a network is congested, it hampers the QoS of a network and users face difficulties and poor quality of services when using Internet services. Software-defined networks help to reduce this problem of congestion. Congestion can be avoided by either limiting the rate or by early prediction. Thus, to predict link congestion in SDN, various machine learning techniques have been used earlier which aim to improve the accuracy and prediction rate of congestion and performance of a network [7].

2 Areas of Study

2.1 Traffic Classification

The software-defined networking mechanisms of the OpenFlow protocols provide an excellent platform to implement network control applications that are based on machine learning. One of the major studies in this area includes understanding and classifying the type of data that can be gathered. There is an increase in the volume of data flowing through networks. With an increase in the complexity of the applications which generate this data, assembling information from this generated data for interpreting and predicting its impact has become of prime importance to perform efficient network administration. There have been many types of IP classification done previously: IP-based, Port-based, ML-based, etc. SDN data has also been used for ML-based classification [8] using SDN-based traffic gives many advantages as

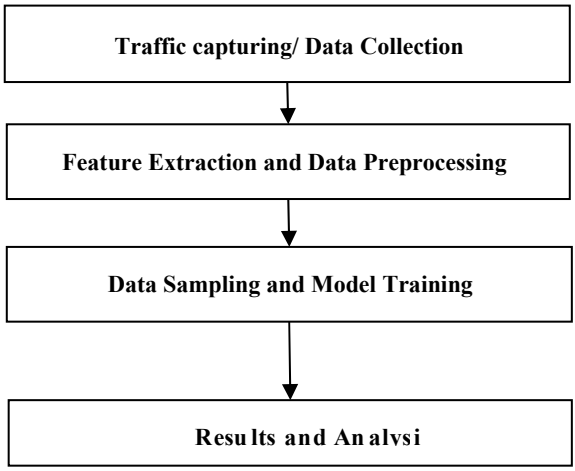

Fig. 2 Process of traffic classification

the statistics are gathered directly at the controller so it allows to directly use that information where the control plane is also present. The controllers can directly manipulate the flow rules based on the classification of data. Previous work includes a collection of various types of traffic packets from different types of applications such as BitTorrent, Dropbox, and YouTube, and various classifiers have been used like stochastic gradient boosting, random forests, and extreme gradient boosting [9] (Fig. 2).

The primary kind of data which needs to be classified is collected via simulating traffic in SDN. Then certain parameters are chosen as features. After this preprocessing is done in which we normalize our data. Later, the data is divided into subsets of training, testing, and validation. Training data is used for our model. Then the model can be applied to the controller to obtain the desired results.

2.2 Congestion Prediction

One of the major problems in networking is the congestion of a link due to the increase in demand for network resources. This leads to an increase in delay of packet transmission and rate of packet loss which in turn adversely affects quality of experience (QoE). A lot of previous work has been done in this field. Most of them are TCP-based while a few of them are UDP-based. The UDP generally has higher throughput with faster transmission time and less delay; therefore, it has a wide variety of applications. The parameters selected as eigenvalues were receiving and sending rates of a switch, bandwidth of the link, switch load, and end-to-end source-to-destination traffic rate [3] (Fig. 3).

Initially, the data that needs to be classified is collected via simulating traffic in SDN. Congestion factor (CF) is calculated based on features from our data collected.

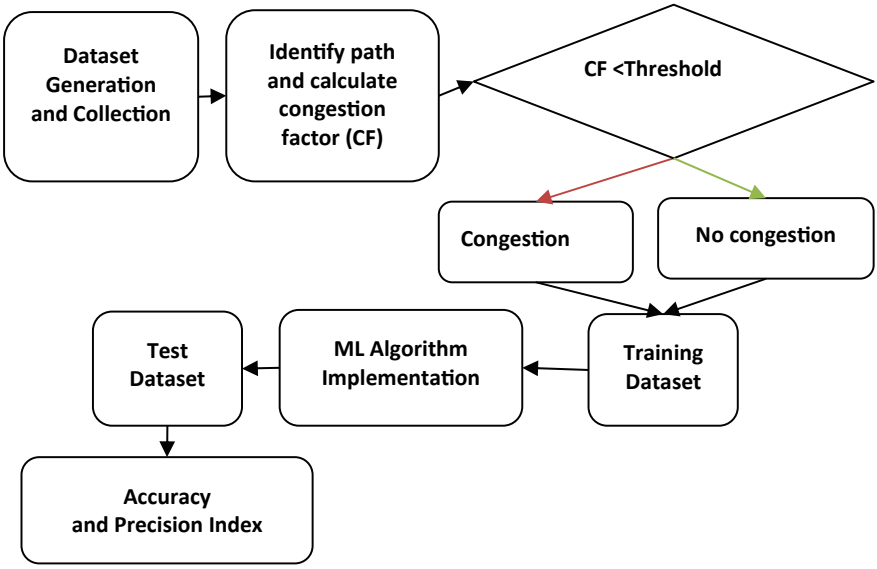

Fig. 3 Process of congestion prediction

If the CF is a greater threshold value, it is classified as congested. The same logic along with extracted features is used to train our model and apply the same to our controller to take necessary action whenever there is congestion in our network.

2.2.1 Congestion Metrics

In traditional networks, there is an uneven distribution of traffic and load. Hence, there should be some threshold value to evaluate the possibility of a link being congested. Normally, a high load on a link greatly impacts the network's stability and performance.

To measure the link bandwidth utilization, the following formula has been used

$$\mathrm{BU}_{\mathrm{Link}} = \frac{\mathrm{Bits}_{\mathrm{Sent}} + \mathrm{Bits}_{\mathrm{Recieved}}}{\mathrm{Time} * \mathrm{Bandwidth}_{\mathrm{Link}}} \tag{1}$$

Whenever the value of $\mathrm{BU}_{\mathrm{link}}$ exceeds 0.7, then the link is said to be congested (refer to Table 1). By combining it with the conventional description of the congestion-degree criteria by experts and the operators, it can be visualized that 70% is selected as the critical value of bandwidth link utilization to determine the degree of congestion of the link. When it exceeds 70%, traffic scheduling strategies and corresponding congestion control strategies must be taken up.

While studying traffic metrics and using the same for the dataset, it is essential to choose the type of data transfer that will take place and corresponding parameters that

Table 1 Standard congestion definition

Standard network link congestion level	Average utilization of link bandwidth
Severe congestion	More than 90%
General congestion	80–89%
High load	70–79%
Normal load	Less than 70%

will be collected during that transfer. For traffic classification, TCP data transmission has been used, and for traffic congestion prediction, UDP data transmission has been used in the dataset for effective analysis [10].

3 Algorithmic Analysis

3.1 Machine Learning

It forms a small but essential part of AI. It is a powerful technique of training machines so that they can improve from their experience and learn: all this, without being programmed explicitly. The machine can determine from the data accessible in its environment (or experience). This is further used to enhance the overall performance. It is further classified into two types.

- Supervised learning methods learn from the data in the past and it generalizes for future data. The data in supervised learning is a 'labelled' data. For example, let us say that a training dataset consists of *X*-*Y* pairs, (*X* being the input and *Y* being the output) where the machine learns an algorithm that evaluates an appropriate output for sample input.
- Unsupervised learning is used to draw surmisings from datasets consisting of information without labels. The most popular unaided approach for learning is analysing clusters (K means), used for identification of hidden patterns among given data points, done by grouping similar data together in a single cluster.

3.2 Neural Networks

A neural network is an aggregation of smaller units called neurons. It is inspired by the working of the human brain. It forms the base of deep learning. These networks take in data, train themselves to recognize the patterns in this data, and then predict the output for a new set of similar data. Some attributes of neural nets include self-organization, adaptive learning, and fault tolerance. They are useful in clustering, classification, and pattern recognition [11].

Table 2 Methodology for dataset collection [3, 9, 13]

Congestion prediction	Traffic classification	Performance prediction
13 switch, 12 hosts. Multiple pairs of source and destination hosts are used to transmit data. Network data is collected every second in real time with each experiment lasting 12 h. The total amount of data is 559929	Two distinct datasets were used, one consisting of an unlabelled set of traffic information, and the second dataset (smaller in size) was a labelled one and contained the applications which generated the data	5 OpenFlow switches. Each is connected to two hosts. POX controller is connected to all switches and hosts. SCP is used to send files of different sizes between two hosts. Runtime was divided into three parts with 60 min each. File size transferred was 100 MB, 50 MB, and 25 MB, respectively.

4 Methodology

4.1 SDN Simulation

In most of the studies conducted, Mininet was used to simulate the network topology and collect the data. OpenFlow switches are connected along with some hosts. Controllers like POX, OpenDaylight are also used in the topology. Data is sent among different hosts for a certain period and is collected at different intervals of time. Different types of performance metrics are collected for different areas of study. For example, flow table, RTT, and throughput are collected in performance prediction. In link congestion prediction, iperf was used to simulate UDP traffic, and five parameters were collected. In traffic classification, the controller determines the protocol by analysing the packet. For example, TCP flags are examined to determine the TCP protocol [12] (Table 2).

4.2 Application of Machine Learning

The collected dataset due to the result of the above SDN simulation then is used to train our machine learning or deep learning model. In the case of performance prediction, the dataset was split up into three parts [13]

- Training set
- Validation set
- Testing set.

After collecting and preprocessing the dataset, it was split randomly into 70%, 15%, and 15%, respectively, for the above-mentioned points. This was then used to train the artificial neural network. For link congestion prediction, four models were trained: 1DCNN, MLP, KNN, and SVM. [14] For traffic classification, accuracy for three classifiers was calculated: stochastic gradient boosting, random forests, and

extreme gradient boosting. The best accuracy model is determined and then applied to the controller to make intelligent decisions and consequently manipulating the flow tables for the switches in the topology.

5 Results and Analysis

5.1 Traffic Classification

Following were the results obtained after the implementation of the algorithms. Accuracy is determined by taking the ratio of correct predictions over the total number of predictions as described in (2).

$$\text{Accuracy} = \frac{T_{+ve} + T_{-ve}}{T_{+ve} + F_{+ve} + T_{-ve} + F_{-ve}} \tag{2}$$

where $T_{+\text{ve}}$ is true positive, $T_{\text{-ve}}$ is a true negative, $F_{+\text{ve}}$ is false positive, and $F_{-\text{ve}}$ is a false negative. The results are promising with great accuracy values for all the websites from which the traffic dataset was collected [15] (Fig. 4).

5.2 Congestion Prediction

Following were the results obtained after the implementation of all algorithms. The graph below shows the classifiers accuracy and precision scores [16].

For SVM, the obtain values by ranging the value of penalty parameter C, between 5 and 15, The used kernel functions are linear, polynomial, radial basis function, and sigmoid, which is shown in (3)–(6).

$$\text{KF}(s_i, s_j) = s_i^T s_j \tag{3}$$

$$\text{KF}(s_i, s_j) = \left(\gamma s_i^T s_j + r\right)^d, \gamma > 0 \tag{4}$$

$$\text{KF}(s_i, s_j) = e^{\left(-\gamma ||s_i - s_j||^2\right)}, \gamma > 0 \tag{5}$$

$$\text{KF}(s_i, s_j) = \tanh\left(\gamma s_i^T s_j + r\right) \tag{6}$$

For MLP, the input data is a 1×5 feature vector. There are two hidden layers, whose units vary from 30 to 70 for performance comparison [14].

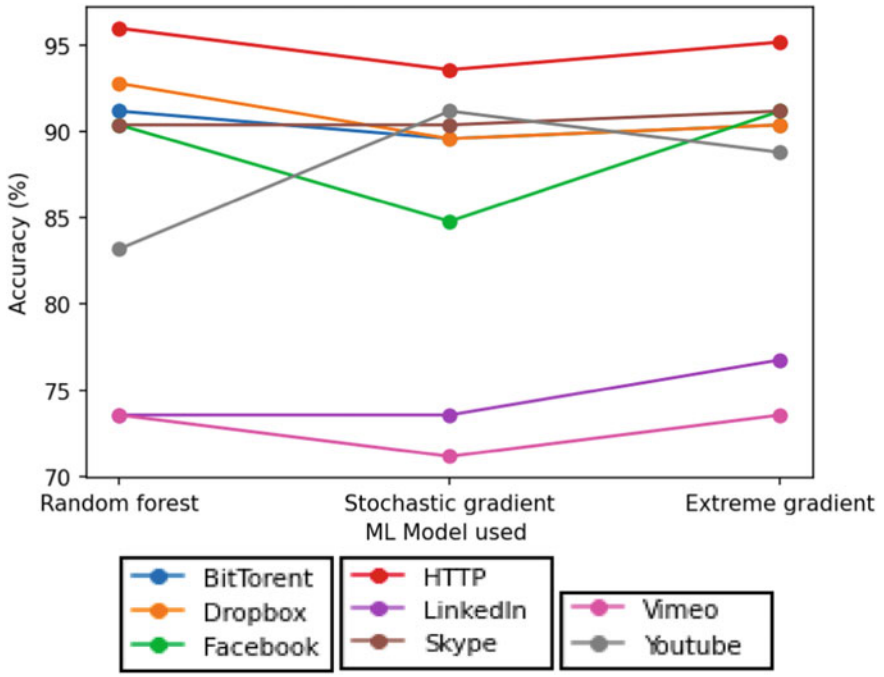

Fig. 4 Comparison of classifier accuracy for the three models

In KNN, Euclidean distance has been used to find the distance between pairs of data points. The parameter k is varied from 5 to 15 for analysis.

Parameters for CNN include batch size = 200, learning rate = 0.05, epochs = 40, input size = 1 × 5 array. Several convolution layers can be around 5, convolution filters vary from 20 to 36, and each convolution layer is followed by a pooling layer and set the down sampling factor to 2. At last, a fully connected layer was produced.

Precision is the fraction of the number of positive class predictions that actually belong to the positive class which is shown in (7).

$$\text{Precision} = \frac{T_{+ve}}{T_{+ve} + F_{+ve}} \tag{7}$$

where $T_{+\text{ve}}$ is true positive and $F_{+\text{ve}}$ is false positive (Fig. 5; Table 3).

6 Conclusion and Future Scope

This article compares the different methods used for the classification of SDN traffic using machine learning. It also describes a variety of machine learning and deep

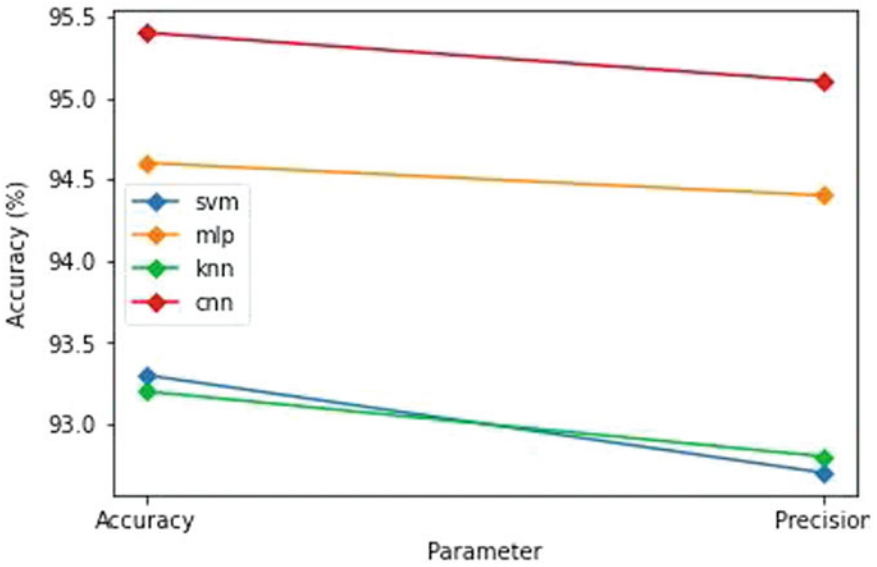

Fig. 5 Comparison of accuracy and precision for different models

Table 3 Comparison of algorithms

ML model	Accuracy	Precision
SVM—Support vector machine	0.933	0.927
KNN—K-nearest neighbours	0.932	0.928
MLP—Multi-layer perceptron	0.946	0.944
1DCNN—Convolutional neural networks	0.954	0.951

learning-based techniques used for predicting link congestion in software-defined networks. In classification, XGBoost was found to show the best classifier accuracy. In congestion prediction, it was seen one-dimensional convolutional neural networks showed the best accuracy from the four used algorithms.

In future, a larger and denser dataset with a greater variety of parameters was utilized. For future works, our aim is to use a larger and denser dataset with a greater variety of parameters. We aim to use a larger topology network (more than 15 nodes) for SDN simulation. Our major focus would be the usage of deep learning, more specifically the usage of recurrent neural networks for prediction purposes. The aim is to apply the model to the controller and predict the congestion rate along with the best path that it should follow so that the controller can redirect the traffic through the least congested path.

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A Comparative Analysis on Sensor-Based Human Activity Recognition Using Various Deep Learning Techniques

V. Indumathi and S. Prabakeran

Abstract To forecast conditions of action or actions during physical activity, the issue of classifying body gestures and reactions is referred to as human activity recognition (HAR). As the main technique to determine the range of motion, speed, velocity, and magnetic field orientation during these physical exercises, inertial measurement units (IMUs) prevail. Inertial sensors on the body can be used to produce signals tracking body motion and vital signs that can develop models efficiently and identify physical activity correctly. Extreme gradient boosting, multilayer perceptron, convolutional neural network, and long short-term memory network methods are contrasted in this paper to distinguish human behaviors on the HEALTH datasets. The efficiency of machine learning models is often compared to studies that better fit the multisensory fusion analysis paradigm. The experimental findings of this article on the MHEALTH dataset are strongly promising and reliably outperform current baseline models, comprising of 12 physical activities obtained from four separate inertial sensors. The best efficiency metrics were obtained by MLP and XGBoost with accuracy (92.85%, 90.97%), precision (94.66%, 92.09%), recall (91.59%, 89.99%), and F1-score (92.7%, 90.78%), respectively.

Keywords Human activity recognition · Sensors · IoT · LSTM · CNN · MLP · XGBoost

1 Introduction

Continuous growth in the health sector has led to astronomical advancements in the field of medicine. Due to this continuous growth, the quality of life has greatly increased when compared to one hundred years ago. Everything from life expectancy,

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physical health, education, safety, and freedom has vastly improved. This rise in health sector growth has led to an increase in healthcare costs. Steadily increasing medical expenses have led to dramatic cost-cutting steps employed by healthcare providers worldwide in tracking patients with chronic disease, monitoring the aged, along with many other cases. New technologies in healthcare will certainly lead to lowering the cost of health care by ensuring that physicians, surgeons, and other medical workers work and perform their everyday tasks in the vicinity of the hospital more effectively.

Choosing the right sensor to match the working environment or application is critical when faced with a human activity recognition challenge. With advanced sensors created each year, the number of different types of sensors to choose from is infinite. Continuous research in the area of behavior identification has driven more firms to try to reap the advantages of forecasting events to boost coordination and efficiency. The numerous types of tasks undertaken for behavior identification are discussed in this section. Body-worn inertial sensors monitor physical exercise activities like riding, jogging, standing still, and powerwalking in related jobs. When these tasks are completed, they generate a specific type of range of body motion, with calculated accelerations that are relatively identical when done by people with different characteristics.

Recognition of human behavior used with powerful technology will theoretically benefit from remote patient control, elderly people, chronic condition patients, and living with environmental assistance. Simple activities such as cycling, running, and jogging have been successfully recognized and classified to date. Complex activities are proving increasingly difficult to monitor, with continuous active research conducted in this area of HAR. The main goal of HAR is to predict common activities in real-life surroundings. Researchers are exploring pattern recognition and human–computer relationships due to their applicability in the real world, such as a human activity recognition healthcare framework. Successfully classifying human activities through wearable sensors generates endless individual information, which provides insight into the individuals' functional ability, lifestyle, and health. In this research, the MHEALTH dataset is analyzed using a variety of deep learning models. These models aim to classify activities performed by volunteers based on data gathered from on-body inertial sensors. The exploratory analysis distinguishes the differences and similarities between these deep learning models throughout this research.

The overall aim is to identify which algorithm best suits the data while discovering which algorithm best classifies each body movement of each person based on vital signs recordings. Two data clustering algorithms analysis identifies relationships between feature attributes and pleasantly visualize the data. Using wearable sensors, human activity recognition (HAR) involves recognizing the physical movements of a subject by analyzing data produced from on-body wearable sensors. Accelerometers, gyroscopes, and magnetometers are these inertial sensors, while the movements are known as everyday living activities (ADL). As described in [1], ADL involves self and body and emphasizes mobility specifically. Due to the applicability of sensor fusion, sensor-based HAR dominates the current study, which requires the incorporation of sensor data from multiple sensors, which drives analytical results in terms of

reliability, accuracy, and completeness. Deep learning methods continue to continuously advance and strengthen the HAR area in this regard. With its in-depth expertise and analytical capacity, XGBoost leads the way in taking data-oriented classification tasks and selecting and processing invaluable features from the data effectively. There are four deep learning (DL) models, which are applied to the HAR problem in this article. Using on-body sensor signal data created from four different sensors, several models were developed, trained, and analyzed for the results to identify which model best fits the data in terms of precision, accuracy, recall, F-score, and the total number of misclassified instances.

This article demonstrates its ability to perform parallel optimization and tree pruning while restricting overfitting and constantly learning sparse features, XGBoost is the highest performing model. Section 2 provides a summary of the work on the recognition of human behavior. The remainder of this paper is structured the following. Section 3 offers a description of the MHEALTH dataset, the design, and the research methodology. Section 4 addresses experiment performance. Finally, in Sect. 5, the conclusion and the future scope of the research work were presented.

2 Related Work

Recognition of human behavior using wearable or mobile sensors supports a variety of applications such as health care, exercise, smart home, etc. For example, medical teams may track elderly people's health conditions based on information about their activity. Daily energy expenditure was estimated and provided with good advice according to the level of operation of the users. [2]. The growth of smartphones and the increase of access to technologies like the availability of high-speed internet and network infrastructure have significantly changed the lives of people. Today, several smartphones contain a range of powerful sensors, including orientation, location, network, and direction sensors. Specifically, motion or inertial sensors (e.g., accelerometers) were commonly used to detect the physical movements of the users. [2]. The sensor is a device that senses and obtains the changes that occurred in the environment and redirects the collected information to the operating system. Smartphone sensors are categorized into three major groups called motion, environmental, and position sensors. Motion sensors use axis-based sensing approach to finding the measurement. Environmental parameters are measured by environmental sensors, for example, temperature, humidity, and light. Position sensors are used for measuring the distance of the reference position. Widely used smartphone sensors are,[3]

1. Accelerometer: It detects variations in smartphone orientation concerning the *x*, *y*, and *z*-axis.
2. Ambient light sensor: It senses the light density of the environment. Auto-brightness adjustment in the mobile phone is the best example of this type of sensor.

3. Barometer sensor: Atmospheric pressure is sensed by the barometer, this sensor assists the GPS to track the location in an efficient manner.
4. Gyroscope sensor: It finds the axis-based motion along with angular rotation so the clean data can be obtained.

Human activity recognition can be achieved through a video-based or sensor-based approach. Video-based HAR investigates videos or photographs that include human movements, while sensor-based HAR focuses on movement data from smart sensors such as an accelerometer gyroscope, Bluetooth, sound sensors, etc. HAR approaches are generalized into a certain type of body-worn sensor, object sensor, ambient sensor, and hybrid sensor. Physical activities that are performed by users can be detected by using body-worn or ambient sensors embedded in smartphones. The physical activities of the users are directly related to the movement and resting of the human body. The body-worn sensors, such as the accelerometer, magnetometer, and gyroscope, are the sensors that users may wear. The environmental changes can be identified by ambient sensors. There are few such ambient temperature sensors, radars, motion sensors, and sound sensors [4]. Human activities are categorized into seven groups such as ambulation, transportation, daily activities, exercise, kitchen activities, transitional activities, and self-care activities. Based on the category, activities are shown below [5]

(a) Ambulation: Sitting, standing, running, lying, falling
(b) Transportation: Driving a car, riding a bicycle.
(c) Daily activities: Watching TV, drinking, eating, using a phone, using a computer, reading the book, listening to music, sleeping.
(d) Transitional activities: Walking upstairs and downstairs, lying down and getting up, sitting down and getting up.
(e) Self-care activities: Combing hair, shaving, brushing teeth, washing hands, washing face, washing clothes, drying hair.
(f) Kitchen activities: Adding tea-bag, add sugar, add milk, removing tea-bag, pour milk, making coffee and tea, cooking pasta, cooking rice, feed fish.

Wesllen et al. stated the essential steps required to recognize the human activity: Data collection, segmentation, feature extraction, and activity classification.

1. Data collection: Extraction of raw data from different sensors embedded in a smartphone. The data must be adequate to produce good models for classification activities. To ensure the correctness of the activity model, some parameters must be considered like sampling frequency, the position of the smartphone, and orientation from the user, and data collection time [6]. But Foerster et al. [7] stated that the technique pursued to collect the raw data from the user is very difficult for any human activities. The accuracy level of ambulation activities for controlled data collection is 95.6% but the accuracy level is dropped to 66% for the natural environment. The proper analysis would recognize a significant number of users with different characteristics. This will give a better result for the new user without obtaining extra training data.

2. Segmentation: The raw data or inertial sensor signals are not recommended to take a decision in the classification process. The raw data, therefore, requires other transformations, such as breaking the continuous raw sensor data into the windows over a certain period. Noise removal from the signal is another important role of segmentation. Inertial sensor signal might have a noise which leads to misclassification; obviously, it affects the model accuracy. Using signal processing techniques like low-pass, high-pass, and Kalman filters, the noisy data can be removed easily [6].
3. Features: Settings defined in the segmentation stage played a vital role to extract the sensor features. The extraction algorithm takes the input from time windows. The selection of good features is a very important factor to classify the labels correctly. For any classification model, the accuracy can be directly affected because of low-quality features. Wesllen et al. described a new principal domain. It is divided into three groups such as time, frequency, and discrete domain. Time-domain uses mathematical approach statistical data are extracted from the signals. Repetitive patterns are captured through frequency domain. The discrete domain makes the signal pattern by converting sensor signals into symbols.

Thus, although the main domain permits for the chaining of features, it is very important to remember that all of them are orientation-dependent features when the time features are handled alone, and when these features are chained with the magnitude or vertical–horizontal components, they all become orientation-independent features. Some of the time domain features are min, max, amplitude, amplitude peak, sum, absolute sum, Euclidian norm, mean, absolute mean, mean square, mean, cross-validation, auto-correlation, skewness, kurtosis. Example of frequency domain: Energy, energy normalized, power, centroid, entropy, domain component [6].

Bashar discussed the deep neural networks, and the model accuracy is expelled even human performance. This survey on the deep learning neural network architectures utilized in various applications for having an accurate classification with an automated feature extraction especially in CNN [8]. Prabhakaran et al. describe the various clustering framework for predicting kidney disease [9]. Indumathi et al. explain the utilization of various machine learning models [10]. This project details a deep learning comparative study of the:

(a) Convolutional neural network model.
(b) Long short-term memory (recurrent neural network) model.
(c) Extreme gradient boosting (XGBoost) model.
(d) Multilayer perceptron.

2.1 Convolutional Neural Networks in HAR:

Jiang and Yin [11] compare multiple deep convolutional neural network (DCNN) architectures using accelerometer and gyroscope data in classifying activities. Jiang et al. [11] perform analysis on the UCI MHEALTH dataset (UCI) [12], USC-SIPI

human activity dataset (USC) [13], and a dataset compiled by the fusion of smartphone motion sensors (SHO) [14]. Jiang et al. [11] compared performances to identify the architecture, which achieved the highest accuracy, recall, and precision along with the low computational cost. Jiang et al. [11] found that SHO achieved the highest accuracy, followed by USC, while UCI performing slightly lower. Hammerla, Halloran, and Plotz [15] compare multiple convolutional and recurrent approaches when using wearable sensors in classifying activities. Hammerla et al. [15] perform analysis on three datasets: The opportunity dataset, Pamap2 dataset, and Daphneit Gair (DG) dataset. Hammerla et al. [15] conduct thousands of experiments to identify the substantial effect of altering hyperparameters. Performance evaluation indicated that the approaches achieved the highest accuracy on DG, the lowest root mean squared error, and the highest F1-score, followed by Opportunity, while performance scores on Pamap2 were slightly lower. Kim and Moon [16] compare the use of deep convolutional neural networks (DCNNs) for activity recognition in classifying activities. Kim et al. [16] also compare DCNNs for human detection. A Doppler radar gathers data, which produces velocity data when placed on a human or near a human. Kim et al. [16] found that the DCNN achieved accuracy as high as 97.6% for human detection. They also found that human activity classification accuracy reached heights of up to 90.9%.

2.2 Long Short-Term Memory (LSTM) in HAR

LSTMs are intended on tackling the vanishing gradient problem. The main difference between LSTMs and RNNs is LSTM's use of memory cells. Memory cells allow for the sufficient storage and sequential processing of data. Time is not restricted and the data does not disappear back into the network. It enables the development of relationships in the data, leading to insightful knowledge regarding the output to be analyzed. Gating is at the core of LSTMs. Gating regarding LSTMs involves component-wise multiplication of the input as seen in related work [17]. This leads to consistent updates in each data cell, due to the gating calculation that applies to each cell. The data must encounter the write, read, and reset gates to process data correctly. The write gate is the input gate. The read gate is the output gate while the reset gate is the forget gate. LSTMs contain information in a gated cell, which is the key idea of these networks. LSTMs can add or delete information to the cell through the gates. These gates are composed of a sigmoid neural network layer and a point-wise multiplicative operator.

2.3 Extreme Gradient Boosting in HAR

Ayumi investigates if extreme gradient boosting is superior in classifying activities in the HAR domain over classical techniques such as support vector machine (SVM) and

Naïve Bayes (NB). The UT Kinect-Action3D Dataset, the Badminton Sports Action Dataset, and the Bali Dance Motion Dataset conduct analysis. XGBoost takes more computational time to run as opposed to the other two methods but prevails as the best method with higher accuracy, precision, recall, and F1-score. Zhang et al. [18] propose an XGBoost method to recognize activities on their own dataset, which they created themselves. The dataset consists of 40 volunteers performing multiple activities contained in an indoor facility. XGBoost outperforms other ensemble classifiers with a higher recognition rate in accuracy, F1-score, and precision. F-score reached heights of up to 84.41% while accuracy surpassed previous studies achieving a rate of 84.19%. Nguyen, Fernandez, Nguyen, and Bagheri [19] explained, the XGBoost model uses wrist-worn accelerometer data to identify events, RGB-camera data, and environmental sensor data. In contrast to previous research, this unique method produced an elevated performance of 38% precision. A Brier Score of 0.1346 was also obtained, which indicates that it predicts the right behavior 90% of the time.

2.4 Multilayer Perceptron in HAR

Mo et al. [20] stated that the classification of activities based on the CAD-60 Dataset compares convolutionary neural networks and multilayer perceptron efficiency. The CAD-60 Dataset [21] provides RGB-D video sequences of events undertaken by volunteers. Sensor signals are recorded by the Microsoft Kinect sensor. In order to produce highly precise performance results, this research focuses on data preprocessing along with feature extraction. By using CNN for feature extraction and using MLP for the classification of the operation, the model presented incorporates CNN and MLP. It proved highly successful with the model achieving 81.8% accuracy across twelve different types of activities. Catal, Tufekci, Pirmit, and Kocabag [22] compare the performance of a model integrating aspects of decision tree, multilayer perceptron, and logistic regression. Accelerometer data is analyzed to classify activities. Related work [23] performs analysis on the Wireless Sensor Data Mining (WISDM Dataset) which contains information from 36 volunteers performing activities as seen in related work [23]. The proposed model achieved state-of-the-art results while achieving a superior performance when compared to a multilayer perceptron approach in related work. Results prove that integrating an ensemble of a classifier yields outstanding results in the activity recognition domain.

Talukdar and Mehta [8] built a multilayer perceptron network to classify physical human activities through the automated analysis of video data. The volunteer performed six activities 25 different times wearing a variation of different clothes each time. The activities performed were; walking, jogging, running, boxing, hand waving, and hand clapping. Talukdar et al. [8] present an MLP network that trains the data through a recurrent neural network that led to a vast reduction in learning time for the features and labels. The model achieved an overall accuracy of 92%. A comparison of the classification efficiency of XGBoost, MLP, CNN, and LSTM is one feature that is absent from the previously mentioned linked work on the machine

and deep learning models. To determine which network best fits the MHEALTH and WISDM dataset, our goal of this article is to conduct an investigation and compare these six different machine and deep learning algorithms with each other. This project revolves around the topic of using deep learning to benefit the healthcare industry.

Remote patient management (RPM) is one feature that could benefit from deep learning. Sufficient real-time surveillance of the actions of distant individuals will provide tremendous benefits in medical settings. Through reviewing, data sent to them by RPM technology, physicians, nurses, and clinicians may establish good relationships with and strengthen the experience of their patients. The data sent to them via RPM, as seen in [2], will establish a customized care plan and participate in shared decision making to encourage better results. Wearable devices can feed data to a clinician in real time by producing this data, leading to a substantial reduction in continuous patient surveillance. This device may be useful for the elderly, those who are vulnerable to heart problems (or severe medical conditions) and those who suffer from chronic illness. According to [4], the most frequent cause of readmission for patients in the USA is chronic heart failure (CHF). It is calculated that up to 84% of readmissions were considered preventable over a seven-day duration, while 76% of readmissions over a 30-day period were still considered preventable [4].

3 Proposed System

See Fig. 1.

3.1 Convolutional Neural Network

In a neural network, neurons learn from each other as they are fully connected. Neurons in convolutional neural networks connect to a fraction of the neurons that are in the previous layer. This layer is the receptive field as seen in related work [24]. Neurons in convolutional neural networks have three dimensions. These dimensions are width, height, and depth.

3.1.1 Architecture

CNNs have a unique architecture. It contains many sequential layers such as the convolutional layer, pooling layer, rectified linear unit layer, normalization layer, and fully connected layer.

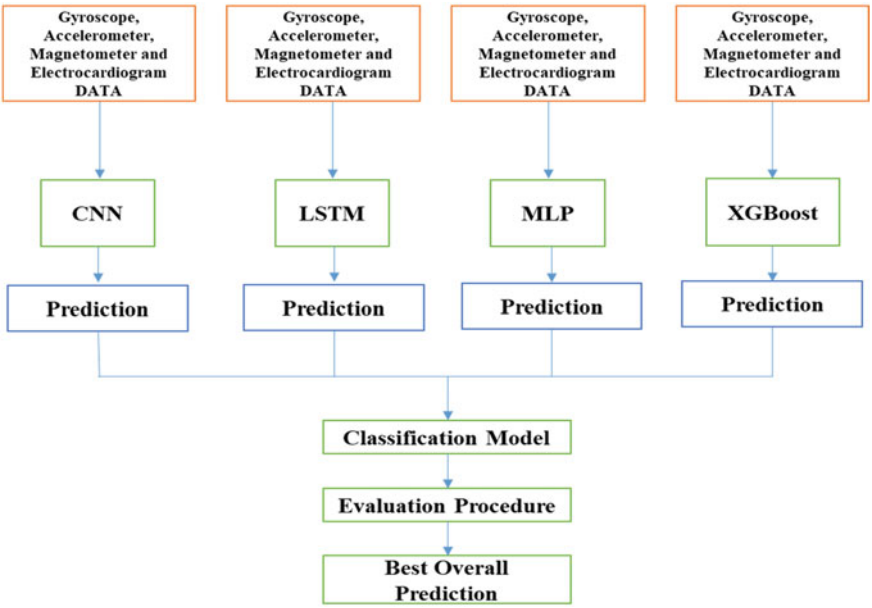

Fig. 1 Data flow diagram for the proposed model

3.1.2 Convolutional Layer

The convolutional layer is the focal point of a CNN. The convolutional layer's main objective is to extract high-level features about the data.

3.1.3 MaxPooling Layer

Pooling layers allow for the reduction in a number of parameters in the neural network. It reduces the number of descriptive parameters used to explain the structure of the neural network. It essentially avoids overfitting as it reduces the spatial size of the network. Training a neural network takes a great amount of time. Pooling ensures the number of computations needed to train the network is minimized. It ensures the classification task runs smoothly.

3.1.4 ReLU Layer

Relations in data are often nonlinear. The ReLU layer ensures there is an increase in nonlinearity. It applies the following element-wise non-saturating activation function to ensure that a neural network can build the nonlinear relation between data points. If there were no ReLU layer, a neural network would not be able to classify nonlinear

data points. When compared to tanh and sigmoid, the ReLU layer prevails in terms of speed, accuracy, and precision. The width, height, and depth of the neural network, also known as the spatial size, are left unchanged.

3.1.5 Dropout

Overfitting is a common problem neural networks face when training data. The dropout regularization technique successfully prevents overfitting. Fully connected layers in a neural network have many variations. Dropout identifies the nodes in a specific layer and removes them. A definitive probability, p, is then applied to the layer. The training process removes nodes linked with the removed layer. As seen in [25], after training, these nodes are placed back into the neural network and assigned their original value (weight). This, in turn, boosts the performance of the neural network. The validation training set benefits the most from this during the deployment of the model.

3.1.6 Optimizer: Adam

Adam is a gradient-based optimizer. It is straightforward, simple to implement, and is computationally inexpensive. It is suited to solving classification problems related to human activity recognition. The data involved in HAR is normally relatively large, leading to Adam to be a perfect fit. The hyperparameters require little or no tuning, which is why Adam is the most common optimizer in convolutional neural networks.

3.1.7 Softmax Activation Function

The softmax activation function is usually set in the output layer and loss layer. This is usually the final layer in the neural network before the output layer presents the result. The following equation is a detailed representation of the softmax activation function. The layers described above make up the full architecture of a convolutional neural network. The equation below incorporates all the layers and functions mentioned above to represent the typical architecture of a CNN (Fig. 2).

Feature extraction, encoding the labels to one-hot type along with separating the training and testing data, is done before the model is initialized.

CNN activity recognition overview:

(a) One input layer containing 23 features.
(b) Two separable convolution 1D layers with max pooling.
(c) Three hidden layers that were big enough to train the data well.
(d) Two dropout layers that yielded positive results.
(e) Quite good performance, moderately slow.
(f) One output layer of 12 results (labels).

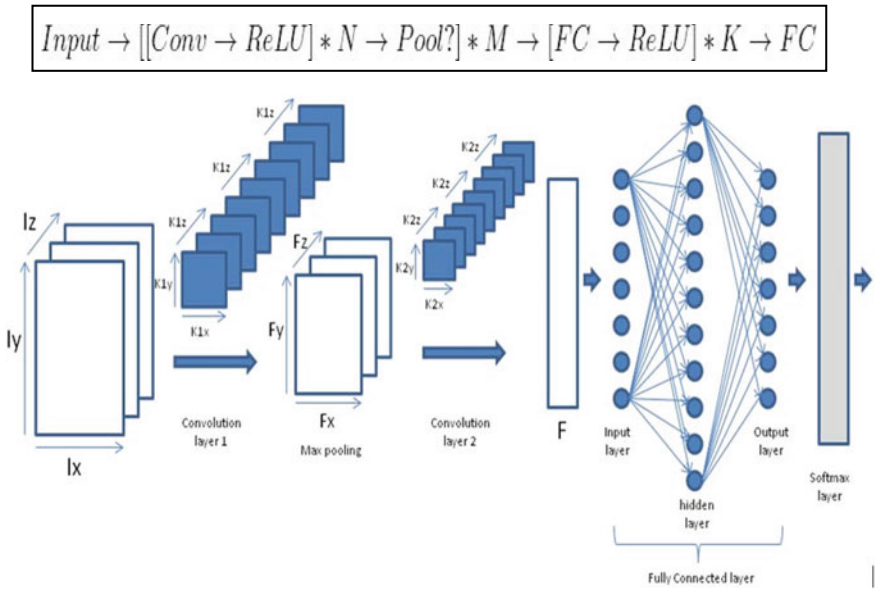

Fig. 2 Typical architecture of a CNN [26]

To classify (predict) the class variable, which is the motion that each subject executes, the neural network found in the CNN model utilizes the data values given for each of the 23 signals reported. This section gives an overview of training the model and hyperparameter setting.

(a) In the training process, the 'fit()' function is used to train the CNN model.
(b) 'X_train' represents the training data.
(c) 'y_train' refers to the target data.
(d) 'X_test, y_test' represent the validation data.
(e) The model is trained on a total of 245,584 parameters.
(f) While training the model:
(g) The Learning rate is set as 0.0005.
(h) Batch size is set as 32.
(i) The training process is run for 20 epochs.

3.1.8 Algorithm Speed

CNN performed excellently on this classification problem. It processed the data relatively fast. Taking into account the speed of the other deep learning algorithms and considering the performance is achieved, the time the model took to train the data was 242 min 18 s.

3.2 Long Short-Term Memory

LSTM activity recognition overview:

(a) One input layer containing 23 features.
(b) Two LSTM layers.
(c) Two dropout layers.
(d) Three hidden layers and one output layer.
(e) One output layer of 12 results (labels).

This section gives an overview of training the model and hyperparameter setting.

(a) In the training process, the 'fit()' function is used to train the CNN model.
(b) 'X_train' represents the training data.
(c) 'y_train' refers to the target data.
(d) 'X_test, y_test' represent the validation data.
(e) The model is trained on 175,373 parameters. While training the model:
(f) The Learning rate is set as 0.0005.
(g) Batch size is set as 32.
(h) Training process is run for 20 epochs.

3.2.1 Algorithm Speed

LSTM performed very poorly on the classification problem. It processed the data very slowly. Upon evaluating all six algorithms, LSTM is the poorest performing algorithm and processes data ten times slower than the other algorithms. The total amount of time the model took to process the data was 10 h. At first, the LSTM model was set to run for 20 epochs. The hard drive used to conduct each experiment was not strong enough to process data for such a significant amount of time. Considering the level of performance and speed of processing, CNN was the poorest algorithm applied to the MHEALTH dataset.

3.3 Extreme Gradient Boosting

Gradient boosting machines are associated with a distinctive type of machine learning branch called ensemble learning. The objective of ensemble learning is to train and predict a variety of models at the same time, while each model aims to outperform each others with respect to their output. Consider for example, the route from Paris to Berlin. There are many alternative travel options. As you proceed to take each route, you begin to learn which route is faster and more efficient, leading to the 'superior' route. Taking time to learn, each model has led to the conclusion that X is the superior route. Ensemble learning simply implies this strategy.

XGBoost implements the boosting. Boosting aims to convert weak learners to strong learners. During boosting, iterations lead to the weights of weak learners to

adjust accordingly. Bias reduces allowing for an increase in performance. Accuracy, precision, and recall benefit from the implementation of boosting greatly, as well as a range of evaluation techniques. Extreme gradient boosting (XGBoost) is the best performing boosting algorithm. XGBoost is a decision-tree-based algorithm that utilizes the use of gradient boosting and ensemble learning. XGBoost performs so well on data due to its ability to transform weak learners into strong learners. It utilizes boosting within the gradient descent architecture. It allows the framework to develop dramatically with its quick and easy to learn optimization techniques and parameter enhancements.

Feature extraction and splitting of the training and testing data are performed before the model is initialized. XGBoost activity recognition overview:

(a) Multiclass classification using the softmax activation function.
(b) Evaluation: multiclass classification error rate.
(c) Learning rate is set to 0.05.
(d) Trained on 161,959 parameters.

The parameters regarding the XGBoost model are discussed.

(a) The model is trained using the parameter list and the training data.
(b) The model is trained for 10 rounds.
(c) Early stopping.
(d) The learning rate of the model is 0.05 while the number of estimators is set to 1000.
(e) Early stopping is used in the validation set to identify the appropriate amount of boosting rounds. This is usually the optimal number of boosting rounds needed. It is set to stop within 5 rounds. It will train until 'validation_0-merror' has not improved in 5 rounds.
(f) The XGBoost model will train until the 'validation_0-merror' has not improved anymore. The 'validation_0-merror' must continue to decrease in order for the 'early_stopping_rounds' to continue to train the XGBoost model.

3.3.1 Algorithm Speed

XGBoost performed very well on this classification problem. It processed the data relatively fast. Taking into account the speed of the other deep learning algorithms and considering the performance it achieved, XGBoost was the second-best performing algorithm.

3.4 Multilayer Perceptron

Feature extraction, encoding the labels to one-hot form along with splitting the training and testing data, is performed before the model is initialized. MLP activity recognition overview:

(a) One input layer containing 23 features.
(b) Four hidden layers that were big enough to train the data well.
(c) Two dropout layers that benefited the results greatly. The top-class algorithm is based on the concept of gradient descent.
(d) One output layer of 12 results (labels).

This section gives an overview of training the model and hyperparameter setting.

(a) In the training process, the 'fit()' function is used to train the CNN model.
(b) 'X_train' represents the training data.
(c) 'y_train' refers to the target data.
(d) 'X_test, y_test' represent the validation data.
(e) The model is trained on 706,317 parameters. While training the model:
(f) The learning rate is set as 0.0005.
(g) Batch size is set as 32.
(h) Training process is run for 20 epochs.

3.4.1 Algorithm Speed

MLP performed excellently on this classification problem. It processed the data relatively fast. Taking into account the speed of the other deep learning algorithms and considering the performance it achieved, the time the model took to train the data was 86 min 40 s.

3.5 MHEALTH Dataset

The MHEALTH dataset consists of body motion and vital signs recordings. Ten volunteers conducted the experiment, each with different characteristics. The subjects' task is to perform 12 different types of activities. The accelerometer, gyroscope, and magnetometer placed on the subjects' body measure acceleration, rate of turn, and magnetic field orientation. These sensors measure the range of motion experienced by each body part. The electrocardiogram sensor positioned on the chest also provides 2-lead ECG measurements. ECG can assist in the basic heart monitoring, checking for various arrhythmias, or looking at the effects of exercise on the ECG.

4 Result and Performance Analysis

Accuracy, precision, recall, F1-score of each DL architecture. Figure 1 outlines the accuracy of the MLP, XGBoost, and CNN machine learning models on the

MHEALTH dataset. The figures are extracted from the model's related confusion matrix. MLP attains the highest values, followed by MLP, then CNN (Table 1).

The four classification models presented in this research perform well when compared to existing state-of-the-art baselines. MLP and XGBoost achieve excellent performance measures, challenging many research papers with improved accuracy, precision, recall, and F1-score. The XGBoost model is the best performing model in terms of overall performance and is highly suited to mobile health data.

Figure 3 outlines the accuracy of the MLP, XGBoost, and CNN machine learning models on the MHEALTH dataset. The figures are extracted from the model's related confusion matrix. MLP attains the highest values, followed by MLP, then CNN (Table 2).

Figure 4 examines the performance of each deep learning model on the classification task, the figures are taken from each approaches confusion matrix output. MLP performs the best in comparison to the other models. The CNN and LSTM models achieved an average performance of 66.2% and 48.9%, respectively. The hybrid and

Table 1 Performance metrics evaluation

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-score
MLP	90.55	91.66	90.55	90.7
CNN	83.91	83.47	83.91	82.98
LSTM	78.09	74.86	78.09	75.6
XGB	89.97	90.09	89.97	89.78

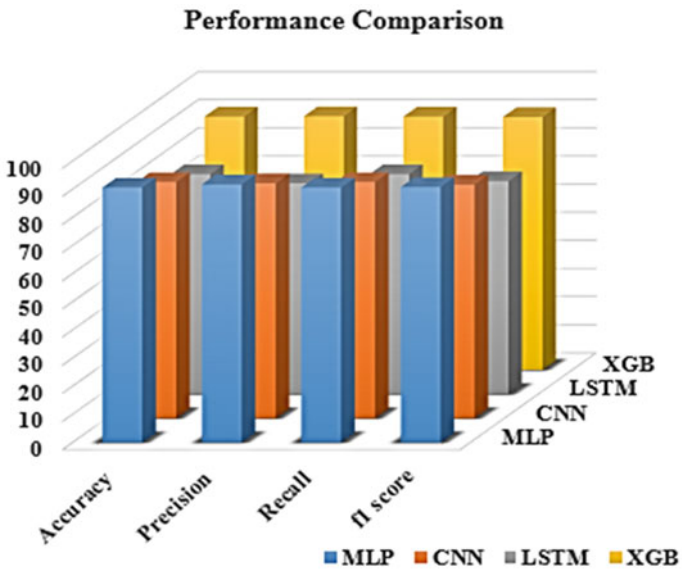

Fig. 3 Performance comparison

Table 2 Performance metrics evaluation

Activity	CNN	LSTM	XGBoost	MLP
Standing still	95	63	94	97
Sitting and relaxing	100	97	96	99
Lying down	100	100	98	100
Walking	45	0	77	96
Climbing stairs	38	0	48	92
Waist bends forward	81	53	76	96
Frontal elevation of arms	86	70	84	96
Knees bending	68	38	67	93
Cycling	33	42	92	97
Jogging	75	47	89	98
Running	61	68	92	91
Jump front and back	12	9	62	67
Average	66.2	48.9	81.25	93.5

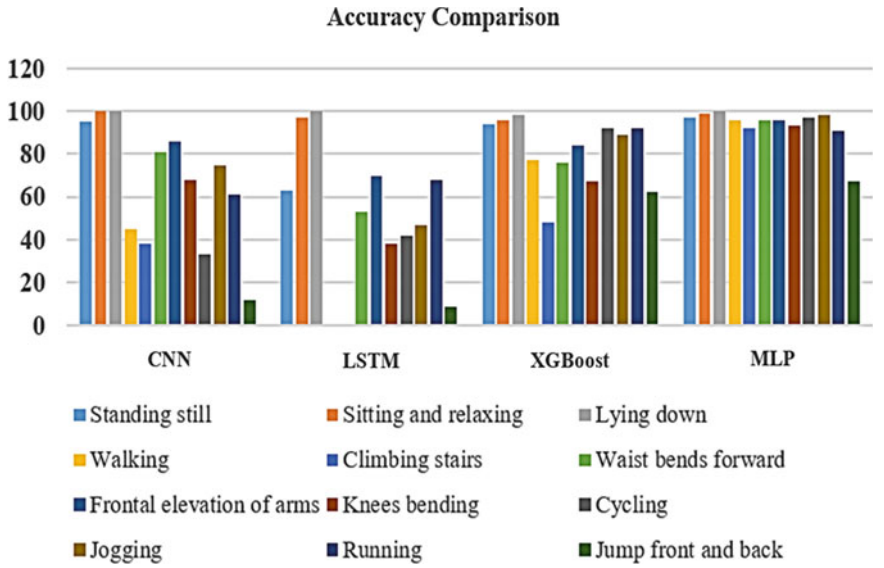

Fig. 4 Accuracy comparison

XGBoost models achieved an average performance of 70.6% and 81.25%, respectively. For each subject, the MLP model attained the best performance obtaining an average performance of 93.5%. The figure identifies the superiority of the MLP model over others by showing a significantly higher performance.

4.1 Accuracy and Loss Results

Fine-tuning each model is to classify the data accurately, which is significant to maximizing accuracy while minimizing loss. MLP, XGBoost, CNN, and LSTM are fine-tuned with hyperparameters, respectively. The loss and accuracy of each model are visualized throughout this section. After fine-tuning each model and using a total of 20 epochs, MLP prevailed as the network with the highest accuracy (91%) and minimal loss. The average accuracy for each model is relatively high. MLP and XGBoost performed better and more consistently than CNN, LSTM. MLP and XGBoost achieved accuracies of 91% and 89%, respectively. MLP and XGBoost were able to converge far more easily as outlined in Fig. 3 which depicts the multilayer perceptron model achieving 91% accuracy.

The following two plots depict the convolutional neural network model achieving 84% accuracy. CNN performed moderately well in terms of accuracy (84%) and loss. MLP and XGBoost increased their accuracy along with diminishing their loss as the number of training iterations increased. Overall, MLP outperformed the other networks with the highest accuracy and lowest loss. The LSTM model misclassified too many instances, which lead it to become the poorest performing model with the least accuracy (78%) and highest loss.

LSTM networks performed poorly with 20 training iterations as depicted in Figs. 5. They both achieved 78% and 84% accuracy, respectively. The following two plots depict the LSTM model achieving 78% accuracy (Figs. 6 and 7).

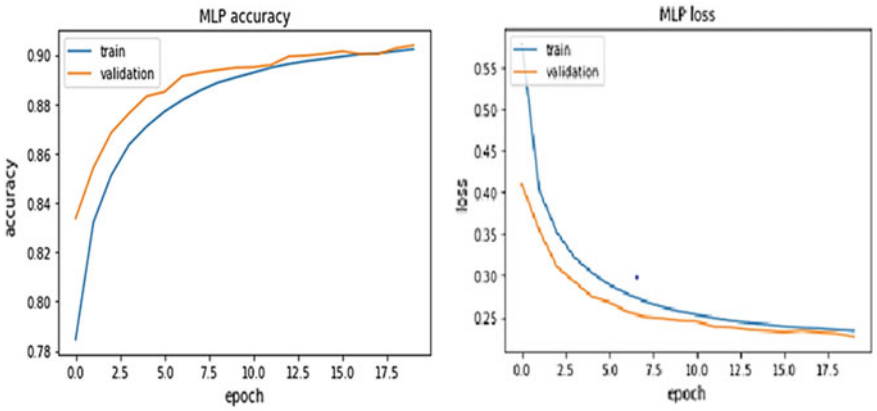

Fig. 5 MLP accuracy and loss

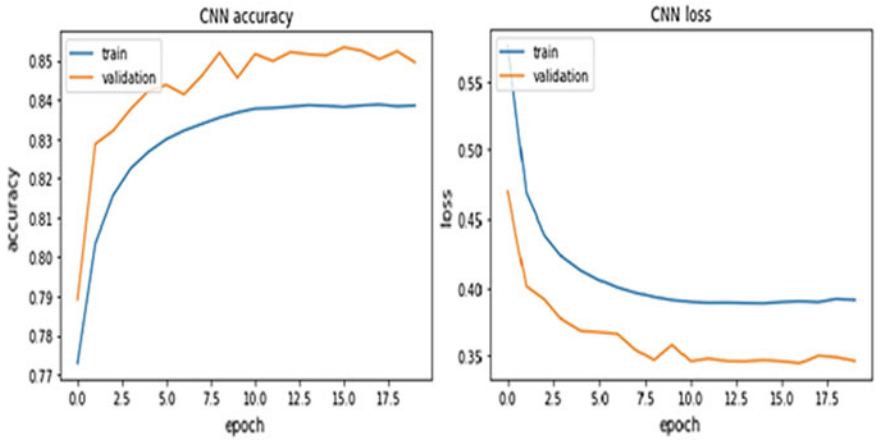

Fig. 6 CNN accuracy and loss

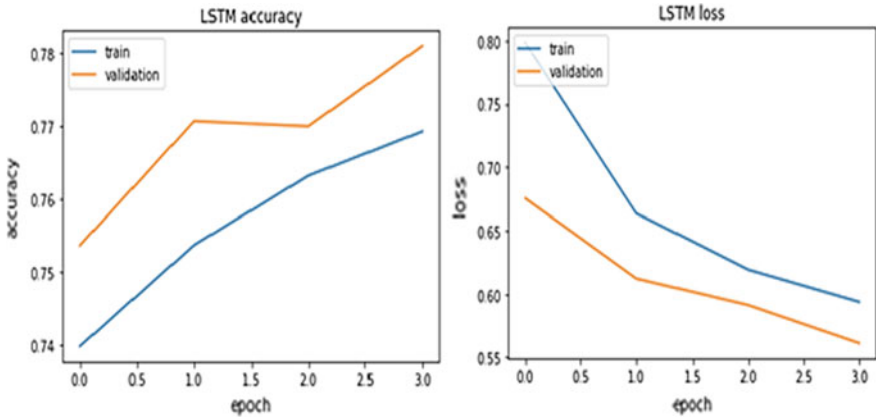

Fig. 7 LSTM accuracy and loss

5 Conclusion and Future Enhancement

Each model performs human activity recognition from wearable sensors such as gyroscopes, accelerometers, magnetometers, and electrocardiograms. To the author's knowledge, for the MHEALTH dataset, XGBoost has not been performed to classify the activities in question. MLP prevailed as the best performing model achieving accuracy, precision, recall, and F1-score of 90.53%, 91.71%, 90.53%, and 90.76%, respectively. XGBoost was the next best performing model that achieves accuracy, precision, recall, and F1-score of 89.98%, 90.14%, 89.98%, and 89.78%, respectively. While MLP outperformed XGBoost in terms of precision, accuracy, recall, and F1-score, 471 instances were misclassified by MLP, while XGBoost misclassified just

281.1341, 2533, and 2742 instances were misclassified, respectively, by CNN, and LSTM. XGBoost is the highest performing model in terms of total precision, consistency, recall, F1-score, and number of correctly categorized instances. This outlines the established area of appropriateness for the XGBoost system, which was never documented using wearable sensors on the MHEALTH dataset. This section presents an account of future work in human activity recognition using deep learning. Some of the ways in which human activity recognition models using deep learning will benefit healthcare in remote patient monitoring: clinician decision support, ambient assisted living / aiding the elderly, drug discovery, developing regions whose healthcare services are limited, app with patient data, diagnostic abilities, reduce need for electronic health records, creating more precise analytics for diagnosis, clinical decision making, risk scoring, and early alerting. Common challenges on human activity recognition presented by this research are unmeasurable uncertainty factors, activity similarity, and the null class problem.

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FETE: Feedback-Enabled Throughput Evaluation for MIMO Emulated Over 5G Networks

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Abstract Mobile networks are playing a tremendous role in our day-to-day activities. In the currently evolving networks such as 5G, satisfying quality of service (QoS) is remaining as a challenging problem due to the dense network deployment. Moreover, multiple technologies such as LTE, Wi-Fi, and 5G contending and cooperating make the resource allocation a complex problem. This paper attempts to optimize the radio resource allocation in heterogeneous wireless networks for a particular geographical region by finding the throughput by maintaining the QoS along with a combination of network parameters. Specifically, the proposed research work uses different parameters such as RSSI, RSRP, and RSRQ for calculating the throughput of user equipment in a specified area. The feedback-enabled method (FETE) is then compared with and evaluated for the MIMO system, where it is observed that an overall throughput gain can be obtained by using right optimization technique for different parameters.

Keywords MIMO · LTE · 5G · Network evaluation · Throughput · Scheduling

1 Introduction

The tremendous growth of 5G will be due to its better performance in terms of capability, capacity, data rate, and latency when compared with other co-existent technologies such as 3G, LTE and LTE-advanced, is incomparable. The rapidly evolving 5G networks have the risk of overcrowding the frequency range of wireless spectrum as a multitude of devices that attempt to connect to a single frequency channel. Furthermore, the overly dense deployment of 5G will present complex challenges, when accompanied by the heterogeneity, scale, and diverse quality of service (QoS) requirements.

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Existing techniques of throughput optimization depend upon maximizing the usage of available network resources. However, due to lack of optimizations based on a geographical region while using MIMO leave some resources non-utilized or under-utilized specifically when paired with the user mobility. Therefore, there is a need to use better techniques which can support the increase in the overall throughput received by the user equipment (UEs) which are mobile. Several schemes are proposed in the literature for improving throughput using different parameters such as channel quality indicator (CQI), round-robin (RR) scheduling for UEs resource blocks (RBs), first in first out (FIFO) based on UE connections, and blind equal throughput (BET) to achieve fairness [1]. Despite these approaches, the QoS is always constrained due to inherently low resources available to fulfill the usage requirements specifically when targeting high throughput and low-latency applications. The resource scarcity in part is addressed using relatively newer efficient solutions that optimize the use of resources based on machine learning and other estimation techniques. Depending on the QoS, these techniques can be classified as user-based or network-based or both.

The existing techniques among other factors also lack an integrated approach or the systems view when dealing with the scarce resources. For example, the BET scheduler aims to provide equal throughput to all UEs under an eNB which in turn lacks the fairness or support to a specific application that is resource hungry. The RR scheduling or best CQI again fails to enhance the throughput of the UEs when additional inputs are required to be captured to provide a holistic view on the network.

To optimize upon the available resources and provide an optimal output for the throughput using the inputs from UEs in a particular area, a closed-loop feedback-based system is essential. In such a system, the additional inputs can be seamlessly added that play critical role in increasing the overall throughput and supporting low-latency. Supporting these views of inputting additional inputs to improve the throughput, this paper proposes a way to optimize the mobile networks for a multiplicity of parameters for the mobile UEs. Furthermore, 5G studies are incomplete without a discussion on MIMO. Therefore, the system is evaluated for the MIMO and show that additional improvements can be obtained using the same. Figure 1 shows that there is a potential of throughput improvement when considering multiple parameters along with the MIMO capabilities when a feedback-based mechanism is used. This paper proposes FETE, a feedback-enabled throughput evaluation method for the MIMO systems.

The rest of the paper is organized as follows. Section 2 summarizes the existing techniques used previously in the literature. Section 3 illustrates the experiment methodology to evaluate the throughput performance. Section 4 details the simulations carried out to calculate the throughput, with or without MIMO by injecting a number of users. The evaluation results are presented in Sect. 5. Sect. 6 concludes the paper with a view on our future work.

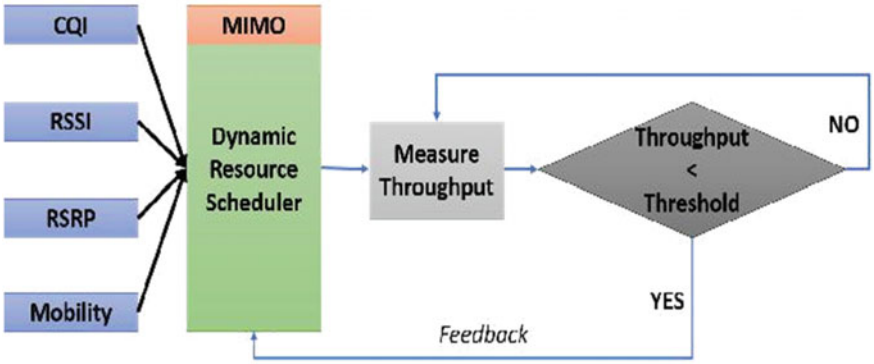

Fig. 1 Feedback-based throughput improvement in 5G

2 Background

Resource scheduling is a vast field. On the one hand, the existing work deals with the multi-parametric approaches to optimize throughput using methods such as estimation [2], prediction [3], resource allocation, machine learning, fuzzy logic [4, 5], and so on. While on the other hand, research has also focused on measurement wherein different algorithms are compared at different settings to find the best possible combination of inputs for a desired output [6, 7].

Currently, the work has evolved when MIMO has taken the precedence over the existing techniques. With the combination of multiple input and output antenna arrays, it is feasible to achieve the higher throughput than the traditional transceivers when the beams are properly aligned. Moreover, using the software-based MIMO enabled using the mm wave [8, 9], it is possible to create a fully software-defined system, thus able to control and coordinate from anywhere.

The software-based automation has provided more meaningful avenues for optimization than ever. The controllable experiments and practical systems can now run under a variety of settings that can be triggered or trimmed in short time. This flexibility encourages us to evaluate the feasibility of having a MIMO system that can be analyzed for different that can be dynamically changed to provide a real-time feedback to the system based upon user mobility and network fluctuations.

This paper evaluates the MIMO system for various parameters. The experiment considers the UE mobility and correlated with the network parameters to calculate the throughput while keeping QoS under considerations. Further,

the system is evaluated with and without MIMO using a real mobility dataset. Our work is distinguished from earlier approaches as it lies at the intersection of evaluation-based enhancement for MIMO that is a key design choice in the 5G networks.

3 Methodology

This section provides the method used in this work to calculate the throughput.

3.1 Dataset Description

In this paper, vehicular movement data collected and emulated using ETSI API for 5G using an LTE eNB at the University of Hertfordshire are used. The various scrambling codes are as follows. For uplink, it is 54 with the target SIR of 17.3. The minimum uplink channelization code length is 8. The downlink scrambling code is 1 with the channelization code of 15. The maximum downlink power is 10.1 and minimum is 9.3 dBm. On a pre-set path, the UEs move across the eNB, wherein the RSSI and throughput are collected for each time tick. The GPS coordinates are also logged for each location at the time tick. Thus, for various UEs, the real dataset is obtained along with their location with respect to time.

3.2 Exploration and Extrapolation

The dataset lacks the measurements at some of the GPS locations for some UEs. Therefore, before using, the data are cleaned by removing any anamoly, and for some points, the throughput is calculated at a given location by considering the available parameters like RSSI, RSRP, and RSRQ whichever were available.

3.3 Analytical Model

The parameters obtained from the dataset are plotted as follows.

RSRP: Reference signal received power (RSRP) is defined as the linear average over the power contributions (in [W]) of the resource elements that carry cell-specific reference signals within the considered measurement frequency bandwidth. UE measures the power of multiple resource elements used to transfer the reference signal but then takes an average of them rather than summing them. Figure 2 shows the received RSRP (in dB) for a sample mobile UE.

RSRQ: Reference signal received quality (RSRQ) is a C/I type of measurement, and it indicates the quality of the received reference signal. The RSRQ measurement provides additional information when RSRP is not sufficient to make a reliable handover or cell re-selection decision. Figure 3 shows the RSRQ (in dB) for a sample mobile UE connected with a base station at different time ticks.

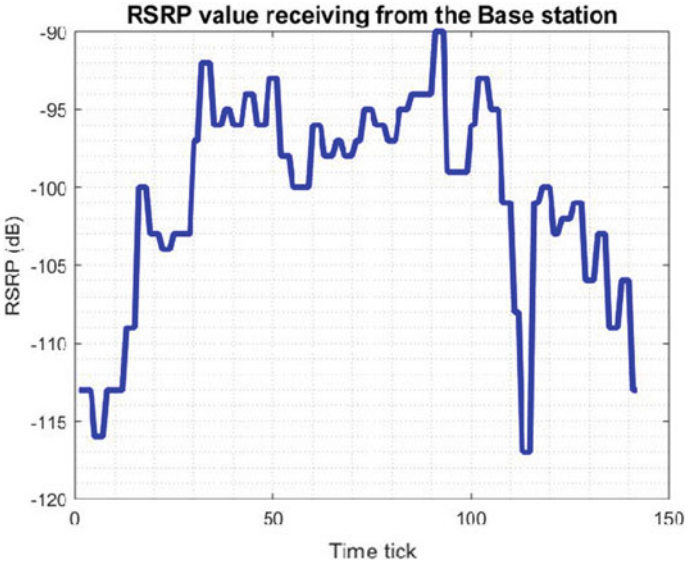

Fig. 2 RSRP values received at a UE from the base station

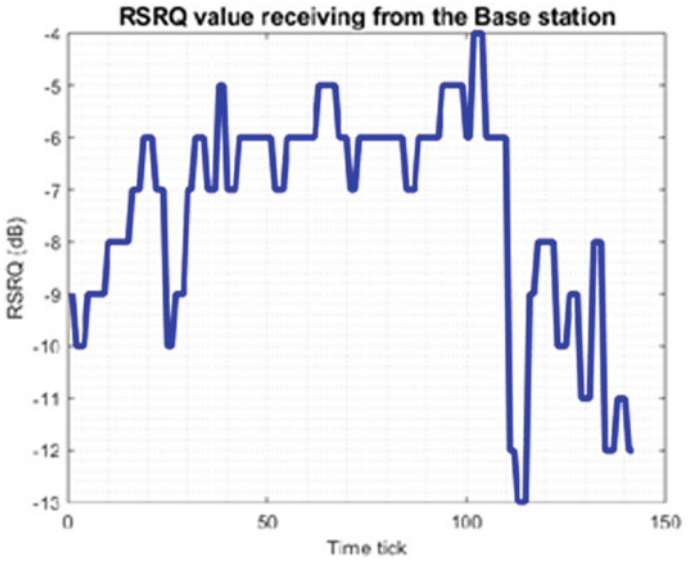

Fig. 3 RSRQ values received at a UE from the base station

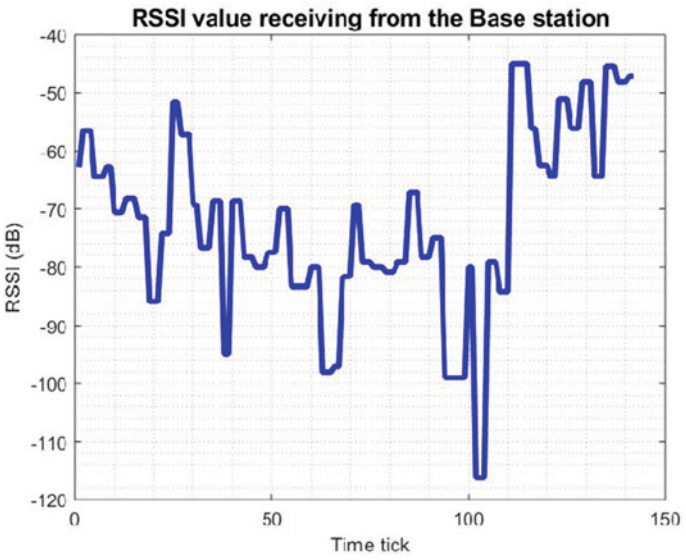

Fig. 4 RSSI values for a sample UE from the base station

RSSI: The carrier receive strength signal indicator (RSSI) measures the average total received power observed only in the OFDM symbols containing reference symbols for antenna port 0 (i.e., OFDM symbol 0 and 4 in a slot) in the measurement bandwidth over N resource blocks. The total received power of the carrier RSSI includes the power from co-channel serving and non-serving cells, adjacent channel interference, thermal noise, etc.

The total RSSI is measured over 12 subcarriers including the signals from serving cell, and the traffic in the serving cell. The relationship between RSSI, RSRP, and RSRQ is given in Eq. 1 where N are the number of resource blocks.

$$\text{RSSI} = N(\text{RSRP} = \text{RSRQ}) \tag{1}$$

Figure 4 shows the calculated RSSI values using Eq. (1)

However, the relative humidity is proportional to the RSSI: When relative humidity increases, RSSI level increases as well. The impact of temperature and relative humidity variation on the RSSI is stronger when the distance between the sender and the receiver is large.

3.4 Signal Continuity

After obtaining RSSI values at discrete locations, 50 users are injected at the random coordinates in the map area. The RSSI values of these users are correlated with

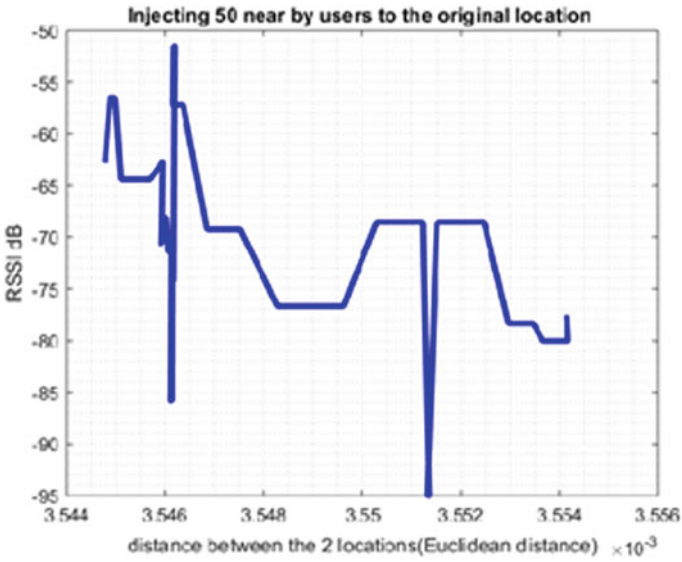

Fig. 5 Euclidean distance versus RSSI for different users

the RSSI dataset by matching them with the closest geographical location and incorporating error corrections.

It can be easily plotted with RSSI value along the *Y*-axis and Euclidean distance between original location and injected user location along the *X*-axis. Figure 5 plots the Euclidean distance between any two users in the system and their respective RSSI value. This provides us a capability of obtaining RSSI at any given location in the map.

4 Feedback-Enabled Throughput Evaluatıon

The feedback-enabled throughput evaluation (FETE) develops a mechanism through which the continuous values of throughput can be obtained in a closed MIMO system.

4.1 System Informatıon

Using the RSSI values for 50 users, the downlink data rate is calculated using transitional CQI value.

CQI: The channel quality indicator (CQI) contains information sent from a UE to the eNB/gNB to indicate a suitable downlink transmission data rate, i.e., a modulation and coding scheme (MCS) value. CQI is a 4-bit integer and is based on the observed

Table 1 Modulation scheme based on the CQI value

RSSI	CQI	Modulation scheme
Excellent	10–15	64 QAM
Good	7–9	16 QAM
Fair	1–6	QPSK
Poor	0	Out of range

Table 2 Bandwidth based on the number of resource blocks

Number of resource blocks	Channel bandwidth (MHz)
6	1.4
15	3
25	5
50	10
75	15
100	20

signal-to-interference-plus-noise ratio (SINR) at the UE. The CQI estimation process takes into account the UE capability such as the number of antennas and the type of receiver used for detection.

Using the RSSI values obtained using the RSRQ and RSRP, the CQI values are determined using Table 1. The CQI values are granulated using the RSSI values to determine if a signal is good or bad for the UE. Based on the CQI values, the modulation scheme is assigned ranging from 64-QAM, to 16-QAM and QPSK. For a low CQI value, corresponding to the poor RSSI range, the UE is considered as out of range. To calculate the modulation scheme given in Table 1, the channel bandwidth is to be considered as provided in Table 5 (Table 2).

Based on the modulation scheme, a modulation index is assigned by the eNB/gNB, and according to that index value, a respective transport block size (TBS) index value is assigned as given in Table 3.

Finally, for the throughput calculation, the allowed rate of bits in each subframe for the given TBS index and number of physical resource blocks (PRBs) is to be determined. The bits/subframe is allocated by the eNB/gNB based on the traffic conditions, UE category (priority, services, etc.), and RF conditions. The standard bits/subframe allocation as per 3GPP for different RBs and TBS index value is given in Table 3 for 50 and 100 RBs, respectively.

4.2 Throughput Calculation

Using the MCS index, TBS index, CQI value, and PRBs, the throughput is calculated as follows.

Table 3 Modulation index and TBS index

Modulation Index	Modulation	TBS index
0	QPSK	0
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10	16 QAM	9
11		10
12		11
13		12
14		13
15		14
16		15
17	64 QAM	15
18		16
19		17
20		18
21		19
22		20
23		21
24		22
25		23
26		24
27		25
28		26
29	QPSK	Reserved
30	16 QAM	Reserve d
31	64 QAM	Reserved

For example, when the RSSI value is excellent, the 64-QAM modulation can be chosen as per Table 1. For the 64-QAM, a granulated MCS index value is allocated by the eNB/gNB along with the PRBs. Consider, for example, that the MCS index is 28 in which case the respective TBS index value of 26 will be chosen as given in Table 3. For a system with 50 PRBs, for the chosen 26 TBS index value, 32,856 bits/subframe (1 ms) is allocated to the UE. In turn, a throughput of 32,856 1000 = 32,856,000 bits/sec, i.e., 32.85 Mbps can be obtained. In this particular example, for a 10 MHz bandwidth, it obtains around 32Mbps throughput, when assuming that all 50 resource PRBs are allocated to a single UE.

4.3 Improved Throughput Using MIMO

The system efficiency can be enhanced or it can increase the throughput with the help of MIMO technology.

MIMO: Multiple input multiple output (MIMO) allows multiple inputs and output antenna to be used simultaneously, thus theoretically improving the capacity manifolds. Consider that 101,101 data is transmitted through a channel with deep fades. Due to the fluctuations in the channel quality, the data stream may get lost or severely corrupted that the receiver cannot recover it. The solution to combat the rapid fluctuation is to add independent fading channels by increasing the number of transmitting or receiver antennas or both. The use of spatial diversity technique, where same information sent or receive across independent channel can help to combat fading, is particularly useful in MIMO. The diversity gain in MIMO is obtained using Eq. (2) where N_{tx} and N_{rx} are the number of transmitting and number of receiving antennas, respectively.

$$G_{\text{diversity}} = N_{tx} + N_{rx} \tag{2}$$

In an ideal condition, for $N_{\text{tx}} = 2$ and $N_{\text{rx}} = 2$, diversity gain is 4. This gain can be obtained by adding the independent fading channel that increases the reliability of the transmission link. Therefore, if this MIMO 2 * 2 technology is used for calculating the same throughput for above mentioned UE, the user will receive around 75 Mbps throughput. The evaluation of throughput with and without MIMO is presented in the next section (Tables 4 and 5).

5 Evaluatıon and Results

The simulation is carried out for calculating the throughput for, with and without MIMO technology using FETE. The entire procedure to calculate throughput is written as in the JavaScript language using the Visual Studio Code software. The node package manager (NPM) runtime environment is used to run the code. The

Table 4 Bits/subframe based on number of physical resource block table

TBS_index	$^{N}P\ RB^{50}$	$N_{P\ RB}100$
0	1384	2792
1	1800	3624
2	2216	4584
3	2856	5736
4	3624	7224
5	4392	8760
6	5160	10,296
7	6200	12,216
8	6968	14,114
9	7992	15,840
10	8760	17,568
11	9912	19,848
12	11,448	22,920
13	12,960	25,456
14	14,112	28,446
15	15,264	30,576
16	16,416	32,856
17	18,336	36,696
18	19,848	39,232
19	21,384	43,816
20	22,920	46,888
21	25,456	51,024
22	27,376	55,056
23	28,336	57,336
24	30,576	61,664
25	31,706	62,776
26	32,856	75,376

plotting is done using Highchart and localhost:8000 is used to show the simulated output in a browser.

By injecting 50 users into the map area, the throughput with and without MIMO is calculated. The simulation code is flexible and incorporates multiple parameters in real time. Figure 6 shows the simulation output for a single run for different number of users. It can be observed that the throughput is higher when using MIMO.

Table 5 presents the average throughput calculated for both, with and without MIMO cases for the first nine locations in Fig. 6. The throughput using MIMO is twice of that without the MIMO.

As the MCS index value is randomly chosen, different results are obtained for various simulation runs. Therefore, Fig. 7 shows the average over 15 simulation runs

Table 5 Average throughput calculation

Throughput without MIMO	Throughput with MIMO
31,704,000	63,408,000
28,336,000	56,672,000
25,456,000	50,912,000
21,384,000	42,768,000
30,576,000	61,152,000
15,264,000	30,528,000
16,416,000	32,832,000
27,376,000	54,752,000
21,384,000	42,768,000
Avg = 21,383,111 (21 Mbps)	Avg = 42,766,222 (42.7 Mbps)

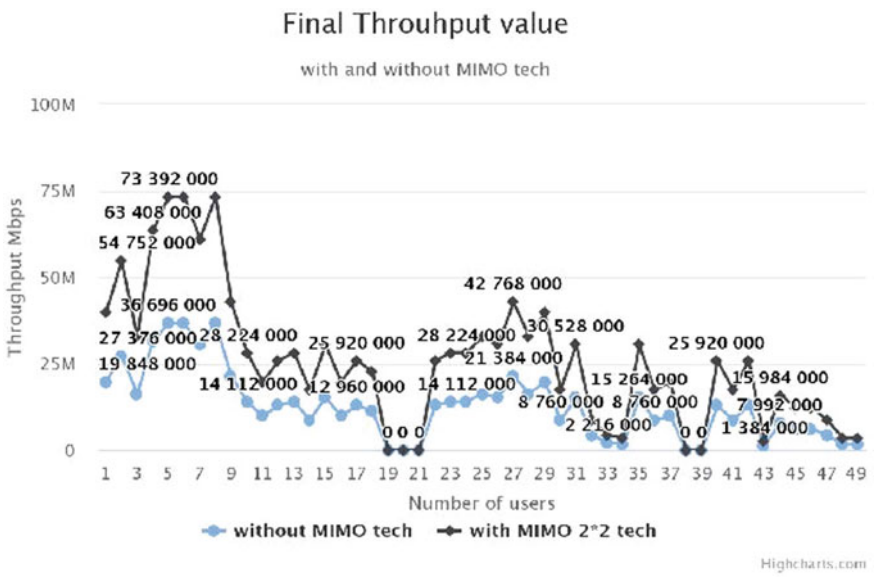

Fig. 6 Throughput for MIMO and without MIMO for different users

for the throughput with and without MIMO. As it can be observed, the overall gain of the throughput is much higher for the MIMO as compared to the one without it.

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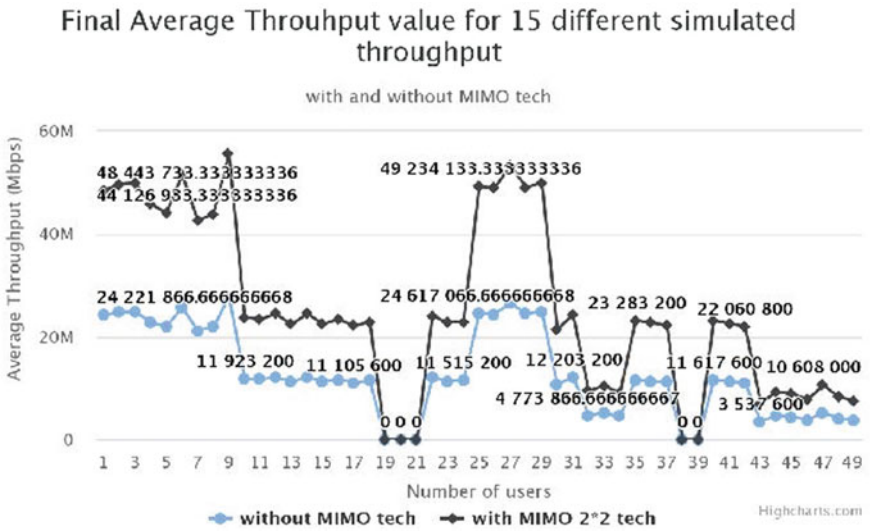

Fig. 7 Average system throughput comparison

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6 Conclusion

This paper presented a feedback-enabled throughput evaluation (FETE) method to analyze the 5G network with and without MIMO technique. Using the network-specific parameters such as the MCS index, the TBS index, the CQI values, and the PRBs, the throughput is systematically estimated for a set of mobile UEs that are obtained from a real dataset. With the help of simulation, it has been observed that the overall gain of the throughout is higher for MIMO in comparison to that of the one without MIMO.

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Automatic Vehicle Service Monitoring and Tracking System Using IoT and Machine Learning

M. S. Srikanth, T. G. Keerthan Kumar, and Vivek Sharma

Abstract Nowadays, vehicle monitoring is emerging as a very tedious job, which requires the maintenance of the record or by recalling the date again and again for the service, and one more problem is tracking the vehicle location for providing better security and safety measures during the travelling. In both cases, it requires more human effort. The proposed model uses the novel technologies like IoT, cloud computing and machine learning. IoT allows various devices to interact and collect data like distance travelled, lubricant level, tyre conditions, smoke emission, other hardware parts conditions and also global positioning system (GPS) to track vehicle location. This data will be collected from various sensors like IR (infrared), MQ 6 sensor, HC SR 04 ultrasonic sensor, light-dependent resistor (LDR) sensor and stored in the cloud storage system. The machine learning algorithm is used to train the proposed model by using the samples data which is collected from the real-time vehicle service stations for service monitoring and GPS data for vehicle tracking purpose. Then this trained model is used to predict the vehicle's condition based on that it will suggest the next date of service. This will help us to condense the quantity of human effort required to predict the vehicle service date. By use of previously fed data and algorithms used to analyse, the model is capable of providing the efficient result. Finally, the collected data is stored in the cloud storage and used to forecast upcoming service date, and all these activities like vehicle service date and GPS location data are provided through an Android application for ease of use to the user and the service provider for their need.

Keywords IoT · Machine learning · Android · Cloud computing · GPS · Tracking system · Vehicle monitoring · Sensors

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1 Introduction

In the modern era, everyone is more dependent on the vehicles either by using public or private transportation. The vehicle servicing is a set of the activities that are followed to maintain the vehicle in the good condition. To maintain the vehicle in good condition, the time to time service is essential. The vehicle servicing is all depend on the internal factors like distance travelled, lubricant (oil) level, tyre conditions, the smoke emission, depending on the other hardware parts conditions and external factors like a year of manufacture, vehicle model, driving conditions, the speed of driving, and the weather conditions. For long usage and maintaining its original performance, the vehicle servicing is important for very regular interval.

Traditional vehicle service is carried out in a very random fashion like first whenever the problem occurs while driving, in this case, definitely the owner faces the very big problem in terms of location or time where vehicle gets off while travelling. In another case, when the owner gets the reminder call from the vehicle service station, but in this case, the owner must be aware of the call and he must be ready with all financial required but here, the vehicle owner as to be depend on the service station.

The main problem from traditional vehicle service monitoring is the vehicle owner as to remember the dates of previous service or he or she has to wait for the call from the service station. In such situations, during the travel, if the vehicle may go off or poor performance before the next date of service, vehicle owner totally unaware of what to do next and where to take the vehicle for service. Proposed model uses machine learning which is one of the most trending technologies [1, 2]. As it is proof from the name, it gives the computer system that which makes it more similar to the humans being. Machine learning is actively being used today, in more places than one would expect. One more emerging technology is Internet of things (IoT) [3–5], where all the devices are connected and communicated to each other using various sensors. Finally, the data which user can receive from all connected IoT devices can be stored in the cloud for further processing and analysis [6–8].

2 Literature Survey

Many works are carried out previously in the area of Android application development for vehicle service monitoring, but no tracking system. In Anusha et al. [3] proposed a method of contemporary technology by means of Embedded C programming language and the unit developed via LPC2148. Kamijo et al. [9] proposed an Android-based vehicle service status monitoring system in which Android application is used to carry out the vehicle facility user-friendly but this application not concentrated on hardware devices, and it covers few features like notification of the service, service status tracking and monitoring. But here, no concepts of storing the data for future prediction and no synchronization of hardware devices. It means that it is not used any technologies like machine learning and IoT. Pham et al. [10] proposed

vehicle tracking system using GPS and GSM modem by using GPS technology; it is easy to find out the cellular mobile towers and the remote devices and the vehicle location. The GPS technology is used to find out the latitude and longitude in the map where the vehicle is located. But there is no service providing facility is incorporated in this model. So vehicle owner completely unaware of what went wrong in vehicle. Celesti et al. [11] proposed a cloud system with IoT using OpenGTS and MongoDB for monitoring traffic and alert. Mahalle et al. [12] proposed the hybrid system of securing data in the cloud. The hybrid combination is implemented using RSA and AES algorithms to improve the safety of the cloud data. Here, author emphasises on providing security for data which is uploaded. The data which is stored, the downloading of that data is done in such a way that the integrity of data is maintained and the data is retrieved in the secured manner and also the proper usage of the private key, public key and secret keys which involved in encryption and decryption which are the important features of RSA algorithm. Then this encrypted data will be further encrypted with the help of a secret key and public key. By use of this method, it is difficult for any third party to decrypt the actual data easily, and hence, this method provides more security.

3 Proposed Framework

In the proposed framework, the vehicle data is captured using various interconnected IoT devices, in order to solve the vehicle owner problem towards monitoring and tracking of vehicle status.

- **The Arduino Uno board**: It is microcontroller board and uses Flash and EEPROM as a storage.
- **NodeMCU**: It is having an USB input and formed by ESP12E. It provides an access to general-purpose input and output (GPIO).
- **Infrared(IR) sensors**: Used for motion detection and used to monitor the heat of the engine.
- **MQ-6 gas sensor**: It is a gas sensor used to detect the gas leakage of a vehicle and its very low-cost device.
- **Ultrasonic sensor**: The accurate distance can be measured by the ultrasonic sensor.
- **Light-dependent resistor (LDR) sensor**: It is made up of semiconductor material and used to sense the light.
- **WIFI module**: Used for WIFI to establish network connectivity across various module.
- **Temperature sensor**: It is used to measure the temperature of any object.
- **Inter-integrated circuit (I^2C)**: I^2C used for intention of message between chips exist in on the same printed circuit board.

3.1 System Design

The proposed model is shown in Fig. 1. It consists of three modules, namely data, service side and user side module. Here, the various parameters of a vehicle such as distance travelled, quantity of emitted smoke and lubricant level are collected from various sensors, and data is stored in temporary memory and moved to cloud for future reference using WIFI module by encrypting the data and same data is decrypted and accede by the Android application. The data stored in cloud can be used by multiple linear regression algorithm for prediction of the service date. It uses various parameters like distance travelled, quantity of emitted smoke, lubricant level for training the data model and efficient estimation of the upcoming service date for the vehicle. The flow chart for the Android application is shown in Fig. 2, and both user and service provider can register and login to the application for accessing the data from cloud. In the proposed model, the Android application repeatedly informs the owner about vehicle service date and nearest service provider details using GPS details, and after the vehicle service, a notification will go to vehicle owner regarding service completion and payment for service. Along with this facility, owner can see previous service history also.

Distance is being collected based on the constant speed of the vehicle. The average speed of the vehicle is 25 m/s. So the total distance covered by the vehicle is determined by using Eq. (1).

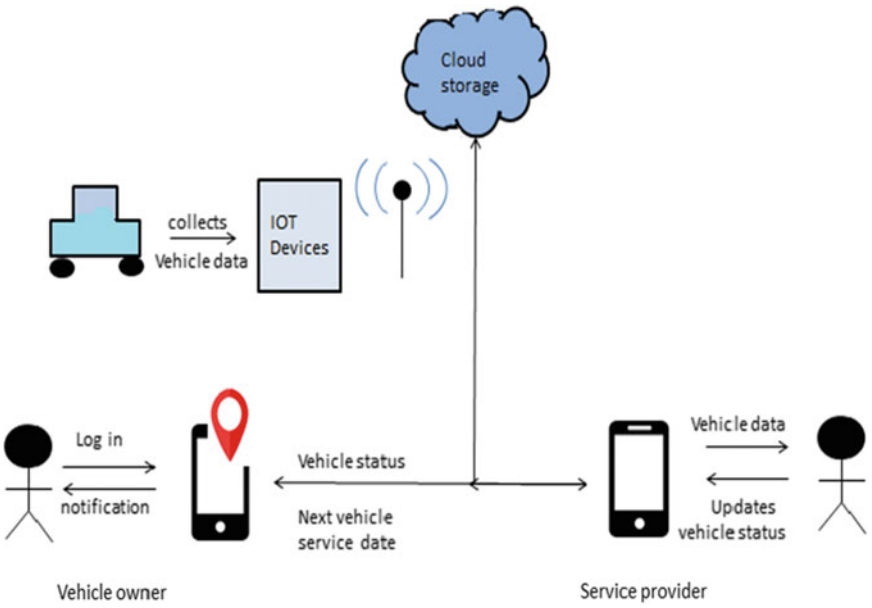

Fig. 1 Proposed model

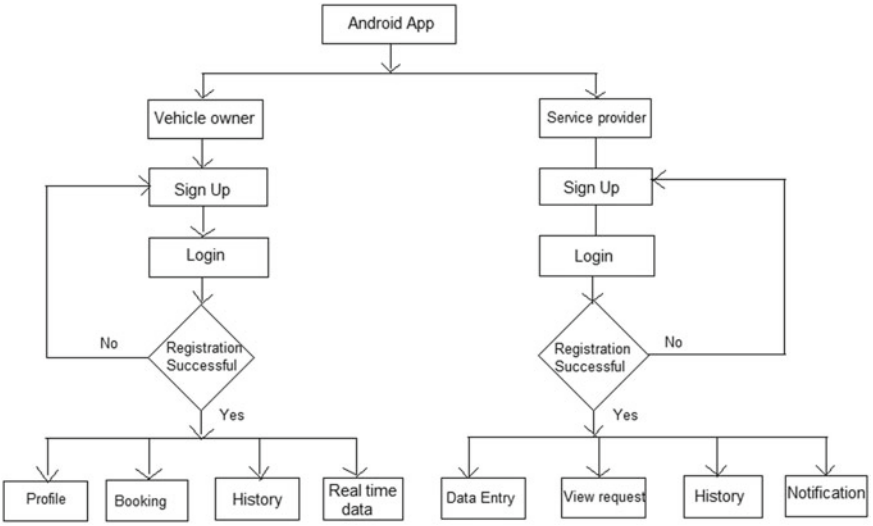

Fig. 2 Flow chart of application

$$\text{Distance} = \text{Speed (meters)} * \text{Time (in seconds)} \tag{1}$$

The multiple linear regression [13] will consider several prediction parameters for getting the output. The output of this framework is also dependent on several parameters like distance travelled, lubricant level, smoke emission, etc., and against these parameters, the next service date of the vehicle is predicted. These parameters are independent variables and the next service date is the dependent variable. The accuracy of the regression model is being determined by using equation Eq. (2).

$$\text{Co-efficient of determination } \left(R^2\right) = 1 - (\text{SSE/SST}) \tag{2}$$

where

SSE error sum of squares
SST total sum of squares
R^2 Co-efficient of determination.

Multiple Linear Regression Algorithm

Actual value = regression · predict(X_cordinates).

SS_Residual error = sum((Y-Actual value)ˆ2).

SS_Total = sum((Y-mean(Y))ˆ2).

r_squared = 1 − (float(SS_Residual))/SS_Total.

All the collected data is encrypted using RSA algorithm and stored in cloud storage. When the data is to be stored in the cloud server, the data is encrypted using the public key, and when the data is retrieved using Android application, the private

key is used. This will not let any third party to access the data. It also uses one common key that is being used along with the private key and public key. Hence, a good security is provided.

3.2 Implementation

Fig. 6 shows the architecture model. Here, various sensors like IR, MQ 6, ultrasonic, LDR sensors, etc. are interconnected to the Arduino board [14]. From these sensors, the data is collected in regular interval, and this data will be used for training the model and thereby used for prediction vehicle condition and upcoming service dates. The proposed model consists of three modules, namely data module, service provider module and user (vehicle owner) module.

In the data collection module as shown in Fig. 3, the various real-time data like total distance travelled by the vehicle, GPS location, level of the lubricant, quantity of smoke emitted from the vehicle, all these data are collected from interconnected sensor devices through Arduino board [15] in regular intervals, and finally, data is encrypted using RSA algorithm [16] to protect the data from the attackers and stored in cloud server. Proposed model can use this data for input for machine learning algorithms like multiple linear regression which is used to predict the next date of vehicle service. The next module is at service provider side; through the application, the service provider can view the status of the vehicle which is registered for the service from the vehicle owner. The application retrieves the data from the cloud [17]. After viewing the real-time data service, provider can take the necessary actions for the vehicle and same is stored again in cloud for prediction of the next service

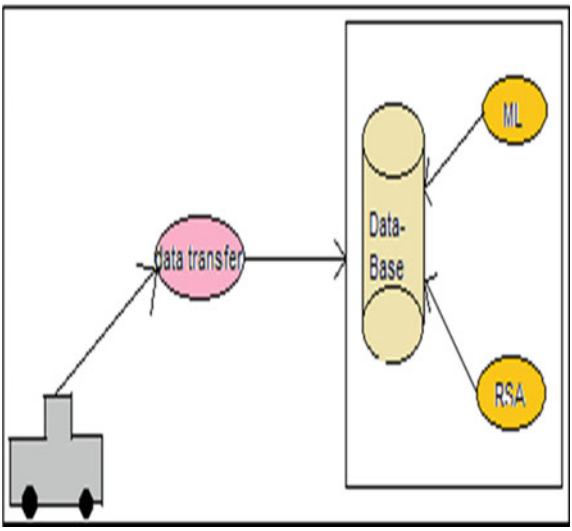

Fig. 3 Data collection module

date for the vehicle, and in the other side, same can be viewed by the vehicle owner regarding the vehicle service status as well as cost for the service as shown in Fig. 4.

Fig. 5 shows user side module, from which vehicle owner can login to the application then he can update its profile and they can search for the nearest service centre. Once the vehicle reaches the service station for the service, the service provider makes use of this application, and he can view the current status of the vehicle and

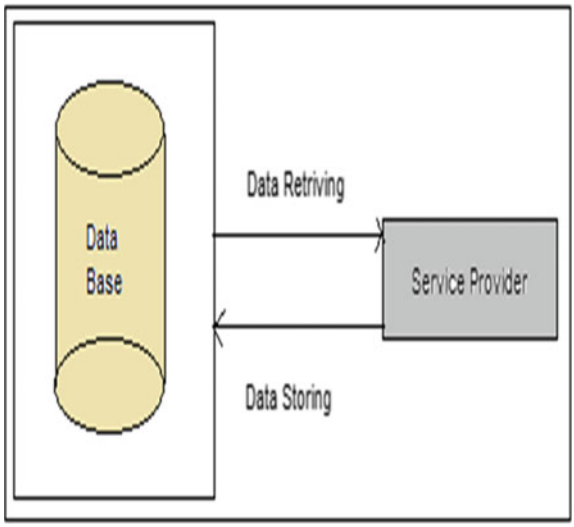

Fig. 4 Service side module

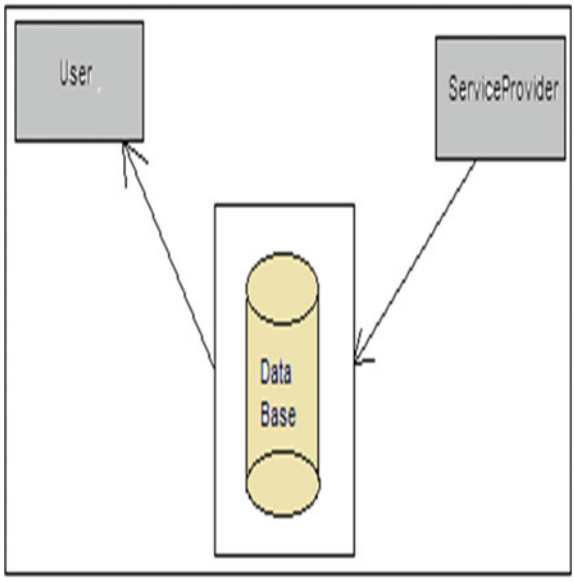

Fig. 5 User side module

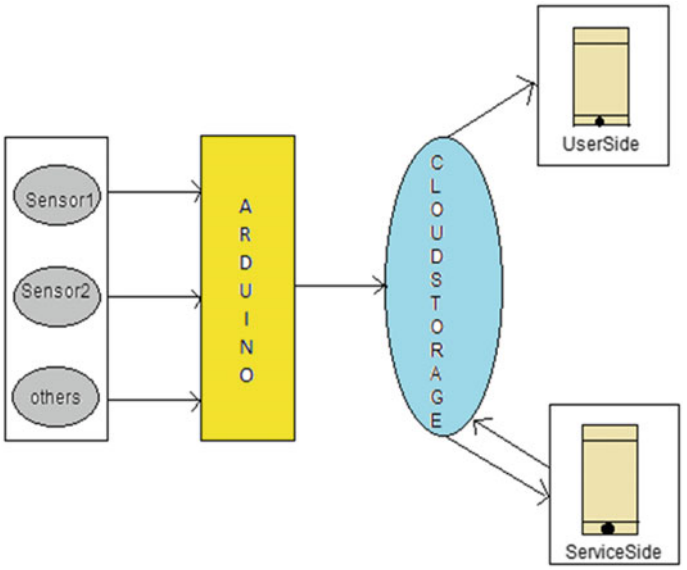

Fig. 6 Architecture model

do the necessary service, and same will be stored in cloud for future usage by using this data for multiple linear regression algorithm for prediction of next service date as shown in the (Fig. 6).

4 Results

Hardware connections to collect distance travelled temperature and level of lubricant are shown in Fig. 7. Hardware set-up for emission test of vehicle is shown in Fig. 8. The use case diagram is represented in Fig. 9. There are two users of this application, one user is a vehicle owner and another one is the service provider. Both vehicle owner and service provider will register for the application and vehicle owner can view the status or current condition of the vehicle after login and service provider can fill the cost for each service and can provide suggestions for the vehicle owner through this application.

The front page and login/sign up page of the Android application shown in Fig. 10a, b, respectively, and Fig. 10c show the registration page of the user. Figure 11a shows the login and sign up/Registration page of the Android application for service provider and Fig. 11b shows the registration page of service provider. The service provider can register by providing service station details like city, vehicle brand and phone number. Figure 12 shows the vehicle booking page; after successful login by the vehicle owner, owner can do vehicle booking by selecting the city where he

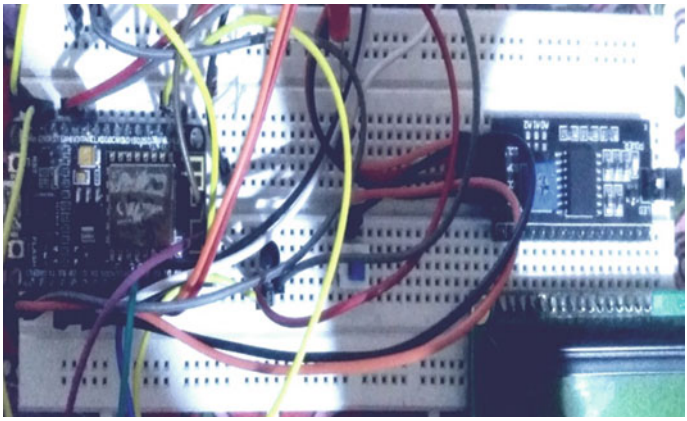

Fig. 7 Connections to collect distance travelled temperature and level of lubricant

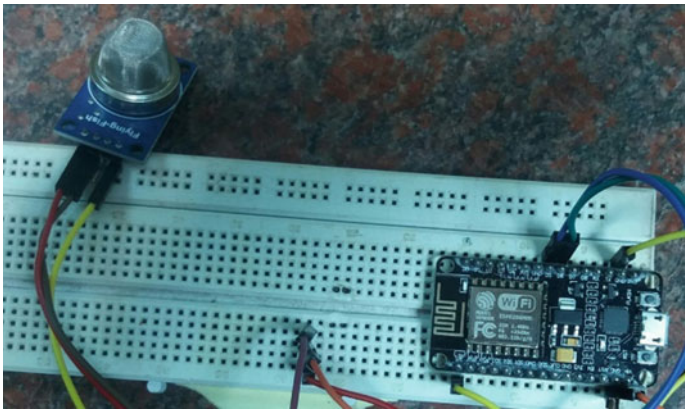

Fig. 8 Hardware set-up for emission test of vehicle

wants to give it for service, date and vehicle brand type. Service provider can see the registered vehicles owner details for service station by logging in to service login page and can accept or reject the request based on the availability. If the request is accepted, then the following factors are checked based on the previous vehicle service history and present status of various factors like battery, brake cam, brake effectiveness, carburettor assembly, carburettor breath hose, clutch, control cables, engine, front wheel, headlamp, kick starter, oil, sparkplug, steering, transmission oil, which are obtained from the various supporting sensors used in this model and are passed as inputs for the multiple linear regression and other relevant algorithms to carry out the service. Once the service is done, same is updated in Android

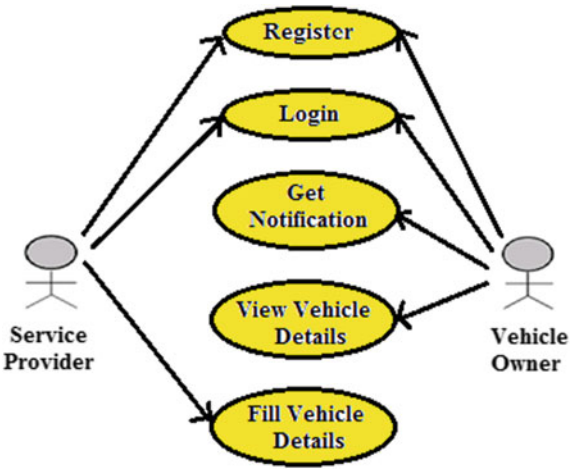

Fig. 9 Use case diagram

application along with cost of each and same thing is reflected on vehicle owner page. Figure 13 shows the coefficients of multiple linear regression algorithm. By using multiple linear regression algorithm, next service details can be predicted.

5 Conclusions

This paper has successfully proposed an Android application for providing vehicle service monitoring and tracking more efficiently to the user. The IoT technology helps in fast gathering of data from various vehicle components and machine learning algorithms are used to process the collected data and give best results to the users. GPS location helps to keep track of vehicle and providing needs in case of emergency. The proposed system helps in automatic monitoring and servicing of the vehicle by notifying the service dates from time to time to the vehicle owner. By this application, the vehicle owner will be conscious of the present status of the vehicle which implemented using IoT and machine learning algorithms. The service provider also can make use of this application for analysing the vehicle status and for prediction of service cost in early time, and user also gets to know about complete service details of his/her vehicle from the application itself. This model helps to keep vehicle in good condition. Finally, this model overcomes the limitations and risks facing the traditional methods and gives the efficient service.

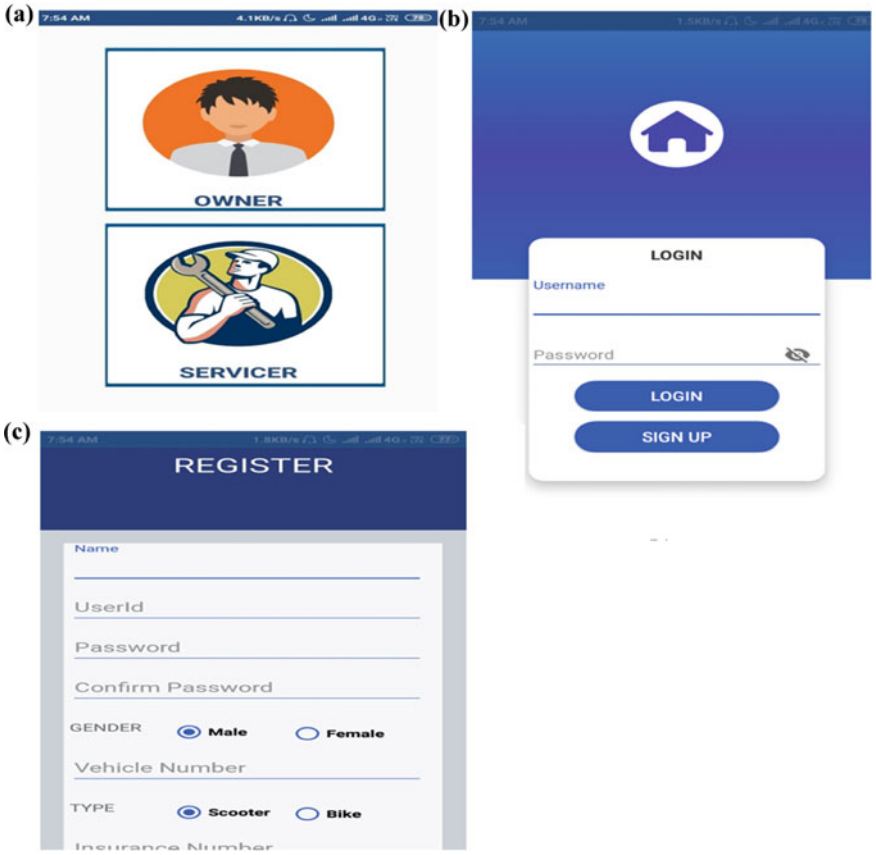

Fig. 10 Android application **a** front page. **b** Login/sign up page of vehicle owner. **c** Registration page of owner

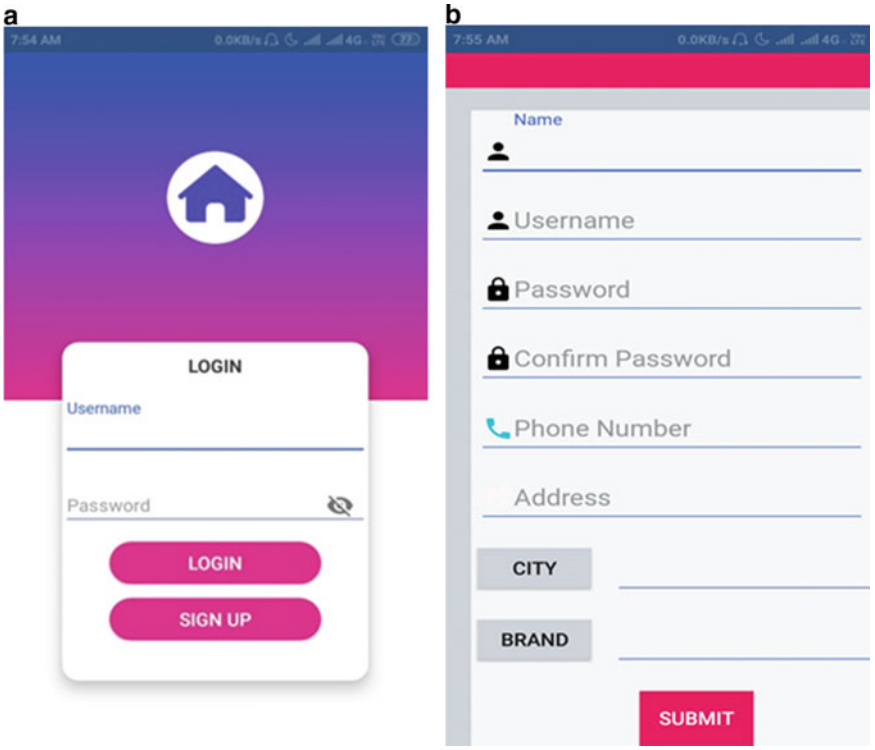

Fig. 11 Android application. **a** Login/sign up page of service provider. **b** Registration page of service provider

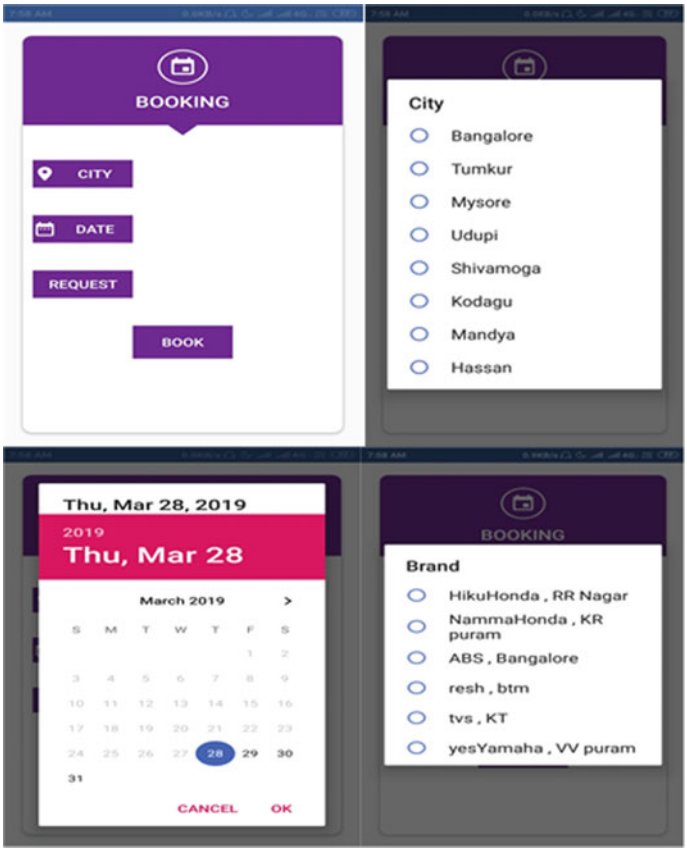

Fig. 12 Vehicle booking page

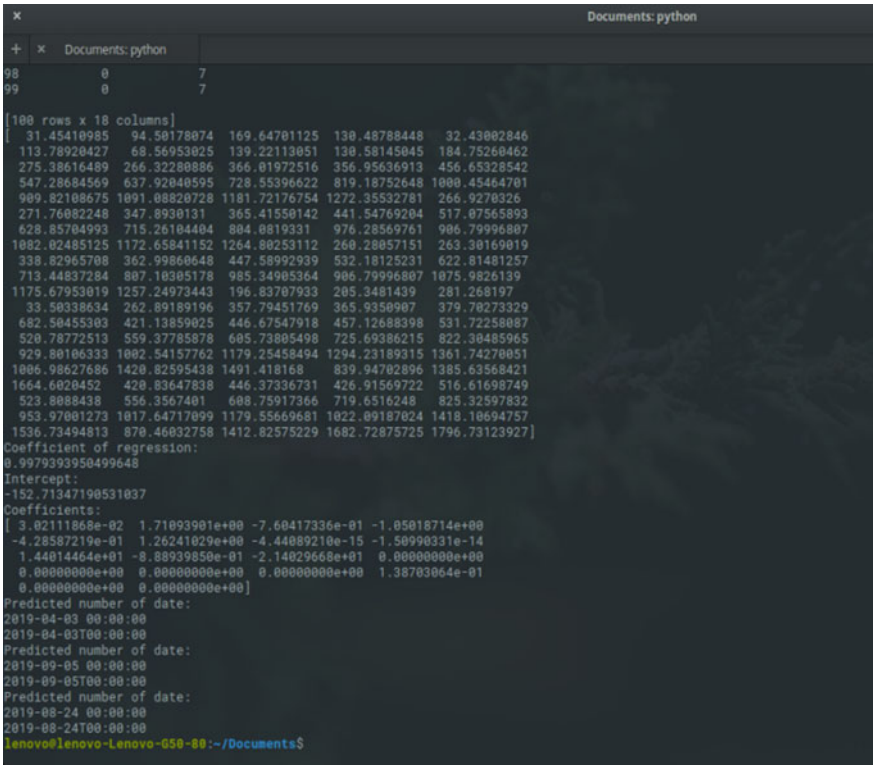

Fig. 13 Coefficients of multiple linear regression algorithm

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Machine Learning-Based Application to Detect Pepper Leaf Diseases Using HistGradientBoosting Classifier with Fused HOG and LBP Features

Matta Bharathi Devi and K. Amarendra

Abstract Pepper leaf disease detection is one of the interesting challenges in the field of machine learning. In this paper, a machine learning-based approach is proposed to extract texture features and use dimensionality reduction techniques called principal component analysis (PCA) and create a composite feature descriptor. There are two different texture-based feature representations extracted by using HOG and LBP feature engineering techniques were used for the pepper leaf images, and PCA is applied to obtain reduced representations. These representations are fused and passed to machine learning models like logistic regression, naïve Bayes, decision tree, support vector machine, and HistGradientBoosting classifier for classification. HistGradientBoosting classifier achieved highest the accuracy of 89.11% and outperformed other models.

Keywords Histogram of oriented gradients (HOG) · Local binary pattern (LBP) · Principal component analysis (PCA) · HistGradientBoosting classifier (HGB) · Machine learning

1 Introduction

Detecting plant leaf diseases is one of the major challenges faced by farmers in agriculture. It is very important to identify the type of leaf diseases accurately for the appropriate use of pesticides. Any mistakes in identifying diseases of plants lead to reduced yield. Plant diseases can be either biotic [1, 2] or abiotic. The primary cause behind biotic diseases is various living organisms like bacteria, viruses, and fungi. Biotic diseases are affected by viruses, unlike abiotic diseases which are affected by inorganic conditions like weather changes and chemicals. Identifying leaf diseases accurately by observing with the naked eye is a difficult task. Hence,

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there is a requirement for an application that can detect leaf diseases accurately. There are various automated applications to identify plant leaf diseases. Most of them used texture representations extracted from leaf images with conventional machine learning models [3–5].

Most of the recent works in the literature used feature extraction techniques like histogram of oriented gradients (HOG), local binary patterns (LBP), gray-level co-occurrence matrix (GLCM) are used in the literature to extract texture-based features from plant leaf images [6, 7]. These features were provided to popular classifiers like support vector machine (SVM) to categorize different types of diseased leaves [8, 9]. However, when using these features directly along with ML models results in reduced performance, so, in this work, the investigation is made to reduce the dimensions of texture features and blend them to get composite representation with pepper leaf dataset [10–12].

Initially, the preprocessing is performed to remove background noise obtained during image acquisition. Later, the two types of texture-based features extracted from pepper leaf images are HOG and LBP feature engineering methods and the principal component analysis (PCA) dimensionality reduction technique is applied to get reduced representations of HOG and LBP features. In our experiments, it can be observed that HOG features are better than LBP. Using reduced representations leads to improve performance. When LBP features are fused with HOG, composite representations are obtained. These representations contain more discriminant information which helps classification models to identify pepper leaf diseases accurately. Our proposed fused representation achieved the highest accuracy of 89.11% with the HGB Classifier.

2 Related Work

This part of the paper provides an overview of various methodologies employed for detecting plant leaf diseases in past. The first part of this section describes various preprocessing techniques used in the literature followed by feature engineering methods algorithms that are used for classification.

In the recent past, several preprocessing techniques have been applied to plant leaf images to correctly identify the type of plant diseases. Most of the previous works used image processing techniques and applied them to smooth, sharpening filters enhance the image and used several filters to remove additive noise from the images [13, 14]. ROI segmentation is a major task employed to detect and segment diseased portions from images to improve the performance of automated plant leaf disease diagnosis systems [15–17].

Texture-based features obtained from images play a vital role and affect the performance of image classification systems. Histogram of oriented gradients (HOG), GIST, scale-invariant feature transform (SIFT), local binary patterns (LBP) are majorly employed feature engineering algorithms to obtain intensity and texture-based features [6, 18, 19]. These feature engineering methods are employed in various tasks like medical image classification, scene classification, object recognition, and

leaf disease identification [20–23]. Most machine learning algorithms like K-nearest neighbor classifier (KNN), decision tree classifier, random forest, support vector machine (SVM), naïve Bayes classifier are trained on these texture-based features for classification purpose [8].

A K-nearest neighbor (KNN) classifier with gray-level co-occurrence matrix (GLCM) texture features of plant leaf images was used to identify plant leaf diseases [24, 25]. Another machine learning-based system is was proposed for grapes plant leaf disease detection by Harshal Waghmare et al. At first, the background of all images was removed and segmentation is performed as a preprocessing step. A high-pass filter is applied on segmented images to analyze the diseased part of the leaf. Local binary patterns (LBP)-based texture features are extracted from preprocessed images, and these features were used to identify different types of grape plant diseases using support vector machine (SVM) classifier [20, 26]. A cotton leaf disease detection and classification technique based on machine learning and image processing tools are proposed by Pooja et al. Initially, region of interest (ROI) is segmented from plant leaf images using image processing tools and features are extracted. These features were passed to SVM classifier to identify the type of disease [27, 28].

In this work, the HOG and LBP features extracted from pepper leaf images and fuse them to create a composite representation. These representations are then projected to a lower dimension using PCA. Then apply various popular classification algorithms like logistic regression, naïve Bayes classifier, decision tree classifier, support vector machine (SVM) with linear and radial basis function (RBF) kernel, and HistGradientBoosting classifier for classification purpose.

3 Proposed Methodology

This part of the paper illustrates various stages of the proposed method for pepper leaf disease detection. Our proposed work consists of four phases, followed one after the other. They are data preprocessing, feature extraction, dimensionality reduction, and classification.

3.1 Data Preprocessing

Data acquired from real-world consist of random noise in the background. So, background subtraction is performed on pepper leaf images to remove random background noise. This is done by creating a suitable mask for every image present in the dataset, and then background removal operation is performed by using corresponding masks. Figure 1a represents images from the original dataset, and Fig. 1b represents background removed images. These processed images are passed to the feature extraction phase.

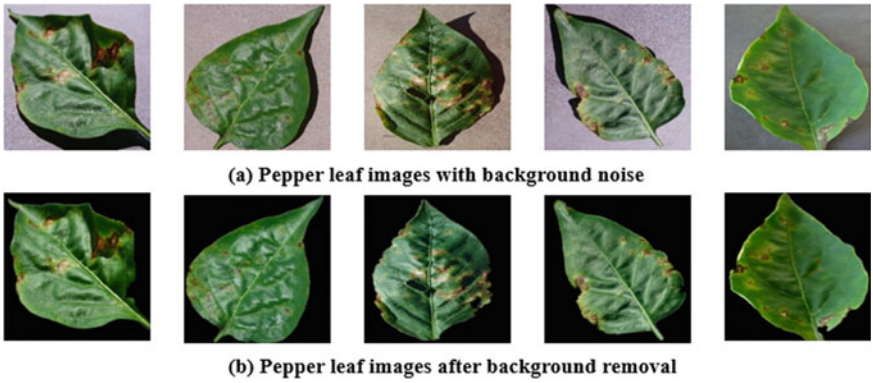

Fig. 1 Pepper leaf images before and after preprocessing

3.2 Feature Extraction

Feature extraction is an important phase in any machine learning task. In our work, the two different feature extraction techniques chosen are histogram of oriented gradients (HOG) and local binary patterns (LBP) which extracts texture-based features from pepper leaf images.

3.2.1 Feature Extraction from Pepper Leaf Images Using HOG

The HOG feature descriptor counts the occurrences of gradient orientation in localized portions of an image. Initially, all processed images of dimension (256 × 256) are reshaped to (64 × 128) dimensions. Next, changes in X- and Y-directions of images (gradients) are computed by dividing the entire image into (8 × 8) patches. Next, magnitude and orientations are computed by using gradients. Then, a histogram of gradients is calculated for each (8 × 8) cell and these cells are combined to create (16 × 16) cells. The gradients of these cells are normalized to get a vector of (1 × 36) dimensions for each cell. Finally, for every image of dimension (64 × 128) obtained a feature vector of 3780 dimensions. This feature descriptor is normalized using the min–max normalization method. Figure 2 represents a histogram of oriented gradients computer for a given pepper leaf image.

3.2.2 Feature Extraction from Pepper Leaf Images Using LBP

Local binary patterns (LBP) compute texture features from local regions instead of computing global texture features as in the case of gray-level co-occurrence matrix (GLCM). Initially, all processed images of dimension (256 × 256) are reshaped to (128 × 128) dimensions. Next, all these images are converted to gray scale. LBP

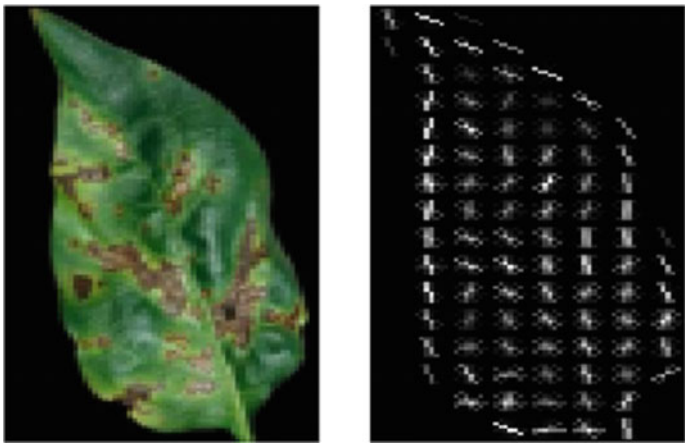

Fig. 2 Histogram of gradients for a given input image

histogram is obtained from those images by appropriately selecting p and r values, where p represents the number of points in neighborhood of a pixel and r is the radios. Finally, for every image of dimension (128 × 128) obtained a feature vector of 26 dimensions. This feature descriptor is normalized using the min–max normalization method. OpenCV module of python is used to extract LBP features.

3.3 Dimensionality Reduction

In this phase, all the features of dimension 3780 obtained from the HOG feature extraction technique and 26 dimensions obtained from LBP are projected into lower dimensional space with 512 and 13 dimensions for HOG and LBP, respectively. For this, the principal component analysis is used. In the case of limited data, high-dimensional features may lead to the affliction of dimensionality. To resolve this

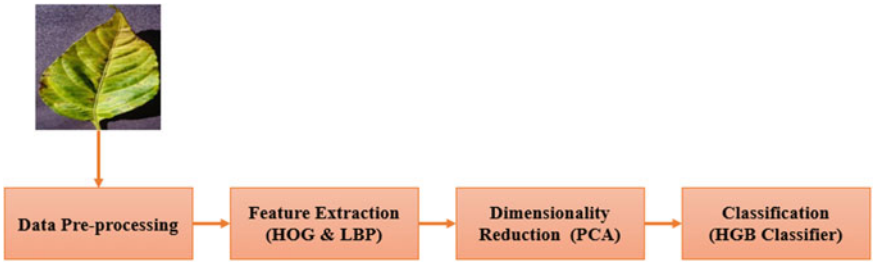

Fig. 3 Architecture of proposed system for pepper leaf disease detection

problem, this module is included in our work. Figure 3 represents the architecture of the proposed method for pepper leaf disease detection.

3.4 Classification

In this work, popular classification models like logistic regression, naïve Bayes classifier, decision tree classifier, support vector machine (SVM) with linear and radial basis function (RBF) kernel, and HistGradientBoosting classifier were utilized. The performance extracted features are tested before and after applying the dimensionality reduction. The SVM along with the RBF kernel and HistGradientBoosting kernels performs better than other classifiers for both HOG and LBP features in both the cases of dimensionality reduction. Finally, the HOG and LBP features were fused to form a composite feature representation of dimension 3806. With these features, HistGradientBoosting classifiers achieved the highest accuracy of 89.11% and outperformed all other models.

4 Experimental Results

This section provides a precise picture of the experiments conducted and the results obtained using the proposed method. Initially, an overview of the dataset used for experiments is described followed by evaluation metrics used to measure the performance of the proposed method. Finally, a summary of experiments and their results is provided.

4.1 Pepper Leaf Disease Dataset

The pepper leaf disease dataset is used, and the part of the plant village dataset is also used which contains 54,306 samples of 26 types of diseased leaf images belonging to 14 types of plant species. This dataset contains 2475 samples of pepper plants representing both healthy and diseased leaves. 997 samples belong to the healthy category and 1478 samples belong to the bacterial spot category. Totally 1980 samples are considered for training, and 495 samples are used for testing model performance.

Table 1 Performance of ML algorithms with HOG features

Model	Accuracy	Precision	Recall	F1
LR	75.4	75	75	75
Naïve Bayes	70.97	78	71	66
Decision tree	67.74	67	68	67
SVM—linear	77.82	78	78	78
SVM—RBF	83.06	84	83	83
HGB	84.81	85	84	85

4.2 Performance Evaluation Measures

Different classification model performance evaluation measures like accuracy, precision, recall, F1-score are calculated to prove the efficiency of the proposed method on test data. These measures can be computed using the confusion matrix.

4.3 Result Analysis

The experiments were conducted in three different ways to check the performance of classification models with HOG, LBP, and fused features before and after applying PCA for pepper leaf disease detection.

4.3.1 Experiments Without Dimensionality Reduction

These experiments are conducted to check how well HOG and LBP features can detect pepper leaf diseases before dimensionality reduction.

From Table 1, it is clear that HistGradientBoosting classifier outperformed other ML by achieving an accuracy of 84.81%. Comparatively, the decision tree classifier could not perform well. SVM with RBF kernel also obtained an accuracy of 83.06% which is the second highest measure. From Table 2, it can be observed that the HGB classifier achieved 83.87% accuracy with LBP features and the naïve Bayes classifier obtained lower accuracy. From both experiments, the HOG features perform better than LBP features for the task of pepper leaf disease detection, and the HGB classifier outperformed all other models used, with both types of features.

4.3.2 Experiments After Applying Dimensionality Reduction

These experiments are conducted to check how well HOG and LBP features can detect pepper leaf diseases after dimensionality reduction (Tables 3 and 4).

Table 2 Performance of ML algorithms with LBP features

Model	Accuracy	Precision	Recall	F1
LR	80.24	80	80	80
Naïve Bayes	67.74	69	68	68
Decision tree	72.58	73	73	73
SVM—linear	81.05	81	81	81
SVM—RBF	81.85	82	82	82
HGB	83.87	84	84	84

Table 3 Performance of ML algorithms with HOG features

Model	Accuracy	Precision	Recall	F1
LR	73.39	73	73	73
Naïve Bayes	76.21	76	76	76
Decision tree	62.5	62	62	62
SVM—linear	77.98	79	78	79
SVM—RBF	84.27	84	84	84
HGB	85.47	85	85	85

Table 4 Performance of ML algorithms with LBP features

Model	Accuracy	Precision	Recall	F1
LR	79.44	79	79	79
Naïve Bayes	82.26	82	82	82
Decision tree	77.02	77	77	77
SVM—linear	80.24	80	80	80
SVM—RBF	83.47	83	83	83
HGB	84.27	84	84	84

From previous experiments, it is clear that after applying PCA, there is a significant improvement in the performance of classification models with both, HOG and LBP features. HGB classifier followed the same trend and outperformed other classification models with both HOG and LBP features after applying PCA. Even after reduced dimension, there is a significant improvement in all measures used to test the efficiency of models.

4.3.3 Experiments with Fused Features of HOG and LBP

This experiment is conducted to check the performance of ML models with composite representation obtained after blending LBP features with HOG features.

Table 5 Performance of ML algorithms with fused HOG and LBP features

Model	Accuracy	Precision	Recall	F1
LR	80.24	80	80	80
Naïve Bayes	75.81	76	76	76
Decision tree	69.35	70	69	69
SVM—linear	81.05	81	81	81
SVM—RBF	88.71	89	89	89
HGB	89.11	89	89	89

From Table 5, it is clear that the HGB classifier trained on fused feature descriptor obtained 89.11% accuracy which is highest when compared with the performance of the same classifier trained on HOG and LBP features before and after applying PCA. So, it can be concluded that fused texture representations of pepper leaf images help to identify diseases accurately rather than using conventional usage of LBP and HOG features.

5 Conclusion

Pepper is the most recently used ingredient in dishes. Identifying pepper leaf diseases is a challenge for farmers. There is a high requirement to automate the process of detecting pepper leaf diseased for correct usage of pesticides and reduce the loss of yield. In this paper, the performance of various classification models along with two different types texture-based features was investigated. During our experiments, it can be observed that models can perform well with reduced representations of HOG and LBP features rather than using them directly. The fused representation of HOG and LBP features helped the models to perform well, and there is a 4% improvement in accuracy with fused features. In our experiments, it can also be observed that the HGB classifier outperforms other ML algorithms in every case.

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Efficacy of Indian Government Welfare Schemes Using Aspect-Based Sentimental Analysis

Maninder Kaur, Akshay Girdhar, and Inderjeet Singh

Abstract One of the simplest methods to understand people's thoughts using images or text is commonly given as sentiment analysis. Sentiment analysis is used mostly in products advertisement and promotion depends on the user's opinion. The process is based on the aspect-based sentiment analysis and it is used to understand and find out what someone is speaking about, and likeness and dislikeness. One of the real-world models of the perfect realm of this subject is the huge number of available Indian welfare plans like Swachh Bharat Abhiyan and Jan Dhan Yojna. In this paper, labeled data is used on the basis of polarity. Tweets are preprocessed and unigram features are then extracted. In the initial steps, tokenization process, stop word removal process, and stemming process are performed as preprocessing to remove duplicate data. The unigram features and labels trained by support vector machine (SVM), K-nearest neighbor (KNN), and a combination of SVM, KNN, and random forest as a proposed model are used in the presented work. Implementation of experimental proposed approach demonstrates that better results in accuracy and precision than SVM and KNN.

Keywords Sentiment analysis · Aspect · Support vector machine · K-nearest neighbor

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1 Introduction

In natural language processing, sentiment analysis is considered as most significant tool because it opens up numerous possibilities to understand people's sentiments on different topics. The purpose of an aspect-based sentiment analysis is to detect the features of the particular entity. The positive and negative aspects of a particular topic can be analyzed through aspect-based sentiment analysis [1]. In this research paper, aspect-based sentiment analysis (ASBA) is implemented on the tweets of the government welfare schemes. This type of analysis is mainly domain specific. The government has launched the various welfare schemes for schools, states, as well as center. The given outlines progress in collaboration with center and state governments. The welfare schemes have been mostly introduced to develop the weaker and minority section of the society [2]. Many schemes are launched but in this research work is on Swachh Bharat Abhiyan and Jan Dhan Yojna. These schemes empower every Indian by helping them financially and providing the basic facilities [3].

A. *Two Types of Sentiment Analysis*

Document Level: If the analysis is performed using documents to identify the positive and negative view of the single entity, then it is document level analysis [4].

Comparative: In many cases, users express their views by comparing with the similar product or entity. The main goal is to identify the opinion from the comparative sentence [4].

The research work is structured as follows: Related works are presented in Sect. 2, proposed model is presented in Sect. 3, results and its discussions are presented in Sect. 4, and finally, conclusion is presented in Sect. 5.

2 Related Work

Various approaches proposed by the researchers for sentiment analysis are presented in this section. Shidaganti et al. [5] presented a technique that used data mining along with machine learning as a combination process. Clustering is done by using k-means clustering and hierarchical clustering approach. This approach helps to analyze the data of different organizations which helps in understanding the thoughts and opinions related to the product. Rout et al. [6] presented the way to deal with unstructured data of social media like blogs, Twitter for sentiment and emotion analysis. The supervised and unsupervised approaches are performed on different databases. The unsupervised approach was used for automatic identification of sentiments for the tweets. The sentiment identification is done by using maximum entropy, multinomial Naïve Bayes, and support vector machine classifier. This approach also works well if it will apply on the larger dataset in future. Mumtaz et al. [7] presented an approach which is a combination of lexical-based approach and machine learning. In this proposed work, hybrid approach was used, which gave high accuracy than

the classical lexical method and provides the enhanced redundancy than learning approach. Natural language processing to extract sentiments from texts is performed in the approach. Al-Smadi et al. [8] worked on aspect-based sentiment analysis to review the hotels in Arabic. Long short-term memory (LSTM) neural networks are used in the research model and it was implemented in two levels that are character level and aspect based with random field classifier and polarity classification based. Chen et al. [9] presented a visualization approach called Tag Net which is used for sentiment analysis. This approach combines the improved node-link diagrams with tag clouds to obtain heterogeneous time varying information. Large datasets scalability is improved using the proposed algorithm. Fouad et al. [10] presented a model for Twitter sentiment analysis which describes the tweet is positive or negative by using the concept of machine learning. The presented work uses different methods to label the input in the training phase using different datasets. The classification is also done by using different classifiers to compare their performances. The concept of feature selection and information gain is used in this work. Jones et al. [11] focused on the implication of PMJDY scheme for the development all over India. The main aim of scheme was to make India digitized, even the rural areas are conscious about their bank accounts to obtain government offering benefits directly. Demonetization of currency and all these measures lead toward the progress in the structure of Indian economy. This scheme ensures the better quality of life in the country and helps improve the living status of the people. India is the only nation where 50% of people are in the working age group. Khan et al. [12] focused on the challenges that Twitter information faces, concentrating on order issues, and afterward consider these streams for supposition mining and sentiment analysis. To manage gushing unequal classes, the sliding window Kappa measurement for assessment in time-changing information streams was used. Utilizing this measurement an investigation is performed on Twitter information for utilizing learning calculations for information streams. Greica et al. [13] presented an analytic model which performs aspect classification, separation and polarity classification for analysis. The testing of domain aspect and sentiment classification is performed on the multilingual SemEval dataset. Pham et al. [14] presented the multilayer architecture for representing customer review. It extracts the views for product from the sentiment aspects and sentences related to review. The multilayer architecture represents the different level of sentiments for input text. This model is integrated with neural network for prediction of overall ratings of the product. Rathan et al. [15] worked on the review of mobile phones by using the tweets. In this lexicon-based approach is used for data labeling and this improves the classification process. The support vector machine classifier classifies the tweets with efficient accuracy level. Kim et al. [16] worked on the co-occurrence of data by using supervised and unsupervised methods. A framework is used for processing texts reviews. This work also finds the aspect categories according to review sentences and provides effective outcomes from the F-score. Pannala et al. [17] presented the existing work for the opinion mining that was done on the word level, not on the sentence level. The work was done on the trained dataset. In this author presents the combination of natural language (NL) and machine learning (ML) model to process the dataset which has 1654 aspects in the

training dataset with different category annotations and 845 aspects in the test dataset with different category annotations for analysis.

The performance of software is measured by SVM and logistics regression algorithm. Previously, work was done on the static parameters which reduce the effective learning of tweets according to its label. The nonparametric approach uses number of coefficient parameters those increase the over fitting. In proposed paper, the hyperparameters are used which reduces the adaptive features of learning. The analysis is on the combined performance of parametric (SVM), nonparametric (KNN), and the random forest is used.

3 Methodology

The data is collected for the experiment from Twitter and stored in a database for preprocessing. After the preprocessing on the feature label, the processed data is learned by KNN, SVM, and proposed model which is the combination of (KNN, SVM, random forest) these. By these respective models, tweets are predicted and classified, respectively. The below-given section describes the proposed methodology of the model and the techniques used in this work in detail. The pictorial representation of the proposed model is presented in Fig. 1.

Step 1: Collection of data
The proposed model used the data collected from the Twitter, regarding government welfare schemes as input. People get easy access to financial and banking services due to Jan Dhan Yojna of government welfare schemes and the main aim of Swachh Bharat Abhiyan is to keep India clean [18]; tweets regarding both the scheme have been used to determine the public review based on aspect-based sentiment analysis. The data that retrieved from the social media is in unstructured form due to intensive information.

Step 2: Data Storing and fetching
The retrieved tweets are put in storage as .csv files, and it is fetched using a Python tool PyCharm [19]. Around 3000 tweets are stored for the purpose of training and testing the datasets. Data mining algorithm (SVM, KNN, and hybrid SVM-KNN) is utilized to train and test the fetched tweets.

Step 3: Preprocessing
The redundant and noise contents are removed in preprocessing step which makes the data suitable for training process [20].

Data cleaning is performed based on the following steps.

(i) All the uppercase is converted to lowercase.
(ii) Remove all the Internet slangs from the data.
(iii) Removing all the stopping words from the list.

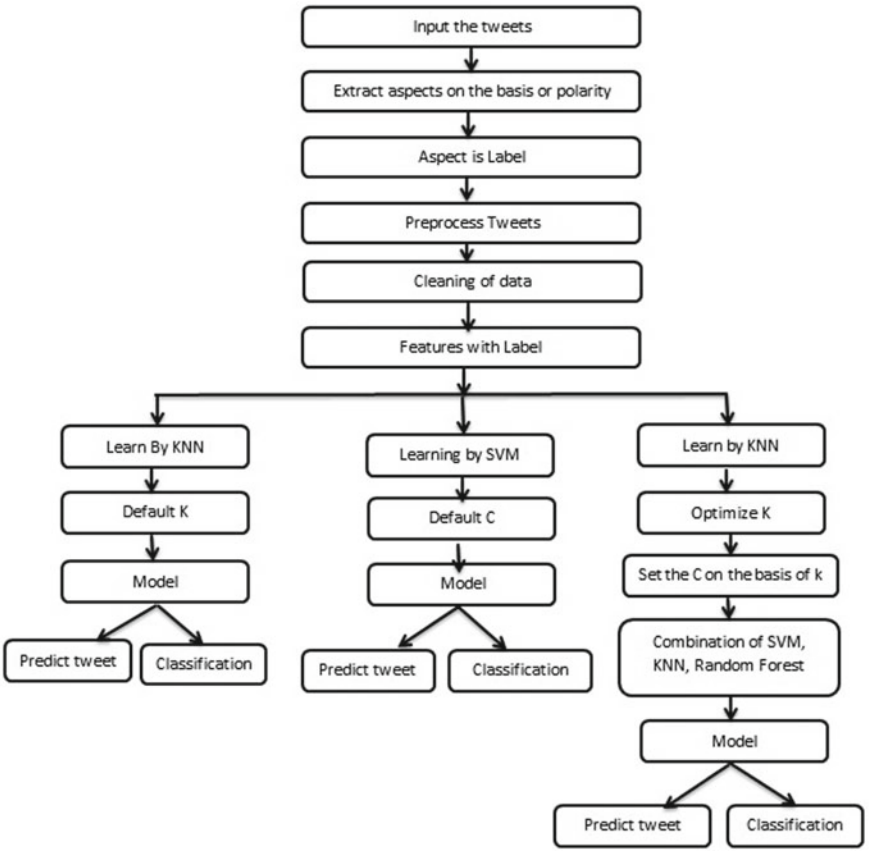

Fig. 1 Proposed framework process flow

(iv) Eliminating all the additional white spaces.
(v) Compress the duplicate words.
(vi) All the hashtags are removed but the hashtags texts are selected.

Step 4: Classification using data mining techniques

Classification is performed using data mining techniques to categorize the data into various aspects such as .

First aspect: increase fund/decrease fund.
Second aspect: improvement in growth/not growth/growth.
Third aspect: goes really fast/works/hard fix.
Fourth aspect: incredible/good/not good.
On the basis of these parameters, the data is trained and tested.

Machine learning models are trained using the training datasets. In the proposed framework, training data is implemented for classification, then testing dataset is prepared that is not before used in the proposed model for training.

Step 5: Optimize the classification results
The classification results are need to be checked to confirm whether the learning models training datasets follow the defined rules or not. This process is performed to obtain accurate and error-free results. Python is used to train and test the proposed KNN-SVM random forest model. The tweets nature is predicted as optimal value based on the classification results.

4 Results and Discussion

The proposed model classification performance is evaluated and compared with conventional approaches to validate the better performance. The experiment result validation is done by using fivefold and tenfold validation approach. The data is divided into k subsets in cross validation which has equal size and the training process and testing process are repeated for k-times. Every time one group of subset will be used for testing of data and other k-1 subsets of data will be treated as training data. The result analysis is done on SVM, KNN, and the combination of proposed model (SVM, KNN and random forest algorithm). The parameters used in this for analysis process are accuracy, precision, recall, and F-measure.

The classification accuracy of all the three models is depicted in Fig. 2. It is observed that the proposed shows the maximum accuracy in both fold testing process. KNN obtains the least accuracy performance of 49.23%, 51.23%, respectively, for both processes.

The precision analysis for proposed model and conventional SVM and KNN model is depicted in Fig. 3. The proposed algorithm shows the maximum precision and KNN obtains minimum precision 50.23, 51.23 in fivefold and tenfold validation process, respectively (Fig. 4).

The overall performance of all the classifiers is presented in figure. It is observed that the proposed model (KNN-SVM-random forest) shows the optimum, enhanced results with 82% in comparison with the SVM and KNN.

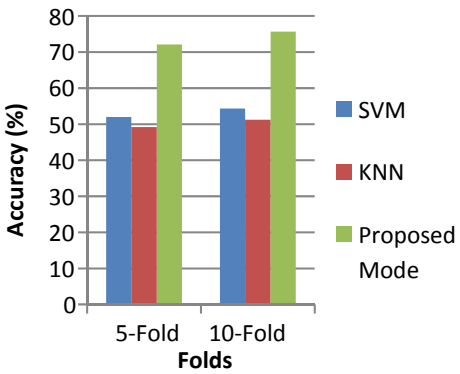

Fig. 2 Accuracy comparison

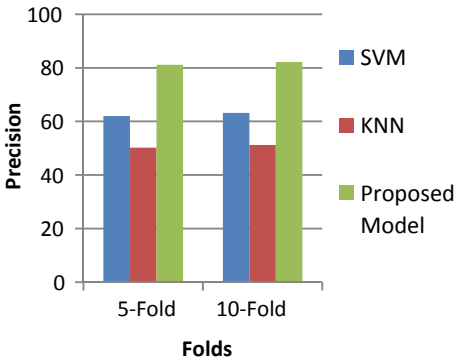

Fig. 3 Precision analysis

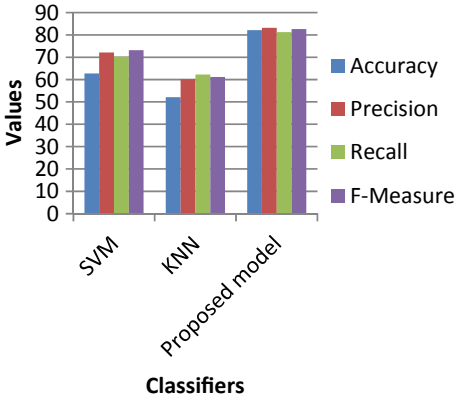

Fig. 4 Overall performance comparison

5 Conclusion

A hybrid classifier is presented in this research work as sentiment analysis model. The proposed hybrid model obtains better results by utilizing part-of-speech (POS) tags and word dependencies for aspect-based sentiment analysis. Efficacy of government welfare schemes using the proposed model is computed 82% under the restricted environment. In future work, improvement in the accuracy will be considered by reducing the feature sparsely by divergence and optimization approaches, improve the classifier by deep learning approaches. Additionally, other tasks that are Aspect Based Sentiment analysis also tested on the applicability on best of learning and concerns with the integration of POS tags, word dependencies, and possibly other NLP tools.

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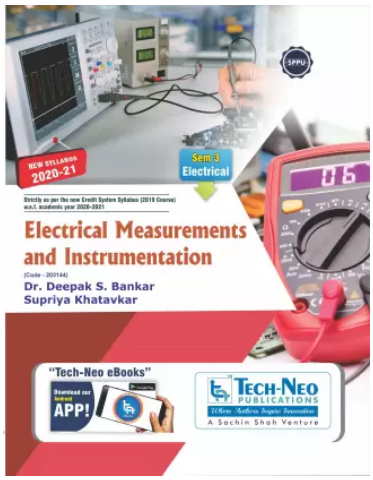

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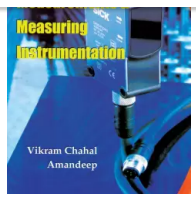

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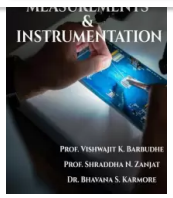

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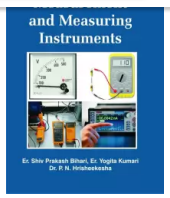

Electrical Measurement and Measuring Instruments

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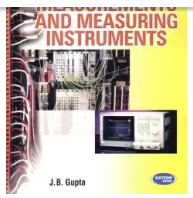

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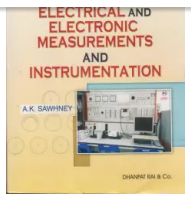

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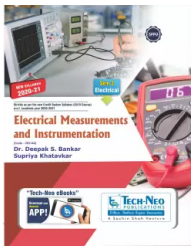

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Advances in Intelligent Systems and Computing 1198

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Efficient Watermarking in Color Video Using DWT-DFT and SVD Technique

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Abstract. With the advancement in Internet technology, a digital video can be easily modified, copied, and distributed among a large audience. Copyright protection and security become very essential aspects because of the extensive use of digital multimedia applications. Digital watermarking is being used for copyright protection, data authenticity for multimedia contents such as image, audio, and video. In this paper, a DWT-DFT-SVD-based method is opted to improve robustness and overall computational requirements. The computed PSNR between original video signal and watermarked signal is improved up to 60 db. The normalized correlation value of the original and the extracted watermark image have a high level of imperceptibility. The proposed scheme shows strong robustness against several geometric and non-geometric attacks.

Keywords: Discrete Fourier transform (DFT) · Discrete wavelet transform (DWT) · Singular value decomposition (SVD) · Digital video watermarking

1 Introduction

The security and unauthorized redistribution of digital contents are getting essential in the digital world. Recent advances in internet technology resulted in an increase in the utilization of the digital video. Hence, the digital data (video) can be shared, copied, distributed, and modified very easily [1, 2]. For the security of digital media in opposition to illegal distributions and manipulations, digital watermarking is being used [3, 4].

The uniqueness of digital media is obtained by extracting the embedded information. Watermarking can be used for many reasons, such as proof of ownership, copy control, broadcast monitoring, and authentication. [5, 6]. Visible watermark and an invisible watermark are two types of watermark. The invisible watermark gives more security to the multimedia like video, image, and document because human eye scan analyzes visible watermark so that attackers can attack without any difficulty on this by different attacks that may be geometric or non-geometric [7].

The watermark embedding, attack, and watermark detection are the essential components of robust watermarking [8]. Goal of watermark is to be robust enough to resist

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attacks, but not at the expense of altering the value of the multimedia data being protected. Digital video watermarking is achieved by inserting secret data in a video sequence to protect the video from unauthorized copying. Video string is still undisturbed with evenly time spaced images. Image data hiding methods can be applied for video watermarking as well, but video watermarking schemes require to face many challenges. Watermarked video is much sensible to plagiarize attacks, namely digital–analog conversion, frame interchanging, averaging of the frame, lossy compression, etc.

The rest of the paper is organized as follows. In Sect. 2, we explained related work done in digital video watermarking. Our proposed algorithm, with its block diagram, is explained in Sect. 3. The experimental results demonstrated in Sect. 4 followed by conclusion of the proposed work in the last section.

2 Related Work

Digital watermarking can be done using discrete cosine transform based on binary watermark technique [9] and QIM technique. Sridha and Arun [10] proposed a discrete wavelet transform (DWT) for security enhancement in video watermarking. Dual SVD and DWT based on selective pixel [11] give high robustness against multiple watermarking attacks. To achieve strong robustness against various signal processing operations, DWT- and PCA-based scheme is proposed [12]. DWT and PCA are used to hide the data in the digital video [13].

A digital watermarking system for video authentication using DMT is discovered by Monika et al. [14]. It presents multi-wavelet-based invisible watermarking. A hybrid DMT-SVD method is determined to be more reliable than the DWT method [15]. In [16], DWT-DCT-SVD is implemented on intravascular ultrasound (IVUS) video. Replacing biomedical signals among hospitals necessitates reliable and efficient communication. In this, binary watermark images embedded into intravascular ultrasound video. The whole video is divided into frames and application of DWT, DCT followed by SVD composes the watermark hiding technique.

Different existing video watermarking technologies based on DWT [17–21] and SVD [22–24] and their properties were studied to make it easier to select an appropriate technique which provides quantitative results. To increase the security and robustness of the watermark, some cases used combined or hybrid two frequency domains [25]. Based on DWT and DCT, for example, a watermark was embedded in a selected subband of the Y-component. The required perceptual quality of the video can be achieved by combining DWT with SVD [26]. The study proposed in [27] presented DWT- and DCT-based digital video watermarking using an invisible watermarking algorithm based on the spatial frequency domain. This paper presents a video watermarking technique using DWT-DFT-SVD, and watermark is embedded in YCbCr color space.

3 Proposed Algorithm

The robustness of the proposed model is improved by utilizing the features of DWT, DFT, and SVD technique. DFT is robust to Gaussian noise, shift invariance, JPEG compression, image sharpening and helps in noise removal. Inserting watermark using

DWT enhances the robustness against attacks, and it retains the image quality. Any change in singular values does not affect the video quality, and singular values remain unchanged to attacks. The presented method consists of two sections, namely the watermark embedding process and extraction process.

3.1 Watermark Embedding Process

The process of embedding watermark in the video is depicted in Fig. 1, and steps are described as follows:

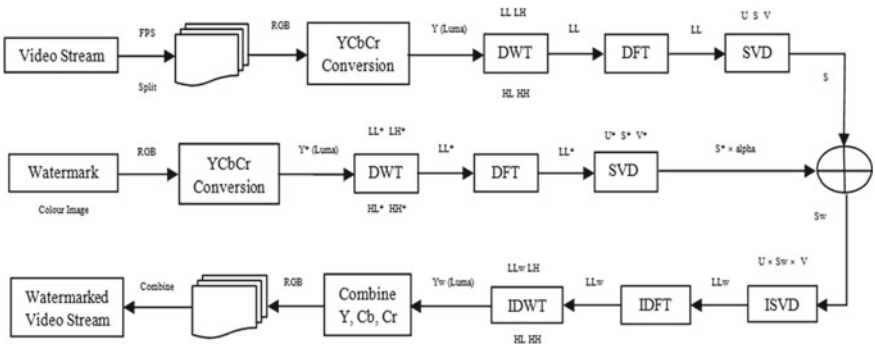


Fig. 1. Watermark embedding process

S1 The input video is divided into frames, and it is converted from RGB to YCbCr color space. The Y-component is used for watermark embedding process.

S2 2D-DWT (Haar wavelet) of single level is applied to the Y luma component. Four sub-bands, namely LL, LH, HL, and HH, are obtained. Out of which LL component is selected from total sub-bands.

S3 DFT is applied to LL component.

S4 To get an array of U, S, and V matrices of the video frame, SVD is performed on the output of DFT transformed LL component.

$$A = \mathrm{USV}^T \tag{1}$$

S5 The watermark video is converted from RGB to YCbCr color space. Here, again the Y luma component is used.

S6 The LL* component is selected after applying DWT on the Y-component.

S7 Complex valued Fourier transformed LL* component is achieved by applying DFT to LL* sub-band.

S8 To get U*, S*, and V* matrices, SVD is applied on the output component.

$$A = \mathrm{U} * \mathrm{S} * \mathrm{V}*^T \tag{2}$$

S9 Singular values of watermark embedded with singular values of every frame. The number of singular values to be embedded in each frame is equal to α scaling factor which concludes the power of watermark.

$$S_W = S + \alpha S* \tag{3}$$

S10 Inverse SVD is applied on U, Sw, and V matrices to get the LLw component.
S11 Untransformed LLw is obtained by applying IDFT using magnitude and phase components.
S12 Watermarked Yw luma component is achieved by performing IDWT to LLw, LH, HL, and HH.
S13 RGB format conversion is done after combining Cb and Cr components to Yw component.
S14 Non-selected frames are combined with the watermarked frames to obtain the complete watermarked video sequence.

3.2 Watermark Extraction Process

The process of extraction watermark is depicted in Fig. 2, and steps are described as follows:

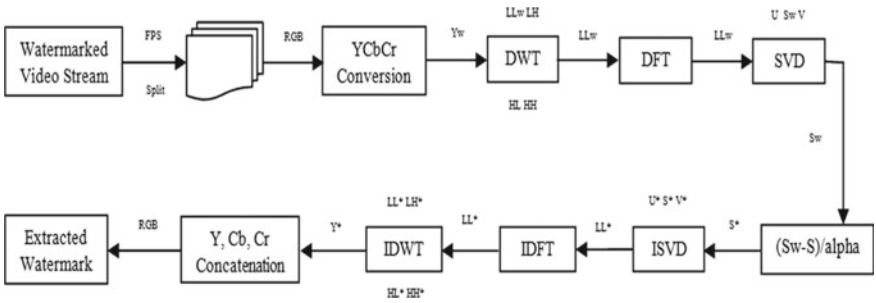


Fig. 2. Watermark extraction process

S15 Initially, watermarked video is split into frames and it is converted from RGB YCbCr color space. For the watermark extraction process, Yw component is selected.
S16 2D-DWT (Haar wavelet) of single level is used to the Yw component which is nothing but the luma component. Four sub-bands, namely LLw, LH, HL, and HH, are obtained. Out of which LLw component is selected from total sub-bands.
S17 DFT is applied to LLw component.
S18 To get an array of U, Sw and V matrices of the selected video frame, SVD is performed on the output of DFT transformed LLw part.

$$A_W = U\, S_W V^T. \tag{4}$$

S19 Singular matrix (S*) of watermark can be achieved by the given equation,

$$S^* = S_W - S/\alpha. \tag{5}$$

S20 To get the LL* component, ISVD is performed after combining S* matrix with U* and V* matrices.

S21 Untransformed LL* component is obtained by applying IDFT using magnitude and phase components.

S22 Unwatermarked Y*luma component is achieved by performing IDWT to LL*, LH*, HL* and HH*.

S23 RGB format conversion is done after combining Cb* and Cr* components to Y* component to obtain the original watermark.

4 Experimental Results

The experimentation of the presented approach is carried out using MATLAB 10. Six video samples were used having various resolutions with distinct format (.avi, .mov, .mp4, .mpg, .wmv). Color watermark with size 384 × 512 in.png format has been selected. Frame selection and embedding have done according to the proposed scheme.

Table 1 shows the original and watermarked video frames of different video samples. It describes that the watermarked and original frames are indistinguishable subjectively. Peak-signal-to-noise ratio (PSNR) is calculated to assure the security of the video. PSNR values are dependent on MSE.

Table 2 illustrates the extracted watermark images for all video samples without attack and after applying different attacks. From this, it is observed that the maximum correlation is obtained between the original and extracted watermark.

Normalized correlation for all video samples is compared and shown in Table 3. NC is used to measure the similarity between the original watermark image and extracted watermark image. The average normalized correlation (NC) of all videos is equal to 0.99, and it gets somewhat degrade for salt and pepper attack as well as for rotation attack. Vid.avi (720 × 1280) and Vid.mpg (480 × 640) give a very low value of NC, which is equal to 0.37 for cropping attack.

The robustness of the proposed algorithm is analyzed by applying different attacks on the video. Figure 3 demonstrates the PSNR with and without attacks for six different video samples, where I1—PSNR without attack, I2—Gaussian noise, I3—salt and pepper noise, I4—rotation attack, I5—cropping attack, I6—median filtering attack, I7—histogram equalization, I8—image sharpening.

The investigational outcomes have validated the proposed model in terms of improved NC and PSNR results by applying different attacks on videos.

Table 4 depicts the comparison analysis of the proposed work with the existing video watermarking techniques. It gives better results than the other methods. In present work, various videos of high-definition resolution are used with color watermark, and several attacks are applied to check the robustness. The given method achieved great PSNR in the range of 63–73 dB with NC value 0.99.

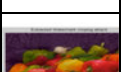
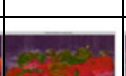
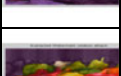
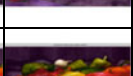
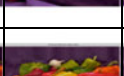
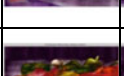
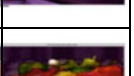
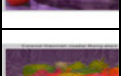
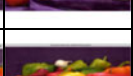
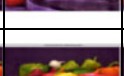
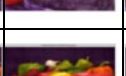
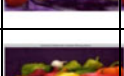
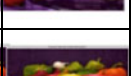
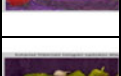
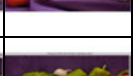
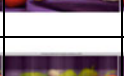
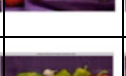
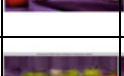
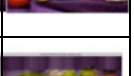
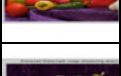
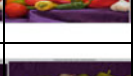
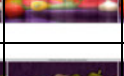
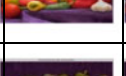
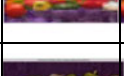
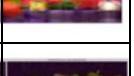
Table 1. Original and watermarked frames of six different videos

	Original video frame	Watermarked video frame
Bus.avi (288 × 352)		
Vid.avi (720 × 1280)		
Vid.mov (720 × 1280)		
Vid.mp4 (720 × 1280)		
Vid.mpg (480 × 640)		
Vid.wmv (720 × 1280)		

5 Conclusion

The primary purpose of the work recognized so far is to give accurate and precise video watermarking. The algorithm is implemented DWT in conjunction with DFT transform and SVD, which is vital for achieving better security. A color watermark has

Table 2. Extracted watermark for six video samples

	Bus.avi (288 × 352)	Vid.avi (720 × 1280)	Vid.mov (720 × 1280)	Vid.mp4 (720 × 1280)	Vid.mpg (480 × 640)	Vid.wmv (720 × 1280)
Original watermark						
Without attack						
Gaussian noise						
Salt and pepper						
Cropping attack						
Rotation attack						
Median filter						
Histogram equalization						
Image sharpening						

been embedded into the original video. Without much loss of data and features of the host video, inserting color watermark in the low-frequency sub-band helps to improve the robustness of embedding procedure. The proposed algorithm is imperceptible and robust against several attacks, and the value of PSNR (more than 60 dB) and NC (0.99) is measured high. There are some ways to be discovered for future work. An alternate watermark can be used, such as audio or video for embedding process to check the robustness of video watermarking. The implementation of this algorithm can be done using VHDL to address the hardware efficiency of this work.

Table 3. Normalized correlation against attacks for different video frames

Normalized correlation (NC)						
	Bus.avi (288 × 352)	Vid.avi (720 × 1280)	Vid.mov (720 × 1280)	Vid.mp4 (720 × 1280)	Vid.mpg (480 × 640)	Vid.wmv (720 × 1280)
W/O attack	0.9798	0.9985	0.9986	0.9925	0.9991	0.9976
Gaussian noise	0.9665	0.9665	0.9628	0.9417	0.9726	0.9698
Salt and pepper	0.9413	0.8892	0.8420	0.8491	0.8434	0.8338
Cropping (50 × 50)	0.9160	0.3741	0.9979	0.3679	0.3703	0.9967
Rotation (2˚)	0.8850	0.8708	0.9541	0.7706	0.5258	0.8024
Median	0.6496	0.9937	0.9951	0.9877	0.9965	0.9830
Histogram equalization	0.9593	0.9835	0.8117	0.9633	0.7898	0.6726
Image sharpening	0.6481	0.9106	0.9268	0.8999	0.9147	0.8863

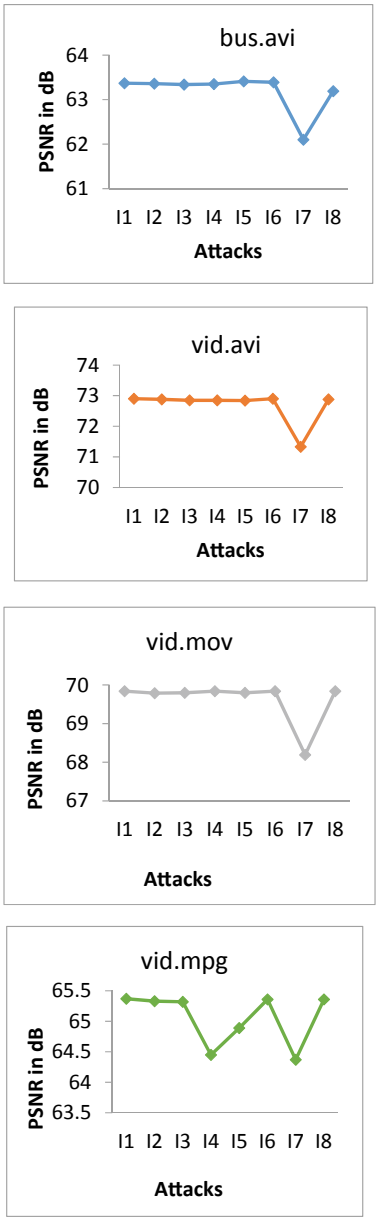


Fig. 3. PSNR with and without attacks for different videos

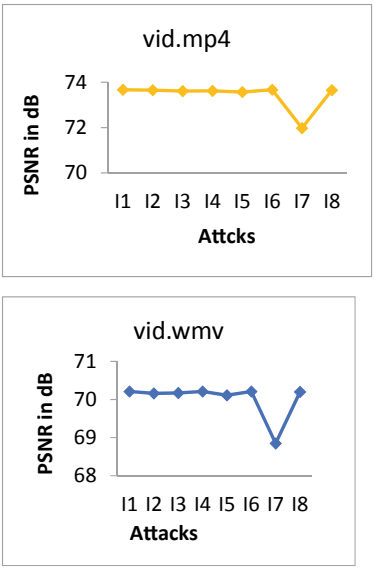


Fig. 3. (*continued*)

Table 4. Comparative analysis

Method	Host video size	Watermark	Attacks	PSNR(dB)
DCT [9]	256 × 256	Binary wm 32 × 32	Gaussian, salt and pepper noise, median filter, histogram equalization	45.98
5-level DWT [11]	256 × 256	Image	Gaussian noise adding, salt and pepper noise adding, frame dropping	45
DWT, PCA–QIM [14]	256 × 256	Image 32 × 32	Gaussian noise addition, hist. equalization, gamma correction, contrast adjustment	45.41
DWT and PCA [15]	Not given	Binary image	Gaussian and salt pepper noise, cropping, rotation, median filtering, contrast adj., hist. equalization.	46.23
MPEG [18]	320 × 240	Not given	Frame dropping and averaging, cropping	31.5–38.5
DWT, DFT, and SVD [Proposed]	(.avi, .mpg, .mp4, .wmv) 720 × 1280	Color watermark 384 × 512	Salt and pepper, rotation, cropping, image sharpening, hist. equalization, filtering	63–73

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Robust Speaker Recognition Based on Low-Level- and Prosodic-Level-Features

S. M. Jagdale, A. A. Shinde and J. S. Chitode

Abstract Speaker recognition is an important task in security applications where a person is recognized through speech input. In speaker recognition, a person is recognized from his or her voice. As no two individuals have same voice and also they have different speaking style, rhythm, tone, etc., speaker is recognized by extracting low-level spectral features and high-level behavioural features. This paper presents a robust speaker recognition approach which combines spectral features and prosodic features to improve the performance. The robust recognition system has been tested under different SNR levels. Two subsystems are implemented (i) speaker recognition based on low-level features such as Mel-frequency cepstral coefficient (MFCC) features. (ii) combined system with MFCC and prosodic features. These subsystems are able to achieve competitive results in classifying different speakers. Experimental results are done on interactive emotional dyadic motion capture database (IEMOCAP). The fusion of low-level and prosodic features achieve approximate 15–20% improvement in accuracy.

Keywords Emotion recognition · MFCC · Prosodic features · Fusion

1 Introduction

Speech is the fundamental mean of communication of human beings. Speech is generated by time-varying filter vocal tract and periodic sound source. The complex speech signal reflects the characteristics about speaker, language and emotions.

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Unlike other biometrics such as face, fingerprint, etc., speech can be used remotely in recognition system as it is easily transmitted by communication channel. Speaker recognition finds its application in forensic data analysis, interaction with robots, in medical field, offer customization in market, etc. Speaker recognition technology is importantly used in forensics, as many times communication is carried out between two parties through telephonic conversations [1].

Speaker recognition system contains the steps like enhancement of the speech signal, extracting related features and taking suitable classifier to classify feature vector. Fusion at feature level is proposed for speaker recognition from speech signal. Features are of following types. (i) short-term spectral features (ii) suprasegmental prosodic features (iii) high-level features. Prosodic and high-level features are more robust and less discriminative [2]. Speaker recognition system performance can be affected by variability of recording system [3]. By adding high-level features in the system, the performance can be improved as low-level features are susceptible to spectral variation due to noise and channel effect [4]. The MFCC and prosodic features are extracted and fused to increase the gain of the system. The *interactive emotional dyadic motion capture* (IEMOCAP) database is used to train the emotion detection system. Ten trained actors were recorded in five dyadic interactions using scripts and improvisations [5].

2 Literature Review

The work of automatic speaker recognition is mainly dominated by a system using low-level cepstral features. The performance is improved significantly when low-level and high-level information are combined together. Following is the review of papers.

Tomi Kinnunen and Haizhou Li present a review of text-independent speaker recognition system. They have explained both the classical and the advanced methods of speaker recognition. They explained the advanced computational techniques to address robustness against noise and session variability. They elaborate the recent development techniques in speaker recognition [1].

Furong Yan et al. state that the lack of robustness in speaker recognition has remained a major challenge. They present feature warping approach and its effectiveness significantly depends on the relative positions of each of the features in a sliding window. As the relative positions are changed due to the non-linear effect of noise. This paper takes the advantage of ranking feature, which is obtained directly by sorting a feature sequence in descending order [6].

Xiaojia Zhao et al. state that robustness in speaker recognition is crucial for real-world applications. They address noise and reverberation issues. They remove background noise using masking technique with deep neural network classifier [3].

Alfredo Maesa, Fabio Garzia, Michele Scarpiniti and Roberto Chave explained an automatic speaker recognition system based on MFCC and Gaussian mixture model. They have used the *Voxforge.org* audio database from which 450 speakers

are randomly selected, their utterances are enhanced using spectral subtraction, then Cepstral coefficients are extracted and these coefficients are statistically analysed by GMM. Two different speech files from each speaker are used: the first one is used to build the profile database, the other one to test the system performance [7].

Joseph P. Campbell presents that automatic speaker recognition using low-level features such as cepstral features which results in high accuracy but they ignore other level information. Accuracy is increased by adding complementary features. Fusion improves the performance [8].

Literature review reveals that maximum work in the area of automatic speaker recognition has been done by only short-term low-level acoustic features. These systems produced indeed high accuracy with minimum error, and they ignore other levels of information beyond low-level acoustics. High-level behavioural features can be used successfully in ASR systems and have a capacity to improve recognition accuracy and robustness against channel variation.

The performance of speaker recognition system can be improved by fusing low levels such as acoustic cepstral features and prosodic features. The success rate of a system is dependent on variations in recording system. By fusing high-level information, error rate can be reduced.

3 Methodology

The speech signal is enhanced by doing framing, windowing, and pre-emphasizing in pre-processing before feature extraction. A digital filter as expressed in Eq. 1 is used to boost the high-frequency components.

$$S'(n) = S(n) - \alpha\, s(n-1) \tag{1}$$

where α is pre-emphasis filter coefficient which lies between 0.9 and 1.0. The pre-emphasized speech signal is segmented into 30 ms frames with 50% overlapping. Then windowing is used on speech frames. Hamming windowing gives accurate results. It reduces spectral distortion and signal discontinuities.

In this work, two methods are implemented, one is speaker recognition using acoustic cepstral features such as MFCC and the second is combined system which has the fusion of MFCC and prosodic features. Also system has been studied at different noise types and different noise levels. A speaker recognition system consists of two main units: a front–end processing unit that extracts the suitable features from the available speech data, and a classifier that classifies the feature vector of the speech utterance [1].

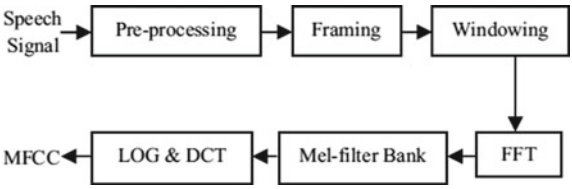

Fig. 1 MFCC algorithm

4 Feature Extraction

4.1 Low-Level Features

They are frame-level features and represents physical traits of vocal apparatus. They deal with spectral properties. The speaker recognition can be improved by using suitable feature extraction methods. Mel-frequency cepstral coefficients are widely used in speaker recognition due to superior performance when compared with other spectral features. Mel scale in MFCC resembles human auditory system [9, 10]. It is approximately linear up to 1 kHz and thereafter, it is logarithmic. Along the Mel scale, triangular filters are linearly placed [11]. The pre-emphasized speech signal is segmented into 20–30 ms frames. Then windowing is used on speech frames. Hamming windowing gives accurate results [12]. Hamming windowing reduces spectral distortion and signal discontinuities. Then fast Fourier transform is applied on windowed signal to obtain frequency response. Mel frequencies are calculated with following equation [13, 14].

For each speech frame of 30 ms set of Mel-frequency Cepstrum coefficients are computed.

$$\text{Mel}(f) = 2595 * \log_{10}(1 + (f/700)) \tag{2}$$

Finally, discrete cosine transform is calculated to convert the signal into time domain. Figure 1 shows block diagram of MFCC algorithm.

4.2 Prosodic Feature Extraction

Prosodic features span over long-term segments and reflect characteristics like emotions, speaking rate, rhythm, different speaking styles, etc. The most important prosodic parameters are fundamental frequency, energy, duration, formants and their related features such as minimum, maximum, mean, median, range, etc., which gives best accuracy. The mean of fundamental frequency conveys physiological property like larynx size and temporal variation in fundamental frequency gives the information about manner of speaking [1]. Pitch F0 is calculated by the autocorrelation function. Basically, pitch means the fundamental frequency of vibrations of vocal

chords. The energy is achieved by averaging energy of each frame. Energy of signal is calculated with the formula $E = \text{sum}(x^2(n))$, where $x(n)$ is speech signal in discrete form. The fundamental frequency (pitch) of the speech signal is calculated with autocorrelation method. Autocorrelation is a correlation of a signal with itself. The maximum of similarity occurs for time shifting of zero. Another maximum occurs when the time shifting of the signal corresponds to the fundamental period. The formant frequencies, i.e. resonance frequencies of vocal tract are calculated with linear prediction method. LPC procedure is applied to calculate linear predictive coefficients. Then the roots of predictor polynomials are calculated to find the peak locations in the spectra of linear predictive filters. Only the roots with positive angles are considered. The angles are converted into frequencies mathematically using equation. Formants F1–F5 are calculated. Euclidian distance classifier is used to classify the feature vector [15, 16].

4.3 Fusion Technique

Feature-level fusion is used by concatenation of feature vectors. Integration at feature level offers good recognition rate. It increases the robustness to unexpected failure of subsystems. The feature set holds richer information about speech signal and also processing time is reduced [17].

5 Results and Discussions

Speaker recognition is implemented with MFCC features at different SNR values, i.e. 10, 20, and 30 dB. Figure. 2 shows FAR–FRR curve for 20 dB SNR with MFCC features. Table 1 shows equal error rate (EER) values for different SNR levels with MFCC. Table 2 shows recognition accuracies with MFCC. The results show that as SNR level improves recognition accuracy increases and EER value decreases.

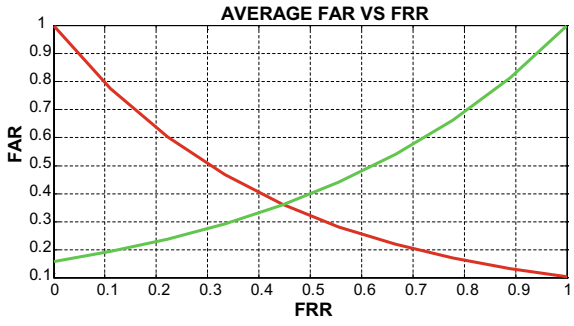

Fig. 2 FAR–FRR curve for 20 dB

Table 1 EER values with MFCC

SNR (dB)	Threshold	FAR (%)	FRR (%)	EER (%)
10	0.38	0.3665	0.3998	0.43
20	0.43	0.3639	0.3181	0.38
30	0.44	0.4677	0.4459	0.36

Table 2 Accuracies with SNR values

Algorithm (dB)	10	20	30
MFCC (%)	58.96	74.21	80.17

Table 3 Recognition accuracies for different SNR values for pitch feature

Algorithm (dB)	10	20	30
Pitch (%)	59.72	74.62	78.91

Table 4 Recognition accuracies for different SNR values for combined features

Algorithm	SNR values		
	10 dB	20 dB	30 dB
MFCC	58.96	74.21	80.17
Pitch	59.72	74.62	78.91
Formants	16.28	33.08	68.81
Combined	73.61	98.61	100

Table 3 shows recognition accuracies for different SNR values with pitch feature. From Table 4, it can be seen that for combined features recognition accuracy increases as compared with only low-level features. Recognition accuracy increases by approximately 15–20% for different SNR levels for combined features technique.

5.1 Results with Pitch

Figure 3 shows the FAR–FRR curves for only pitch feature. The recognition accuracies are shown in Table 3 for only pitch feature.

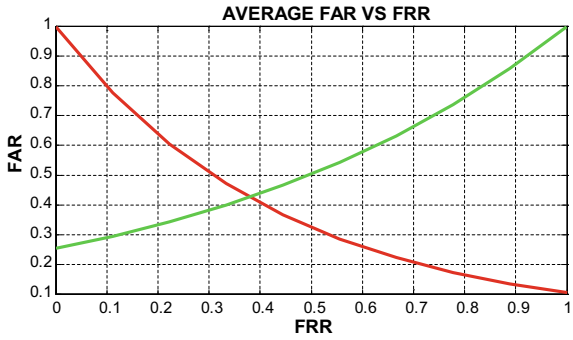

Fig. 3 FAR–FRR curve with pitch (20 dB)

6 Conclusion

Speaker recognition is a need in forensics for voice authentication purpose. Low-level features are having low error rates but ignore other levels of information. Low-level features are susceptible to channel variation and noise present in the system. High-level features show excellent performance when combined with low-level features. High-level features potentially increase the robustness. Fusion improves the performance approximately by 15–20% in speaker recognition system.

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Comparison and suitability of motors for propulsion in electric vehicles

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Abstract. In this research various motors used for propulsion of electric vehicles are studied. Various motors are brushed dc motor, brushless dc motor, squirrel cage induction motor, synchronous reactance motor, permanent magnet synchronous motor and permanent magnet assisted synchronous reluctance motors. The performance of each motor is taken into account. All motors are compressed with various parameters like size, power, efficiency, starting torque, time required for 0-100 rpm, load carrying capacity, noise produced under running condition, cost etc. Hub motor is also studied in detail. Multi-motor drive for electric vehicle is also studied. Comparison of hub motor and normal motor is also done.

Keywords: Electric vehicle, electric motor, hub motor

1. Introduction

The research is related to electric vehicles [1]as various motors used in electric vehicles are compared. Further the research is pertinent to electric motors as various types of motors are used in electric vehicles. [3] In addition the idea is related to electrical engineering as the motors utilized in electric vehicles [2] work on electric energy. Additionally the concept is related to automobile engineering as the electrical motors are used for propulsion of auto mobiles. Furthermore the concept is relevant to transportation as the various electric motors are used in electric vehicles. [1] Likewise the research is related to construction of electric car as an electric motor is used in making car. Similarly the research is to environment as electric vehicles [4] are environment friendly. In the research it is related to pollution control as e vehicles help to reduce pollution. Over and above the research is related to carbon emission as electric vehicle is free from carbon emissions. On the top the idea is related to global warming as electric vehicles [1] help to reduce global warming by eliminating the emissions from the vehicles. Co-jointly the idea is related to oil crisis as electric vehicle do not require any fossil fuel to run. Besides the idea is related to compact electric vehicles [5] as the

electric vehicles are compact as compared to internal combustion engine vehicles. Asides from the idea is related to light weight electric vehicles as electric vehicles [3] are lighter than internal combustion engine vehicles as various parts of internal combustion engine vehicle are eliminated. Beyond that the idea is pertinent to green vehicles [4]as electric vehicles produce no pollution. Together with the idea is related to renewable energy sources as the electric vehicles can utilize the energy produced from renewable energy sources like wind energy and solar energy. Apart from the idea is related to smart vehicles as the electric vehicles can work smartly by using electric motor. Supplementary the idea is related to autonomous car as electric vehicles [5] can work autonomously easily with certain modifications. Correspondingly the idea is related to mechanical engineering as electric motors are coupled mechanically with wheels of electric vehicles. Likewise the idea is related to economy as the electric vehicles are economical.

Manivannam studied electric vehicles. IC engines powered vehicles lead to major emission of Green gas. Improvements in technology does not attract global customers. Because it cost more and is less compatible .Thus a concept of low cost solar powered electric vehicle is being introduced. SPEV consist of inbuilt solar panels(500 watt) to charge the vehicle. It consist RFTD authentication for detecting authorized user. It consist of tachometer for measuring rotation speed. Further it consist of motor controller and a 24V brushless dc motor. It contains a Android OS supported interface. Ultrasonic array for obstacle avoidance is used which use Lora, GPS maps and AI. SPEV charging module consist of a panel made of polycrystalline solar panels (500 watt), a lead acid battery (2 batteries), a motor driver and BLDC motors. The above module charges the battery from solar panel and delivers it vehicle. Since polycrystalline solar panel are simpler and cost effective so they are used. Solar panel placed on side wall delivers 80 watt. The front end provides 20 watt. And at last the top panel provides 400 watt of power. In total 500 watt is generated. There are two batteries which is connected to panels based on SOC data. MPPT is a electronic converter that delivers the best power that a solar panel can give to battery. It is connected to the output of the panels which compare it to the battery voltage supply. It takes the best power to get maximum current into the battery. MPPT are generally 93 to 97% efficient. The power gain varies upto 20 to 45% in winter and 10 to 15% in summers. Charging and discharging of battery depends upon states of SOC. To determine this SOC of battery, open circuit voltage method is used. He provided details of maximum power point tracking. It is a one kind of converter built from electronic devices. It increases the charging efficiency of battery from solar power. He also gave details

of state of charging. It is one of the parameters of battery charging system. He provided details of battery. He used a lead-acid battery. The battery voltage is 24 V. Ampere hour rating of battery is 25AH He also furnished details of motor He used brushless DC motor. Efficiency of the brushless DC motor is high. The efficiency is more than 75%. The life of the BLDC motor is larger than DC motor with brushes. He provided details of charging circuit. The various component of the charging circuit are state of charge detector, microcontroller unit , photovoltaic relay and load relay. The various components of solar photo electric vehicle are – battery ,maximum power point tracking charger , solar panels , GPS unit, GSM circuit , microcontroller unit , RFID reader , LoRa , tachometer, BLDC motor ,controller for the motor and ultrasonic sensors. Authentication of user is done by RFID. For transferring the data Bluetooth technology is used. In his vehicle 32 bit microcontroller id used. He also provided specifications of electric vehicle. The running time of the battery is 6 hr. In his electric vehicle ,location of the vehicle can be found. The dimension of his solar powered electric vehicle is 2mX1.2mX1.6m The capacity of his vehicle is for a single person. His vehicle consume 410 watts per hour. His vehicle can run for 6 hr in one day. So energy consumption of his vehicle in one day is 2460 wattXhr. The solar panel used in his vehicle generated 500W in one hour. In 5 hours the energy generated is 2500 wattX hr. The solar powered vehicle developed MANIVANNAN consist of RFID for user authorization. He used android application for display of parameters like battery status. He provided block diagram for solar powered electric vehicle. The various block in the diagram are solar powered electric vehicle, RFID authentication ,solar power source, android application, electric vehicle server , solar charger , wireless module , motor controller and driveless module. His vehicles are mostly used for universities, amusements parks and industries. He developed unmanned electric vehicles using Google maps. He used ultrasonic sensors to avoid obstacles. He used long range wide area networks for his vehicles. He used LORI for bi-directional communication. He used solar charging trees for charging the vehicles. His vehicle makes no pollution. His vehicles are in category of green vehicles.

2. Objectives

1. The objective is to compare various motors suitable for electric vehicles
2. Further aim is to find the suitable motor for electric vehicles

3. One more goal is to find the motor which is more efficient for electric vehicles
4. Further motto is to find the better motor for the road having steep slope.
5. Likewise the motive is to find the motor which is suitable for heavy load.
6. In the same way the goal is to find the motor which makes less noise.
7. Furthermore aim is to reduce the cost of the electric vehicles by selecting less costly motor for electric vehicles.
8. One more goal is to find the light weight motor so that the weight of the electric vehicle is reduced.
9. Further plan is to find the compact motor for electric vehicles.
10. Besides the motive is to find the motor which is easy to construct and suitable for electric vehicles.
11. Likewise the goal is to find the suitable motor for particular application like transportation, earth moving vehicles etc.

3. Motors Used In Electric Vehicles

1. Brushed D C motor,
2. Squirrel cage induction motor
3. Brushless dc motor BLDC
4. Switched reluctance motor
5. Synchronous reluctance motor
6. Permanent magnet synchronous motor
7. Permanent magnet assisted synchronous reluctance motor
8. Universal motor

4. Classification of electric vehicles

A. According to energy source used:-

1. BEV's – Battery Electric Vehicle.
2. PHEV's-Plug in Hybrid Electric Vehicle.
3. HEV's-Hybrid Electric Vehicle.

B. According to capacity

1. Electric Buses- Range 249km, capacity 31-40 person.

2. Car-Range 500km, Capacity 5-7 person.
3. Scooter-Range 100km, Capacity 2 person.
4. Bike-Range 170km, Capacity 2 person.
5. Boards-Range 20km, Capacity 1 person.

C. According to usage

1. Commercial Use: - Bises, Trucles ,Tasci etc .
2. Private use:- Family cars [2], bike , scooter , boards , etc.

D. According To Type Of Battery Used

1. Lithium-Ion Batteries -0%
2. Nickel-Metal Hydride-12.5%
3. Lead-Acid Batteries.
4. Ultra Capacitors.
5.

E. Method of charging:-

1. Charging station.
2. Solar power
3. Regenerative braking downhill charging.
4. Home wall unit 120volt or 240 volt o/p.

F. According to medium of vehicles

Medium	vehicle
Road	car
Air	aerial vehicle
Water	electric board
Under water	submarine under water

5. Manufacturing Companies

A. Scooters

1. Ather energy pvt. Ltd.
2. Batt RE Pvt. Ltd.
3. KLB KOMAKI Pvt. Ltd
4. Light X Motors Pvt. Ltd
5. Atom Motors
6. Hero motors
7. Hero electric
8. Greendzine Tech
9. Sincero B6
10. CEEON INDIA
11. YO BIKES

B. Motorcycles

1. Ather energy
2. Atom motors
3. SVM Bikes
4. Menzamotors
5. ULTRAVIOLETTE Automotive

C. Hybrid cars [2]

1. Toyota Prius
2. Honda Accord Hybrid
3. Toyota Camry
4. MG HECTOR
5. Suzuki Ciaz
6. Suzuki Swift

D. Buses

1. Ashok Leyland
2. Tata motors
3. Goldstone

E. Mini pick up trucks

1. ECOYAN
2. Mahindra
3. Croyance Automotive; ELECRO

6. Advantages of electric vehicles

1. Electric vehicles have less running cost
2. Less maintenance cost
3. No pollution
4. Can use renewable energy
5. Less harmful to health as no pollution of air surrounding the vehicle
6. No smoke produced
7. Good performance
8. Less noise
9. Easy to drive
10. cost effective

7. Conclusions

It is concluded that if multi motor is use small motors can be used. Likewise they are easy to fit in the vehicle. Further the motors can be connected in series or parallel to increase or reduce the voltage level. Besides it is concluded that the switched reluctance motor are robust. Additionally it is concluded that the efficiency of the switched reluctance motor is high. It is also concluded that the switched reluctance motor good power density. Over and above the switched reluctance motor has good torque density. It is also concluded that the cost of the switch reluctance motor is less. The speed range available in switched reluctance motor is wide. In the same way it is concluded that the switched reluctance motors are suitable heavy electric vehicles.

8. Acknowledgment

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BİOGRAPHİES

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Enhancing Performance of an Electric Vehicle on slope Using Supercapacitor

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Abstract. In this research super capacitor is used in the electric vehicle along with the battery. The electric vehicle performance is increased with the super capacitor. The super capacitor is switched on at the time of slope. The load on the battery at the time of slope is eliminated using the super capacitor. The battery is protected from drawing the over current at the time of slope. The battery life is also increased with the use of super capacitor. The switching of super capacitor is done automatically.

Keywords: Electric vehicle, super capacitor, battery

1.Introduction

The goal is related to electric vehicle as super capacitor is used In the electric vehicle. In conjunction with the idea is pertinent to super capacitor as super capacitor is used to support the battery. Over and above the idea is relevant to batteries as battery life is enhances using super capacitors. Apart from, the idea is related to electrical engineering as super capacitors ,brushless motors and a battery is used in the experiment. Supplementary the idea is to road slope as the performance of electric vehicle is improved on slope by using electric vehicle. Together with, the idea is to protect batteries as batteries are protected from drawing over current at slope due to use of super capacitor, Additionally the idea is related to clear technology as electric vehicle performance is improved by using the super capacitor. Beyond that the idea is related to pollution as pollution is eliminated by avoiding use of hybrid vehicles consisting of ic engines to be utilized at the time of slope. Yet another idea is related to energy of the electric vehicle as energy is utilized efficiently by the use of super capacitor. Conjointly the idea is related to energy storage as electrical energy is stored in super capacitors and is utilized when the slope comes. On the top the idea is related to automation as automatic switching of super capacitor is sone at the time of the slope. Asides from the plan is related to improving the performance of the electrical vehicle at the slope by using super capacitor.

K.W.E. Cheng studies electric Vehicles. He studies various components of electric vehicle. He studied batteries of electric vehicle. He studied charging technology of electric vehicles. He presented a comparison of various motors used for electric vehicle. He also presented the work related to braking and steering mechanism. In electric vehicles motor is used instead of internal combustion. Electrical energy is used to run the electrical vehicle. Now a days commercial electrical vehicles [1] are also used. The tax on electric vehicle is also less in mass of the countries as they create no pollution. In some countries charging facility of electric vehicle is free. Hybrid electric Vehicles are also developed. Almost all car manufacturing companies have developed hybrid cars. In hybrid electric vehicles [1] the car does not depend only on battery. Even battery of electric vehicle can be changed from internal combustion engine if required. There are two typed of hybrid electric vehicles. [1] One type is series electric vehicle and other type is parallel hybrid electric vehicle. In series hybrid electric vehicle all propulsion power is derived from battery only. In parallel hybrid electric vehicle propulsion power is derived from both motor and internal combustion engine simultaneously. Motor act as generator during breaking. During deceleration time motor act as a generator. In both series and parallel hybrid electric vehicles [2] motor act as a generator during breaking and deceleration. That energy can be used to charge the battery. In plug in hybrid electric vehicles [2] the battery is charged from supply at convenient time. The major components in electric vehicles are battery, battery charger inverter and motor. If ac motor is used for propulsion of electric vehicle the voltage from battery is inverted using a suitable inverter as the battery gives DC voltage. The components of electric vehicles [2] are used using a dc to dc converter. DC to DC converter can give reduced dc voltage varying from 5 to 20 V. Various types of motors are used in electric vehicles. Various motors used in electric vehicles are DC motors ,DC brushless motors, induction motors switched reluctance motor and permanent magnet are used. Normal dc motor the commutator of the motor carbon brushes are rested so as to collect or give supply to electric machine i.e. electric motor. There is a wear and tear of brushes and brushes are to be replaces from time to time. In golf electric cars DC electric vehicles [3] are used. Induction motors are also used in electric vehicles. Induction motor are used along with a variable speed drive. For electric vehicles more than 5KW induction motor is preferable. For providing sufficient torque and speed control vector drive is used. DC brushless motor is also used in electric vehicles. [3] Conventional DC motors are not mechanically much strong. In conventional DC motors the low power winding i.e. Filled winding is stationary. THE higher power winding conventional DC motors are rotating. In the brushless dc motor these disadvantages are overcome. In brushless dc motor high power winding is stationary. The low power winding is kept on a rotating motor. In the motor

permanent magnet is used. The brushless DC motor is lighter than conventional DC motors. With a pertinent driver circuit brushless DC motor can be employed at the place of conventional DC motor. Brushless dc motors are used in small electric vehicles. [3] Permanent magnet synchronous motor are also used in electric vehicles. The motor of the permanent magnet are fixed. In permanent magnet motors the air gap is developed by permanent magnet. Sinusoidal AC voltage for running the permanent magnetic synchronous motors. Switched reluctance motors are also used in electric vehicles. [4] The fault tolerance capacity of reluctance motor is more. Reluctance motor has a feature of variable reluctance. In direct drive mechanical losses are reduced. In electric vehical motor can be filled in the wheel. Because of this construction clutch of the gear box is not needed. The speed of the vehicle can be controlled using speed control of electric motor fitted in the wheel. The motor fitted in the wheel of elastic vehicle is called as hub motor. Four independent motors can be fitted in the four wheels of the electric vehicles. [4] The advantage of this construction is that each motor can be controlled separately. with the help of this construction of electric vehicle parallel breaking can be used. The construction of the electric vehicles [4] is simpler than the conventional vehicle. Various types of motor are employed in the wheel of the electric vehicles. Most of the time reluctance motor is preferred. Each winding of reluctance motor is independent. The fault tolerance of such motor is higher. Permanent magnet is not used in the reluctance motor. Due the elimination of the permanent fluctuations caused due to permanent magnetic material are avoided. In electric vehicle battery is used for energy storage. The battery is the most important component is electric vehicle. Nowadays lithium-ion battery is used in electric vehicles. [4] Lithium-ion battery is not stable and there is a risk of explosion. So as compared to lithium –ion other lithium batteries like LiFePo4 is more suitable. Other lithium batteries like LiCO2 and LiMn2O4 may have the problem of thermal instability. These batteries may also have problem of over charging. To reduce the cost still lead acid batteries are used in electric vehicles. [5] The battery with crystal structure have charging speed 100 times higher than lithium ion batteries. Ultra capacitor may also be employed in electric vehicles. [5] Ultra capacitor is a static device. The charging and discharging speed of ultra capacitor is very high. Ultra capacitor has a power density and low energy density. The energy storage density of ultra capacitor is less than 20% of the lead acid battery. Research is going on to increase the capacity of the ultra capacitor. Ultra capacitor can withstand larger no. of charging and discharging cycles than battery. It can withstand higher temperature also. Ultra withstand around 5lakh charging and discharging cycles. The working temp. range of ultra capacitor is from -45degree celcius to 85 degree celcius. The cost of ultra capacitor is 50 thousand dollars per KWH. The energy density is 5WH/kg.

2. Challenges in electric vehicle

1. The electric vehicles produce less driving force as compared to I C engine vehicles.
2. Battery of the electric vehicle require more charging time.
3. Further the life of the battery of the electric vehicle is less.
4. Similarly charging stations are required to be built along the roads
5. Need time to time battery replacement as battery efficiency becomes less after some days.
6. Electric vehicles are not suitable for area of load shedding.

3. Objectives Of The Invention

Objectives of the innovation are as follows.

1. The aim is to use a super capacitor to support battery
2. Likewise the goal is to increase the life of the battery by using super capacitor
3. Similarly the target is to protect the battery from drawing over current at the slope
4. In the same way the purpose is to improve the performance of the electric vehicle at the slope
5. Further the intention is to increase the distance travelled by an electric vehicle in one charging cycle
6. Furthermore the plan is to reduce the number of charging and discharging cycles of the battery required for the given performance of a electric vehicle
7. Besides the objective is to reduce the money spent to purchase the battery'
8. In addition the endeavor is to increase the efficiency of the battery
9. Additionally the aspire is to reduce the overall running cost of the battery'
10. In the same way the ambition is to increase the utilization of electric vehicle

4. Major Electric Vehicle Manufacturing Companies

1. Mahindra India
2. Tesla
3. Suzuki
4. Honda
5. Hyundai

5. Advantages Of Electric vehicles

1. No fuel consumed by electric vehicles.
2. Similarly electric vehicles emit no smoke.
3. Likewise electric vehicle produce no pollution
4. In the same way running cost of the electric vehicles is less.
5. Further electric vehicle requires less maintenance cost
6. Furthermore performance of the electric vehicles is better.
7. Besides electric vehicles are environment friendly
8. Asides from renewable energy can be used to charge the electric vehicle
9. Over and above smart vehicles can be used to store the energy from renewable energy sources and can feed energy to the grid
10. Correspondingly electric vehicles use eco friendly materials
11. Additionally electric vehicles are better for health as no smoke is produced
12. In addition weight of the electric vehicles is less as compared to petrol and diesel vehicles
13. Conjointly electric vehicles do not depend on foreign import of oil
14. Together with there is a saving money on running cost of electric vehicle.
15. Beyond that electric vehicles produce less noise pollution.
16. Supplementary there is less risk of explosion in electric vehicles.
17. Top of that electric vehicles require no gas and petrol required.

6. Electric Vehicle Motors

1. D C motor
2. Squirrel cage induction motor
3. Brushless dc motor
4. Switched reluctance motor
5. Synchronous reluctance motor
6. Permanent magnet synchronous motor
7. Permanent magnet assisted synchronous reluctance motor

7. Super capacitor

Super capacitor is also known as ultra capacitor. The capacitance of the super capacitor is very much larger than the normal capacitor. The voltage rating of the super capacitor is less. Super capacitor has the ability to store almost 100 times extra energy than electrolytic condensers per unit mass or volume. Super capacitor can charged in a very less time. Even it can also be discharged in a very less time. Super capacitor can with stand more number of charging and discharging cycles. Super capacitors have applications in automobile sector. There are various types of super capacitors available. Electrostatic double layer capacitor is one of the types of super capacitor. In this type of super capacitor electrodes are made up of carbon. Another type of super capacitor is electrochemical pseudo capacitor. In this type of super capacitor electrodes are made up of metal oxide. Sometimes conducting polymer is also used as an electrode material in this type of super capacitor. The third type of a super capacitor is a hybrid capacitor.

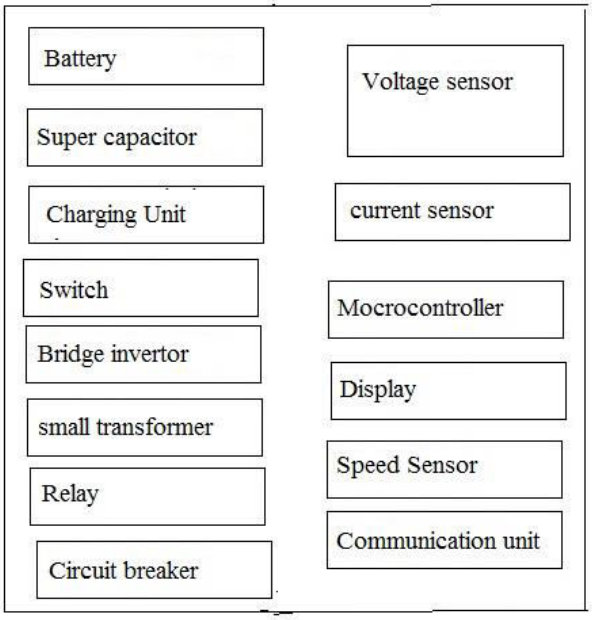
8. Statement Of Invention

In this innovation the electric vehicle is equipped with a super capacitor. When the electric vehicle moves on the slope there is a load on the battery. The electric vehicle draws more current from the battery. The battery can be discharged earlier if the electric vehicle has to travel on the slope. Here the idea is to use a super capacitor at the time of the slope. The energy is fed to the electric vehicle at the time of the slope. The battery is cut from the circuit at that time. The battery is saved from discharging at the time of slope. Super capacitor is a device which can be charged and discharged in a very less time. It feeds large amount of energy to the vehicle at the time of slope.

9. Description of research

In the research super capacitor is used at the time of slope. Under normal conditions i.e. when there is no slope on the road, batteries is used to supply electricity to the motor of the electric vehicle. By the same time super capacitor is charged using a dynamo fitted on the wheels of the vehicle at the time of the retardation. So to charge the super capacitor electricity is not drawn from the battery

Description Of Figures



Block diagram of an electric vehicle equipped with super capacitor

10. Parts of the electric vehicle super capacitor system

1- Battery
2- Super capacitor
3- Charging unit
4- Switch
5- Bridge inverter
6- Small transformer
7- Relay
8- Circuit Breaker
9- Voltage sensor
10- Current Sensor
11- Microcontroller
12- Display
13- Speed Sensor
14- Communication Unit

11. Advantages Of Using Super Capacitor Along With The Battery

The advantages of the innovation are as follows.

1. Battery life if electric vehicle is increased as on the slope super capacitor feeds power to the electric vehicle
2. Performance of the electric vehicle is improved on slope considerably.
3. Distance travelled by electric vehicle in one charge is increased
4. Number of charging circles requires for a battery in a life time of a battery is reduced
5. Cost spent on purchasing new battery is reduced
6. Efficiency of battery is improved
7. Over all running cost of electric vehicle is reduced
8. Over current is not drawn from the battery at slope
9. Battery plates are protected from bending
10. Utilization of electric vehicle is increased

12. Claims

The claims of the innovation are as follows.

1. It is claimed that the performance of the electric vehicle is increased by using a super capacitor along with the battery. Similarly battery plates are protected from bending as drawing of large current is avoided at the time of slope.

2. As stated in the claim 1 it is claimed that the number charging and discharging cycles required for the vehicle are reduced. Likewise it is claimed that the battery life is increased.

3. As per claim 1 it is claimed that the super capacitor is charge during the retardation of the vehicle by using a dynamo so no electricity is drawn from the battery to charge the super capacitor. Further it is claimed that the distance travelled by the electric vehicle in one charge is increased.

13. Conclusions

It is concluded that the performance of the electric vehicle is enhanced with the use of super capacitor. It is also concluded that the life of the battery is increased considerably. It is also concluded that the current drawn from the battery at the time of slope is eliminated. In the same way it is concluded that the cost required to purchase a new battery is saved. It is also concluded that the overall running cost of the battery is reduced.

14. Acknowledgment

We are thankful to Army institute of technology, Pune, India for providing supercapacitors for providing anemometers.

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River water pollution management utilizing smart sensors along with internet of things

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Abstract. In this research the monitoring system for river water is developed using Internet of Things. The river water is polluted because of urbanization of industrialization, because of pollution of river water lot of health issues have arisen. In this research the river water is monitored using various underwater sensors. The data is transmitted to control room or cloud. The remedial measures can be taken to prevent the pollution of the river water

Keywords: Internet of things, river, sensor

1. Introduction

The research is related to river as pollution of river is monitored using internet of things. [1] The idea is related to water pollution as pollution of river water is being monitored using IOT. Likewise plan is related to water as water quality is being monitored used Internet of things. [1] Furthermore, the research pertinent to underwater sensor as underwater sensors will be used to monitor the river water pollution. In the same way the research is related to various sensors will be used to monitor the river water parameters. Correspondingly, the research is relevant to Internet of Things[1] is utilized to monitor the river water. In addition, the research is related to processors as various processes like Arduino and raspberry pi is used for processing the data. Additionally, the research is related to communication of data as data collected by various sensors is transmitted to the control room or to the service engineering. The research is related to health of human beings as river water is required to health of human beings as river water is required to human beings for various purposes. Next, the research is related to flora and fauna around the river bank pollution is being monitored. Beyond that the research is relevant to aquatic life of river as polluted water may be harmful to various underwater animals like fishes, frogs, etc. On the top the idea is pertinent to boating, as in the polluted water it is difficult to run the boat. Further the research is related to water transportation system, as in the polluted water it is

harmful to people commutating through boat. Further the research is related to boating competitions clean water in the river will be appreciated. Further the research is related to monitoring chemical factories which dump process chemically in the river water unauthorisly. Further the research is related to smart city as in smart city as in smart city prime importance is given to the cleanliness of river water.

Priya Matta gave details of internet. Internet of things[1] technology started in 1999. Various components of Internet of things are discussed by Priya Matta. The term internet of things [1] was first used buy entrepreneur from Britain. The range of the Britain entrepreneur is Kelvin Ashton. The internet of things network of objects is made globally. All these objects are connected by some radio signal. The network of computer is global range is called as internet. Internet of things [1] provides connectivity among the thing which are connected and also provide computer facility. Nowadays, use of internet has increased to a large extent. There is good internet connectivity in all sectors. Due to mobiles, everyone has an internet connected in the pocket. People of towns used to communicate using the internet. In Internet of Things, [2] the devices are connected to each other by internet. IoT consists of various things, actuators, sensors and storage devices. These consist of various devices, objects, computers, human beings animals, smart phones, vehicles, etc. There are various sensors used in IoT. These sensors perform task and data collection for various applications, pertinent sensors are used. The sensors may be for vision, tactile sensor i.e. touch sensor, hearing sensor, position sensor, temperature sensor, moisture, etc. The role of the sensor is to convert functional energy into electrical signals. In IoT, actuators play an important role; its role is to convert electrical signal into a function. Various types of actuators used are electrical actuators, numerical actuators, hydraulic actuators, piezoelectric actuators, etc. The role of the actuator is to initiate a motion, the data collected by sensor is processed by processors. The processor can be Arduino, or the Raspberry Pi. The actuators and sensors are the key components in IoT. Sometimes hydraulic power is used for movement in hydraulic actuators. Pneumatic energy is used for movement in pneumatic actuators. Thermal energy is used for movement in thermal actuators. Electricals energy is used for movement in electric actuators. In IOT lot of devices are used according to applications. Various communications methods are also used in IOT. Large amount of data is produced in IOT. Various storage devices are needed to store this data. This data is also needed to be processed for particular application. Various processors like Ardino, Raspberry pi are used for processing the data. Internet of things [2] can be used for monitoring smart banking. Internet of things [2] can also be utilized for monitoring health. Similarly IoT can be used in smart banking. In IOT data is

stored using cloud technology. In IOT various things are involved. The various things involved are machine, animals, human beings, plants and various objects. Internet of things [2] consists of things equipped with computational facilities. IOT also consist of various sensors like touch sensor , vision sensor ,position sensor, distance sensor , hearing sensor etc. Conventional internet is not equipped with sensing ability. Conventional internet is used to connect intelligent devices. Internet connectivity plays a vital role in IOT. In IOT cloud computing plays a key role. There are various companies which provide free clouding facilities. These companies are providing free hoisting services for IOT devices. Various companies which provide free cloud computing and free hoisting facilities are NIMBITS, Arkessa open IOT, littlebits etc. Various sensor sense the data from the things. These collected data is further sent to the cloud. This collected data is processed over there. So, cloud technology serves this purpose. Firstly cloud computing technology can be used for storage purpose. Secondly, the cloud computing technology can also be used for processing and computation of data. Due to increase used of IOT, the amount of data generated is increased. This data is also collected from large geographical area. The size of the data collected is also large. The no of things involved in collection of data are also larger. The data collected is also of various types. In IOT such data is needed to be stored. Further this data is processed according to the requirement. This data is also required to be accessed frequently. Various types of data is also require different speed for collection. Different types of data have varied volume. Such kind of data is called as BIG DATA. Various technology are used to handle these BIG DATA. Various technology used to handle these data are ISaaS, Hadoop , SCIDB. These technologies are used for analysis of BIGDATA. Various sensors collect the data. This data is used as input to the computer deuce. BIGDATA plays a vital role in Internet of Things. [2] Various enabling technologies are used in Internet of Things. Various enabling technologies used in Internet of Things are ZigBee , Optical codes , Quick Response codes(QRC), near Field communication, Radio Frequency Identification(RFI) & Z-Wave, ITE Advanced & 6LOwPAN,etc. ZigBee enabling technology is a one kind of communication technology. The data Transmission rate in ZigBee technology is less. The data transmission range is also less in ZigBee enabling technology. The cost of ZigBee Technology is also less. ZigBee technology consumes less power. The range of the ZigBee technology is from 10 to 100 meters. There are various applications of ZigBee for short distance. ZigBee can be used in medical devices for collection of data. Similarly, ZigBee can be used in wireless switches. Further, ZigBee can be used in home automation system. In the same way, ZigBee can be used for management of system. Near field communication is also one of the technologies used for communication purpose. Radio Frequency identification technology is also used in

IOT. Radio Frequency identification technology is better than near field communication. Radio signals are used in both RFID and NFC technologies. In Radio Frequency identification radio waves are used for Identification of Things. The various components of radio frequency identification technology are Antenna, Reader and Tag. In RFID Technology transmission of signals takes place from reader towards the tag using Antenna. The role of the tag is to generate the Information and to broadcast it. Active RFID tags consist of a power source. Normal RFID tags receive power from RFID reader. The broadcasting range of RFID technology is from 25 to 100 meters. For secure data transmission near field communication is used. Optical code technology is also one of the enabling technologies. Optical codes are in the optical form. Optical codes can be read by the machines. Optical codes consist of information related to objects. There are 2 types of optical codes. The optical codes may be one-dimensional or two dimensional. Optical code may be one dimensional or two dimensional. Quick response code technology is also one of the enabling technologies. Quick response code technology is also one of the enabling technologies. In QR code various black colored squares are used. In QR code technology square Background of white color is used. In Quick Response code the Black squares are arranged in a grid format. Imaging devices are used to scan the code. They use various encoding modes. Various encoding modes used are; kanji , binary , alphanumeric and numeric. Data is stored in these codes. These codes are fast readable. All the above features made quick response codes suitable for identification of object. So, quick response code is very much suitable for internet of things. [3] LOW PAN is one kind of IPV6 i.e. Internet protocol. LOW PAN is also used in IOT as one of the enabling technology. It is used for communication purpose. LOWPAN stands for low power wireless protocol data network. It is a kind of internet protocol. Conventional internet protocol do not support wireless network covering low power. Some conventional internet protocols are not much reliable. Some conventional internet protocols are not much secure. IPV6 6 LOWPAN overcome all these drawbacks. IPV6 6 LOWPAN internet protocol is much secure. It has a facility of auto IP authentication. It provides encryption facility. It also provides web service facility. IPV6 has larger capacity as compared to IPV4. IPV4 has only 32 bit address capacity. IPV6 can store 3.4*1038. In IOT large number of embedded devices is used. These devices are enabled with internet protocol. All these devices are connected to each other. All these devices have their unique identity. The number of IOT devices will become in trillions in the coming future. IPV6 providing large space for addresses. IPv6 is more suitable for communication in Internet of Things. [3] Another eruption in technology in the Internet of Things [3] is LTE Advanced i.e. LTE-A. LTE stands for Long Term Evaluation. LTE-A is an upgraded version of LTE. LTE-A is an efficient device

for communication. Its used for high speed communication. It is compatible with 4G systems. Its used for communication between vehicles. One more communication protocol used in Internet of Things [4] is Z wave. It can be used for automation purpose. Mostly its used in home automation system. It can be used for wireless control of lighting system. It can be used for opening and shutting of doors and windows. In the same way it can be used in swimming pool management. Likewise it can be used in garbage management system. It can be used for home security system. There are various IoT platforms. These various IoT platforms are "Xively, AllJoyn,2lementry, IoTivity, EVERYTHING, Homekit". Xively is a one kind of cloud computing service for public. It is one kind of IoT service platforms. Xively provides data services. In the same way it provides directory services. Likewise it can also provide security service. Likewise it can also provide security service. Further it can be used for web management. It can be used as a storing the data in cloud. It has software and hardware facility for storage purpose. It can process large numbers of messages every day. It can even process upto 90 billion messages. It can provide information about product. It can collaborate with some systems it provides complete automation. It can monitor the user profile. It can also update user profile. AllJoyn is also one of the platforms used in IoTs. It is one kind of open framework. It provides communication facility between various devices. It also provides facility of cloud connectivity. It allows different devices to communicate with each other even if their manufacturer is different. In this technology the device which produce the signal is called as consumer. The device which senses the signal is called as Consumer. It can be used in home automation system. In home automation system it can be used for management of smart circle. It can also be used in smart television and smart audio etc. IOTVITI- It is also one of the platforms used in IoT. It is one kind of one source framework. It provides facility of connecting various devices. It provides facility of connecting the devices with each other and also with the internet. It also provides facility of messaging service. It also provides security system. 2lementry- It is also one of the platforms of IoT. It provides facility of connecting the devices, individuals and enterprises. It converts raw data into real time data which is useful to consumers. It also provides good security of data. It uses different encryption techniques. Homekit- It is also one of the platforms used in IoT. It provides a facility of connecting various devices. It provides the interface facility for human beings. It provides facility of multiple users. It has facility to work with third party communication. It can discover the devices. It has the facility of dispatching the data. It is also one of the platforms in IoT. It is one kind of cloud based platform. It provides cloud computing facility. It has facility to manage the real time data. It provides good security by using encryption and authentication. IoT can be used

for environment monitoring in smart cities, in smart energy meters, in smart water facility, in retail sector, in security services, in industrial control system, logistics, in animal farming, agriculture farms.

2. Objectives Of The Research

The objective is to develop a system for monitoring the river water pollution.

1. Further aim is to use Internet of Things [4] to monitor the pollution of river water.
2. Likewise the motto is to monitor the river water pollution round the clock.
3. In the same way the target is to monitor the river water pollution with reduced man power.
4. Furthermore, the goal is to reduce the cost required to monitor the river water pollution.
5. In addition the purpose is to develop an automatic system to monitor the river water pollution.
6. Yet another motive is to keep an eye on the chemical factories disposing the harmful chemicals in the river water by monitoring the quality of water.
7. Next motto is to provide a research facility to carry out research on aquatic life on river.
8. Another goal is to carry out the research on impact of pollution of river water on fishes.
9. One more goal is to keep the river water clean flowing through the city.
10. Yet another goal is to move the health of the people staying near by the river bank.
11. Further goal is to promote the river water transportation system by keeping the river water clean.
12. Further goal is to promote the boating competition in the river water by keeping river water clean.
13. Further goal is to promote tourism in the city by keeping the river water clean.
14. Further goal is to provide clean water to the agriculture sector for irrigation purpose.
15. Yet another goal is to provide clean water to farming, preventing soil pollution.
16. Further goal is to display the pollution level of river water for people living near the river bank.
17. Further goal is to prevent the pollution of underground water bodies by keeping the river water clean.

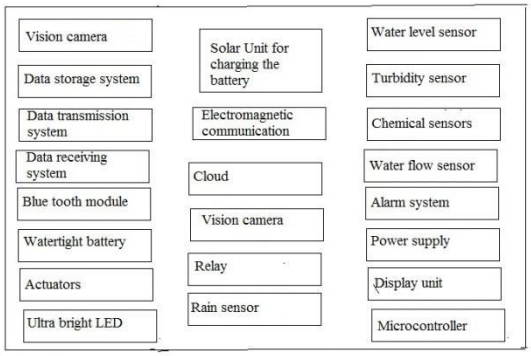
3. Statement Of Invention

In this research the river water is being monitored using internet of things. [4] Various sensors are fitted in the river. The water pollution level of the river is also monitored round the clock. The water level in the river is also monitored using water level sensor. This information can give the information of the probable flood situation. If pollution in the river is maintained to a minimum value it can promote tourism in the river water. Boating facility can be provided in the river. Clean water will be available to the farmers. The crop produced will be of good quality.

4. Description Of Invention

The innovation is in a providing the river water monitoring facility using internet of things. [5] Various water parameters of the river are monitored round the clock by using suitable sensors. Turbidity of the river water is being monitored. The presence of harmful chemicals in the river can also be monitored. This prevents the chemical companies from delivering chemicals in the river. The aquatic life in the river I saved due to this. The fishermen get fishes for fishing if the river water is of good quality as there is a good rise in the number of fishes available in the river. The flora and fauna around the river is increased. There is great help to enhance the biodiversity near the river bank. The number of tourists visiting the river bank are increased. The overall economy around the river is strengthened.

5. Description Of Figures



Block diagram of a river water monitoring system using internet of things

6. Parts of the river water monitoring system

1. water level sensor
2. water pollution sensor
3. Turbidity sensor
4. water flow sensor
5. Rain sensor
6. microcontroller
7. Display unit
8. Alarm system
9. Data storage system
10. Data transmission system
11. Communication system
12. Cloud
13. Battery
14. Vision camera
15. Vision sensor

7. Advantages Of The River Monitoring System Using Iot

1. The Quality of river water can be monitored easily round the clock.
2. Similarly, the manpower require to monitor the river water using IOT is less.
3. Likewise the cost required to monitor the river water pollution is less.
4. Further the water pollution can be monitored easily using IOT.
5. Furthermore the data related to water pollution can be stared easily.

6. In the same way the data collected related to river pollution can be stored on cloud.
7. Complete automation of the system is developed for monitoring the river water pollution.
8. Research facility to carry out research on river water is provided.
9. It is easy to keep a watch on the chemical factories disposing dangerously chemically in the river water.
10. Aquatic life is saved by preventing the pollution of river water.
11. River water is kept clean throughout the year by preventing the human beings through the harmful pollutants in the river water.
12. Impact of pollution of river water on fishes can be studied easily with the IOT equipped monitoring system.
13. River water transportation is promoted by keeping the river water clean.
14. The pungent odor of river water is prevented keeping the river water clean.
15. The health issues of the people staying around the river bank are not created.
16. Clean water can be supplied to the agriculture factor.
17. Tourism in the city can be increased by keeping river water clean.
18. Boating competitors can be held in the river water if the water is clean.
19. Clean water can be provided to agricultural sector so as to prevent the pollution of soil.
20. Cleanliness parameters of river water can be displayed for the public easily using IOT.
21. Pollution of underground water bodies can be prevented by preventing the water pollution.

8. Claims

1. It is claimed that by using this system equipped with IOT the river water pollution can be monitored round the clock. The water level of the river can be monitored round the clock which can be useful in preventing the flood situation.
2. As stated in the claim 1, it is claimed that by using the system the manpower required to monitor the river water pollution is reduced. Likewise it is claimed that the flora and fauna around the river bank is increased.
3. As per claim 1 it is claimed that the river water pollution data can be transferred to the control room or the cloud immediately. It is further claimed that the chemical factories are preventing from delivering chemicals I the river water.

9. Conclusions

It is concluded that using this system river water pollution can be monitored round the clock. Further it is conclude that by using Internet of Things, [5] the less manpower is required to monitor the river water pollution. In the same way it is concluded that the water pollution data can be transmitted to control room or cloud automatically frequently. It is also concluded that the river water monitoring method using IOT is very efficient. It is also concluded that using this system it is easy to keep an eye on the industries which dispose harmful chemicals in the river. It is also concluded that using this system the river water can be maintained very clean. It is also concluded that due to clean water of river the health issues of the people staying near the river bank are reduced.

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Green House management Using Intelligent sensors and Internet of Things

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Abstract. . In this research the green house is equipped with internet of things. Various sensors are used to monitor the growth of crop in the green house. The data is being captured around the clock and is send to cloud. The data can be accessed remotely and growth of crop can be monitored. Various processors like arduino and raspberry pi are used for processing the data. The water is fed to the plant automatically. The water pumps are started automatically when the signal is fed by the moisture sensor. The human power is required is reduce due to internet of things. The overall cost of production is reduced to internet of things.

Keywords: Green house, Internet of things, sensors

1. Introduction

The research is related to internet of things [1]as it is used to monitor the green house. The research is related to agricultural sector as the growth of crop is monitored using iot. Likewise the research is related to computer engineering as data collected is stored on the computer. Further the research is pertinent to cloud computing as data is stored on cloud. In the same way the research is relevant to sensors as various sensors are used in the proposed system. Over and above the research is related to electrical engineering as various electrical equipment are used in the system. Furthermore the research is related to processors as processors as arduino, raspberry pi are used in proposed system. Similarly the research is related to electronics engineering as various electronics system are used in proposed system Further the research is related to the batteries as battery backup is used in increase the reliability of the proposed system. Besides the idea is related the vision sensors as various vision sensors are used to monitor the growth of the crop. Furthermore the idea is related to saving of water is given to the crop. Further the idea is related to saving of water as in this system required amount of water is given to crop using IOT. Research is related to agricultural yield as

agricultural yield is enhanced. Research is related to agricultural research as this system can be used to conduct research.

Komal Jaiswal carried out the research related to security of internet of things. [1]Security is the vital component for Internet of Things. [1]There are four layers of Internet of Things. [1] The first layer is called an Observation layer, which identifies the data from physical things. In observation layer, various sensors lie touch sensor, vision sensor, position sensor, distance sensor and hearing sensor are used. The second layer is called the Network Layer. Network Layer performs the task of exchanging the data. The third layer is called as application layer, which provides human-machine interface. The fourth layer is called as Data Handling layer, which performs the task of data management. In IoT, wireless technology is used. In IoT, radio frequency identification system plays an important role. In RFID technology, RFID tags are used. RFID Tag is one kind of micro chip. RFID Tag is connected to receiving device. Some RFID Tags are equipped with power supply. In IOT , sensors play an important role and are connected to a network. IOT can be used in military applications, industries, the environmental parameters and in the medical sector. Middleware is one of the prime components of IOT and consists of four sub layers. The first sub layer is called as application layer and provides a facility to design and structure to the user. The second sub layer is called the service composition sub layer, the role of which is to collect the services for particular applications. The third sub layer is called as service management sub layer. The task of the service management sub layer is to manage objects. The fourth sub layer is called as abstraction sub layer which accesses the device. Because of the evaluation of wireless technologies some security issues have emerged. Various protocols have been developed to tackle the security issues.

In IOT, various sensors are needed to be installed. There are various hardware issues in IoT, there is also an issue of networking. Some security issues in IOT are clowning, blocking, replay attacks, eavesdropping and jamming. There are various hardware issues in IOT. There is also issue of network in IOT. Some security issue in IOT are tag cloning , blocking , replay attack , eavesdropping and jamming etc. There can be some network issue like attack on sensor network. Due to jamming there is a disturbance in the communication system of internet of things. [1] Noise is related by radio transmitters. If the data is interrupted during data generation and transmission by it is called as eves dropping. Sometimes the data is hacked by attacker. Attacker can use duplicate tag for hacking purpose. Shielding is provided to the tag to avoided replay attack. Due to shielding of tags duplication of tag becomes impossible. Sometime tag is blocked by attacker. Due to blocking of tags there is interruption in service. This situation is called denial of

service DOS. The situation is called as blocking. Security issue of blocking is tackle by detecting the blocking at initial stage. If the duplicate tag are prepared by the attacker then it is called as cloning of tag. Authentication is used to tackle the cloning the issue of tag. There are various type of attack on sensor network. There can be attack on authenticity and secrecy. These type of security issue can be reduced by using cryptography. Sometimes the attacker bring hurdle in of network availability. In that care of internet of thing[2] cannot work. Sometimes the attacker attack the actual data. Similarly the attacker can attack the system physically. There are various challenge in implementation of IOT. The various challenge in internet of things[2] are security of data , security , issue of android , security of protocol and verification of the data. Authorization and verification of data is one of the prime challenges in internet of things. [2] Security of data is second challenge in internet. The data is in huge amount which also cause some security issue. There are two method to make the data secure. The first method of securing the data is called as the amassing. The second method of securing the data is called as anonynmization. Sometimes data hiding is structure use to hide the data to improve security of data. For securing the data various cryptosystem are used. Various cryptosystem and key cryptosystem. Open key cryptosystem give better performance for data security and authenticity. There are various security issue in android system as well. When various devices are connected to android system security issue is arise. Due to this spillage of data can occurred. Cryptographic sensor system consist of various component. The first component is called as detection mechanism. The second component of cryptographic sensor is called as security routing system. The third component of cryptographic sensor is called as key administration. The various technique use for security of data are security leading method , by using instrument for detecting the interference , key course method and coding method. Administration of key is also one issue in data security. Security of routing system is also one of the issues. Security is needed in transfer of data. For securing the data three method are used. The first method is called as secure routing methodology. The second method of securing the data is called as various level base directing. And the third method of securing the data is called are bared steering. In care of interruption the sensor system does not work. So tackle this interruption, interruption detection system is used. Data security system is prime component of internet of things. [2]

2. Objectives Greenhouse using IOT

1. The objective is to facilitate the green house with iot
2. Further goal is to monitor various environmental parameter in the green house
3. Next target is to utilize the resources carefully by using iot
4. One more aim is to monitor the moisture in the soil of green house
5. Further objective is to provide information to the owner green house with advance communication system
6. Farther more goal is to monitor the growth of plant in green house remotely
7. Yet another aim is to reduce the man power required for the green house management
8. Further goal is to reduce the manufactured cost of the crop
9. Next goal is to improve the quality of the crop by using iot
10. Further aim is to reduce water consumed by the crop without hampering the growth
11. Next goal is to reduce the money spend on fertilizer by providing proper amount of fertilizer to the crop using iot
12. Further aim is to increase the agricultural field using iot
13. To control the environment precise using iot
14. Yet another goal is to store data related to crop automatically

3. Statement Of Invention

In this research a green house is equipped with internet of things. [3] Different sensors are fitted in the green house to monitor various parameters in the greenhouse. The soil moisture in the greenhouse is monitored using moisture sensor. The temperature in the greenhouse is monitored using temperature sensor. The humidity in the greenhouse is monitored using humidity sensor. The water sprinklers are monitored using internet of things. [3] Drip irrigation system in the greenhouse is also controlled using internet of things. [3] The data collected from the greenhouse can be stored on cloud. The data stored on the cloud can be accessed remotely.

4. Description Of Invention

The invention is in the facilitating the greenhouse with internet of things. [3] Various parameters in the greenhouse can be monitored round the clock. Parameters like soil moisture, humidity of air in the greenhouse, temperature in the greenhouse can be monitored effectively. The amount of water given to the crop by drip irrigation and sprinklers can also be controlled using internet of things[4] in an efficient way. The data captured from the greenhouse can be fed to cloud. The data on the cloud can be accessed easily from remote location. The quality of the crop is enhanced with the use of internet of things. [4] The effort required by human being for greenhouse management is reduced considerably.

5. Applications of IOT

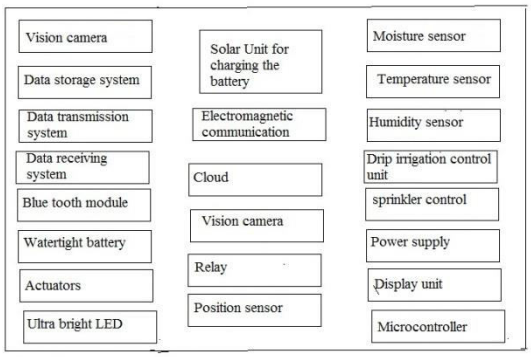
1. Use of IOT in energy management.
2. Use of IOT in industrial application

3. Use of IOT in home automation
   i. Smart door.
   ii. Smart living room.
   iii. Smart cooling.
   iv. Smart washroom.
   v. Smart kitchen.

4. Use of IOT in smart city.
   i. Smart traffic
   ii. Smart parking.
   iii. Smart transportation.

5. Use of IOT in environmental monitoring
6. Use of IOT in mall.
7. Use of IOT for damage management.
8. Use of IOT for forest management

6. Description Of Figures



Block diagram of the greenhouse equipped with internet of things

7. Advantages Of Greenhouse Equipped With IOT

1. Agriculture yield is increased considerably due to use of IOT.
2. Man power required to monitor is reduced significantly.
3. Cost of fertilizer is reduced hugely.
4. Growth of the plant can be monitor easily.
5. Consumption of water is reduced noticeably.
6. Quality of corps is enhanced by using IOT.
7. Labour cost required to monitor the crop is reduced significantly.
8. Round the clock information about the crop can be achieved remotely.
9. This technology can be useful for research in agricultural sector.
10. Various sensors can be employed to monitor the growth of crop in the green house
11. The data can be captured around the clock 7*24 hours and is send to cloud.

12. The data can be accessed remotely and growth of crop can be monitored.
13. Various processors like arduino and raspberry pi can be employed for processing the data
14. The water is fed to the plant automatically.
15. The water pumps are started automatically when the signal is fed by the moisture sensor.
16. The overall cost of production is reduced to IOT.

8. Claims

The claims of the research are as follows.

1. It is claimed that the due to use of IOT the parameters for the greenhouse can be monitored round the clocks. Further it is claimed that due to use of internet of things[4] the manpower for monitoring is reduced. Likewise it is claimed that there is saving in the water given to the crop due to internet of things. [4]
2. As stated in the claim 1 it is claimed that due to employee internet of things the information about the various parameters in the greenhouse can be communicated to the remote location easily. Furthermore it is claimed that due to utilization of intersect of things there is enhanced in the agricultural yield. Besides it is claimed that due to deployment of intersect of things in the greenhouse the quality of crop is intersected.
3. As per claim 1 it is claimed that due to use of IOT the overall profit of farmer is increased. Likewise to use of IOT the research can be carried easily on green house. In the same way due to deployment of IOT the fruits or flowers grown on the planet can be monitored easily.

9. Conclusions

It is concluded that the greenhouse equipped with internet of things[4] gives greater yield. Besides, by using internet of things [5] there is a saving in water

required for the crop. Similarly, by employing internet of things [5] there is saving in electricity required for the greenhouse. In the same way, with the help of internet of things [5] the research work can be carried out efficiently. Furthermore, by employing internet of things [5] in the greenhouse the quality of the crop is enhanced in a large extent. Further by employing internet of things [5] in a greenhouse the effort required by human being is reduced drastically.

10. Acknowledgment

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Modal Analysis of Ultrasonic Stack Assembly

D. B. Jadhav, P. V. Jadhav, and D. S. Bilgi

Keywords Passivation · Ultrasonic assisted electrochemical machining · Modal analysis · Finite element method

1 Introduction

Electrochemical machining (ECM) is the unique process to create the complicated shapes and intrinsic contours on hard materials [1]. It is unavoidably associated with the process of passivation which causes the reduction in the machining process [2], cavitation phenomena and removal of the byproduct from the inter-electrode gap (IEG) during micro or deep hole drilling are some of the critical issues faced by the industries. ECM coupled with an ultrasonic machine called as ultrasonic assisted electrochemical machine (USAECM) found to be the most effective method to overcome the problem of passivation as well as micro or deep-hole drilling. Ultrasonic refers to waves with frequencies between 20–60 KHz, which are higher than the range of human hearing (20 Hz to 20kHz) [3]. The merits of ultrasonic vibration during ECM process are: causes acceleration of the reactions (catalytic effect), improves the characteristics of the electrodeposited layer, diminishes the effect of passivation and improves the diffusion process in liquid and solid phase [4].

There are two ways through which one can give the vibration during USAECM operation. (i) direct vibration (ii) indirect vibration. In the case of direct vibration, vibrations are given either to the tool electrode or the workpiece (w/p). In indirect

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vibration, it is given to the electrolyte cell. The frequency of ultrasonic vibration is given by the formula:

$$\omega_n = \sqrt{\frac{k}{m}} \tag{1}$$

where, ω_n - natural frequency (Hz), k - stiffness (N/mm^2) and m - mass (Kg)

The natural frequency is directly proportional to the stiffness and inversely proportional to the mass. If the ultrasonic vibration is given to the w/p due to anodic dissolution, the material is removed from it and will reduce the mass of the w/p which in turn increase the natural frequency. So there are only two options which are vibrations can be given either to the tool electrode or electrolyte cell.

The ultrasonic stack assembly found to be one of the main components of USAECM. Piezoelectric transducer, booster, horn, and tool are the sub-components of stack assembly. Standard 230 V, AC and 50 Hz frequency electrical input is converted into 28,000 Hz 300 V electrical signal with the help of an ultrasonic generator. Transducers main function is to convert the electrical energy (applied voltage) into reciprocating harmonic motion, with low amplitude and high frequency [5]. The amplitude of ultrasonic vibration is either increased or decreased using a device called a booster. Amplification of the ultrasonic vibration to the desired level is done using the horn. Figure 1 shows the schematic layout of the ultrasonic stack assembly.

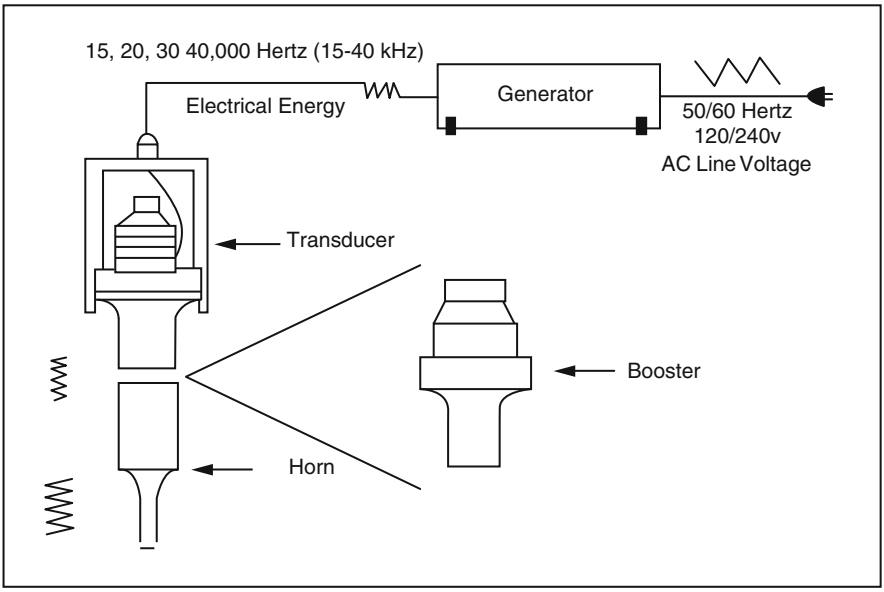

Fig. 1 Schematic layout of ultrasonic stack assembly [6]

Vibration characteristics (natural frequency and mode shapes) of the ultrasonic stack assembly were determined by performing the modal analysis using Ansys 19.2 workbench software [5]. Modal analysis is also termed as the free vibration analysis of a structure or body [7]. Mode shape is an inherent property of the structure. Its value depends upon (i) material properties viz. stiffness, damping and mass (ii) boundary conditions to which it is exposed.

2 Components of Ultrasonic Stack Assembly

2.1 Transducer

The transducers which are popular in the industry are (i) Piezoelectric (ii) Magnetostrictive (iii) Electromagnetic (iv) Capacitive [8]. The dimensions of some materials found to be changed due to the application of electrical fields. Contrary to their dimension, changes in force will produce an electrical potential. These materials are called piezoelectric [6]. The merits of the piezoelectric transducer are; high amplitude, impedance matching, small size and high energy conversion efficiency makes it dominating over the other types [5]. Modern transducer uses piezoelectric ceramic discs made of lead zirconate titanate (PZT). It has been proved that PZT has superior electromechanical conversion efficiency. It is in the order of 95% or better [9].

Piezoelectric transducer mainly consists of four to five sub-components namely: back mass, front mass, copper discs, pre-stress bolt and piezoelectric ceramic discs [10]. The PZT disc of Morgan industry, made of 801 series is used for the research. To obtain the low resonance ultrasonic frequency (e.g. 20 kHz) from transducer made of piezo-ceramic material, the limitation is the requirement of larger length of the piezoelectric. In case of sandwiching transducer, one can achieve the resonance frequency at a shorter length by using two metal blocks of different materials containing numbers of piezo-ceramics in between [11]. The material on both sides of the metal pieces is not the same in order to achieve different amplitudes at both ends. The workpiece is connected to the side of the transducer where larger vibration amplitude is obtained and the other side is free. The energy developed in the transducer is mostly headed towards the workpiece and very negligible energy is transferred on the other side of the transducer which is free. This will minimize the loss or distribution of energy of the work process [9, 12]. The metallic piece connected to the workpiece with higher vibration amplitude is called as matching or front mass and the other, which is free and has low vibration amplitude, is called as backing or back mass. To transmit maximum energy in the forward direction the back end is made heavier than the front end. The materials mostly used for the transducer are titanium, copper, beryllium, PZT and cold worked tool steel. In this research work, the material for the back mass was selected as titanium (grade5) Ti-6Al-4V material. The front mass material was selected as aluminum of ASTM 7075 grade. The aluminum has the advantage of high energy transmission efficiency

but it does have some limitations viz., aluminum is subjected to low mechanical strength, cracking and screwing slide wire.

Screw transducers were assembled using screw and nut connection. This causes the compression of pieces [9]. The pre-stress bolt of M10∗40 mm of tool steel material manufactured at Unbrako company was selected. It was used to assemble all components of the transducer together. The main function of the bolt is to pre-strain the piezoelectric stack so that it will not break during extension. In the transducer, a number of piezo-ceramics discs used in its construction are directly proportional to the power generation. If the transducer is screw one then the piezo-ceramic parts must have the capability of being screwed through [9]. For holding and supporting the transducer on the machine one required the node and anti-node. The location where there is a zero or negligible vibration is called a node and where there is maximum vibration it is termed as anti-node [9].

2.2 Booster

Booster is of two types; unity booster and tapered shape booster. Tapered shape booster is utilized to either increase or decrease the vibrations. Unity booster transfers the same vibration.

2.3 Horn

The function of the horn is to amplify the vibrations received from the booster. It also transfers the vibration from the booster to the tool electrode by staying in resonance with the generator and piezo-ceramic transducer [7]. The designer has to design and optimize the horn for proper tuning, required amplitude and lower stress concentration. The resonant frequency and resonant length are the two important aspects of horn design.

The horn is of many types but to list a few important ones are; stepped, conical, exponential and catenoidal/hyperbolic [7]. The horn can be made of different material viz. titanium alloy, monel, steel, high-speed steel, stainless steel and aluminum [13]. The horn materials should possess the following properties; it should have high fatigue strength, hardness, low acoustic losses and should be easily brazed and soldered [13]. The tip of tool electrode is of 3 mm diameter, for creating small holes. The inter-electrode gap between the anode (work-piece) and cathode (tool) is to be maintained as 0.5–1 mm for ultrasonic assisted pulse electrochemical machining (USAPECM).

3 The Geometry of Ultrasonic Stack Assembly and Meshing

The ultrasonic stack assembly is assembled in solid works 2014. Figure 2 represents the assembled model of ultrasonic stack assembly prepared in solid works. For the simplicity of the analysis, small features such as holes, champers and fillets were ignored to avoid the stress concentration at these junctions. Figure 3 represents the meshed model of the ultrasonic stack assembly.

4 Meshing

The meshing of the ultrasonic stack assembly was done using volumetric elements solid 45 or solid 95. Solid 45 is a cubic element having eight nodes and shape function of 1st order [9, 12]. Solid 95 is also a volumetric element but it has 20 nodes and has a 2nd order shape function. The accuracy of the solid 95 element is found to be more than that of solid 45 [9, 12]. In this research work, we have used the solid 185 element which is the lower version of solid 95 element. It has a solid 3D

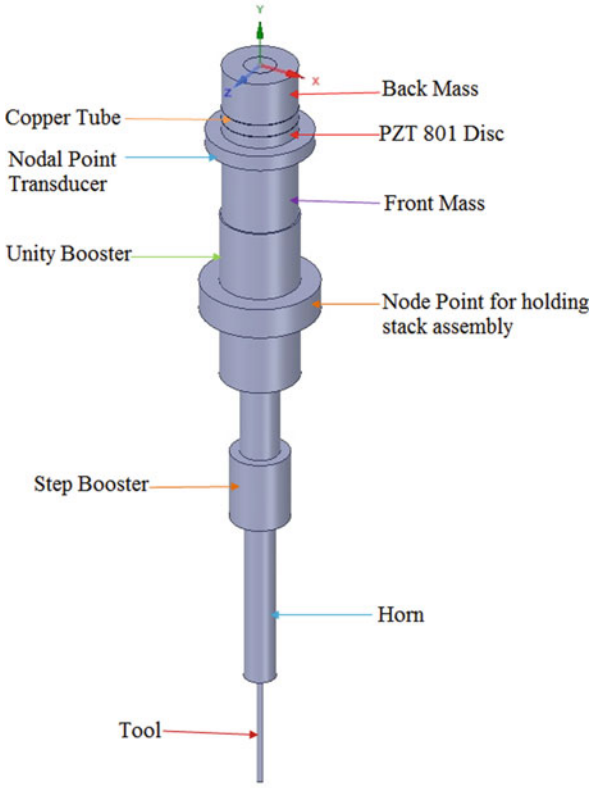

Fig. 2 Nomenclature of ultrasonic stack

Fig. 3 Meshed model of ultrasonic stack assembly

structure with eight number of nodes. It has the property of plasticity, stress stiffening, large deflection and large strain. Solid 95 element has all properties as that of solid 185 with additional creep property.

5 Material Properties

The material properties of subcomponents and PZT 801 series have been given below in Tables 1, 2, 3 and 4.

Table 1 Material properties of subcomponents

Material	Density (Kg/m$^{3)}$	Young's modulus (Pa)	Poisson's ratio
Aluminum ASTM7075	2810	7.17×10^{10}	0.33
Copper	8300	1.1×10^{11}	0.34
Tool steel	7800	2.1×10^{11}	0.3
Ti6Al4V	4418	1.1×10^{11}	0.342
PZT801	7680	–	–

Table 2 PZT 801: Piezoelectric stress matrix (C/N) [14]

	X	Y	Z
X	0.00	−1.07	0.00
Y	0.00	18.31	0.00
Z	0.00	−1.04	0.00
XY	9.32	0.00	0.00
YZ	0.00	0.00	9.32
XZ	0.00	0.00	0.00

Table 3 PZT 801: Permittivity (F/m) [14]

PERX	781
PERY	694
PERZ	774

Table 4 PZT 801: Elasticity matrix (Pa) [14]

1.365×10^{11}	–	–	–	–	–
8.066×10^{10}	1.263×10^{11}	–	–	–	–
8.087×10^{10}	8.066×10^{10}	1.365×10^{11}	–	–	–
0	0	0	3.096×10^{10}	–	–
0	0	0	0	3.096×10^{10}	–
0	0	0	0	0	3.047×10^{10}

6 Boundary Conditions and Inputs

6.1 Assumption Made

For the finite element analysis following assumptions were made; (i) The resonance frequency is dependent on the geometry and poison ratio which was not considered here. (ii) Sound velocity $C = \sqrt{E/\rho}$ is changing with respect to change in geometry which is also neglected. (iii) Pre-compression loading of the transducer and mechanical properties of joining screws were also neglected. (iv) Pre-stress was ignored. (v) Impact of non-axial symmetry is ignored with axial symmetry. (vi) There is no external system load under the free body condition.

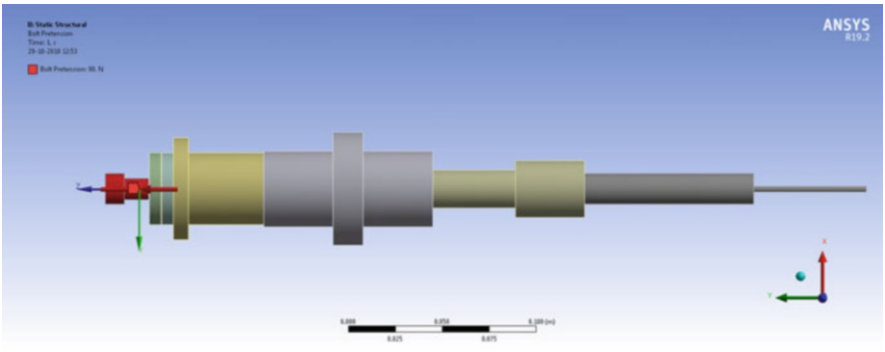

Fig. 4 Pre-stress of bolt

6.2 Inputs and Boundary Conditions

Block Lanczos method was used to solve the equations. The solver used is a sparse matrix direct solver. Case1. Modal analysis without pre-stress boundary condition; midpoint 'O' of unity booster as a supporting position is a node at this position transducer was fixed in x, y and z-direction (Fig. 4).

Case2. Modal analysis with pre-stress boundary conditions (a) Screw transducer: it is preloaded. (b) Tension load of 90 N was applied on the free end of the screw. (c) Inverse force (compression) load act on the free end of the matching. (d) Nodes with a degree of freedom fixed and pre-compression load on the transducer were considered. As the upper part of the tool was fixed in horn so no longitudinal and rotational movement were allowed. (e) Contact between two PZT disks was made frictionless.

In the analysis setting, the mode numbers and frequency limit was inserted. The different parameters were selected to carry out modal analysis. Maximum number of nodes to extract is 20; with minimum range 20 KHz and Maximum range as 35 KHz.

7 Results

Ultrasonic stack assembly's function is to provide the vibrations to the USAPECM for carrying out the drilling operation. The tool which is connected at the end of stack assembly should vibrate at the desired frequency. Ultrasonic stack assembly is subjected to six modes of vibration namely; longitudinal (L), torsional (T), flexural (F), a combination of LT, TF, and LF. For drilling application the longitudinal mode

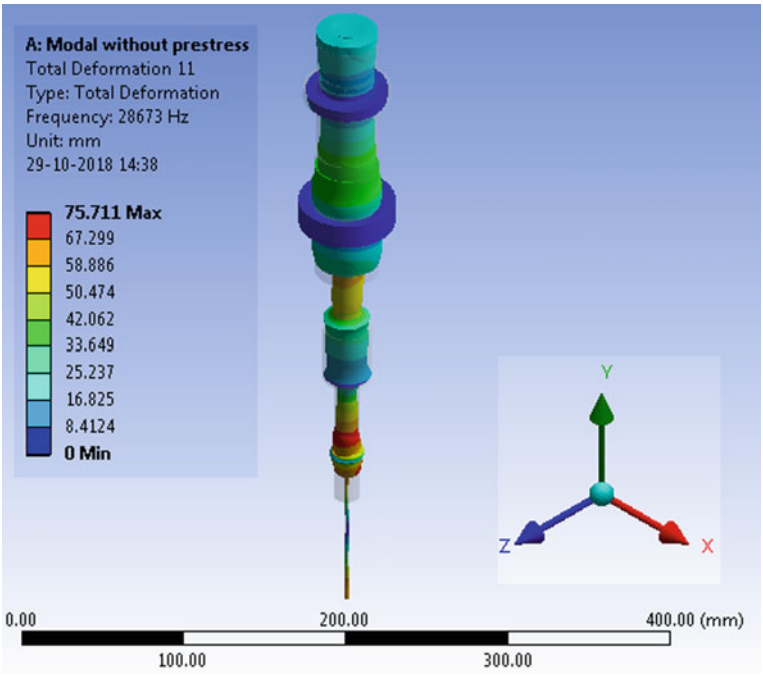

Fig. 5 Natural frequency without pre-stress

is important. Figure 5 represents the natural frequency without pre-stress. At the 11th mode number, the obtained frequency is 28,673 Hz in longitudinal Y- direction within frequency range 20–35 KHz in ANSYS 19.2 modal analysis.

The margin of Separation for without and with pre-stress: Mode number 11 gives value 28,673 Hz in the longitudinal direction which is nearer to the desired value (28 kHz).

$$\text{Margin of Separation} = \frac{28673 - 28000}{28000} \times 100 = +2.40\% \tag{2}$$

The natural frequency of 28,884 Hz at 11th number mode in the longitudinal direction was obtained when a pre-stress of 90 N at the bolt location was applied. The margin of separation of the resonant frequency is +3.16%. Figure 6 represents the natural frequencies with pre-stress of 90 N.

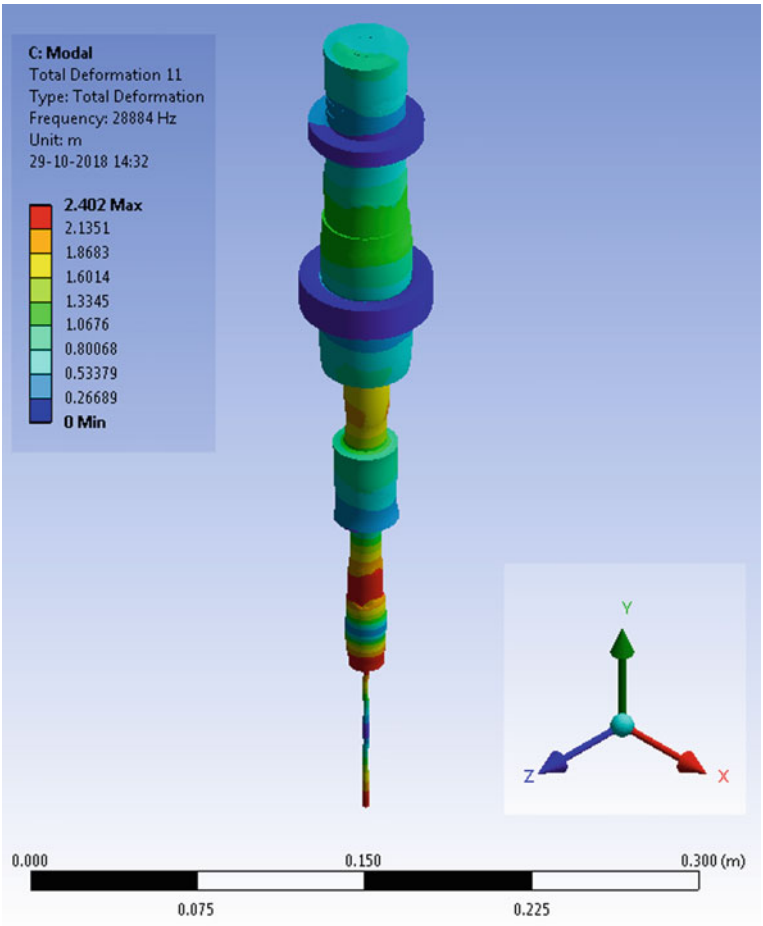

Fig. 6 Natural frequency with pre-stress

8 Conclusion

Ultrasonic stack assembly was subjected to six modes of vibration but for the drilling operation, which is the focus of current investigation the longitudinal mode is most crucial. The application of the stack assembly in USAECM is to vibrate the tool in the longitudinal direction i.e. along longitudinal Y-axis. Mesh independence study was performed to find the optimum value of element length. The results of the modal analysis performed with and without pre-stress effect are very much close to the desired frequency of 28 kHz. Finite element method (FEM) found to be a very effective tool to design the ultrasonic stack assembly which otherwise to be designed by trial and error method. It reduces the no of prototypes as well as time to develop the product.

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Experimental Investigation of Crack for Tensile Loading Condition by Using Hole Drilling Method

Hanumant P. Borate, Pradeep Jadhav, Sachin M. Khomane, Sandeep S. Wangikar, and Uttam L. Anuse

Keywords Crack arrest hole (CAH) · Crack tip · Stress concentration

1 Introduction

Crack initiation and propagation behavior have been evaluated to prevent early failure of machine parts. Arresting the crack initiation and propagation is important for the maintenance of machine parts as well as for the detection of crack initiation.

Various methods for arresting crack propagation have been investigated by many researchers, for example, the efficiency of several fatigue cracks retarding methods were examined. Aluminum alloy flat specimens with a central hole starter notch were tested in a closed-loop servo-hydraulic test machine. After the cracks had propagated to a predefined value, the following crack retarding methods were considered: repair welding, welded metal reinforcements, adhesively bonded CFRP patches, single peak tensile overloads and fatigue crack arrest holes [1]. The method of hole stop drill near or at the crack tip is often used in fatigue damage repair. Optimal shapes are by no means circular, and we focus on the shape of a

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single hole centered at (or in front of) the crack tip. It was shown that the stress field at the crack boundary can be significantly improved by noncircular shapes. As a by-product, an alternative method for extracting the stress intensity factor from a finite element analysis has been presented [2]. To prevent crack growth, a stop hole was drilled at the crack tip. Reducing the stress concentration factor is the reason behind that. Also, it was investigated whether fatigue crack reinitiation and growth from a stop-drilled hole can more effectively be retarded by providing additional holes [3]. A practical method for preventing further crack growth from cracks by drilling holes in the vicinity of the crack tips was investigated. A series of fatigue-crack-growth tests was performed using double-edge-pre-cracked specimens. In some specimens, holes were drilled in the vicinity of the crack tips. Also, pins were inserted into the holes in some cases. The crack growth lives of some specimens were longer than those of specimens without holes. The longest fatigue life was observed in the case of a specimen with the pins [4].

Those researchers found that reducing stress concentration and introducing compression residual stress in the vicinity of a crack tip is the best method of arresting and retarding crack propagation. These methods are widely used in the maintenance of aeronautics, bridges, railways, and ships. Therefore this method can be considered as a temporary reparation method before crack re-initiation, but no tool is actually available to evaluate the efficiency of this method [5].

In this paper, numerical simulation of a specimen was performed with the following configurations:

1. Changing the ratio of the crack length (a) to the width (w) of the specimen for different arrangements. In this case, a range of the ratio of 0.2–0.5 was evaluated to find the effect of different crack length to stress concentration factor.
2. In this case, a single hole of fixed diameter drilled at a varying distance (r) from the crack tip in the crack direction was studied. A range of distance 10 mm < r < 20 mm was taken to find out the optimum length for stress concentration.
3. In this case, drilling the hole with a varying diameter (d) at a distance (r) from the crack tip in the crack, the direction was studied. A range of hole diameter 4 mm, 6 mm and 8 mm were investigated in order to evaluate the optimum diameter of the hole for stress concentration.

2 Material and Analysis

2.1 Material

The Material used in this study is Stainless Steel 304 whose chemical composition (mass, %) and mechanical properties have been shown in Tables 1 and 2, respectively. ρ, σ_t, U_t E, μ are density, tensile strength, ultimate tensile strength, Young's modulus, poisons ratio respectively. Specimens with mechanical notches/cracks of different lengths were prepared. Several relative notch lengths a/w ratio were studied: 0.2, 0.25, 0.3, 0.35, 0.45 and 0.5, where a is the notch length and W the

Table 1 Mechanical properties

ρ (Kg/m$^{3)}$	σ_t (pa)	U_t (pa)	μ	E (pa)
7750	2.07×10^8	5.86×10^8	0.31	1.93×10^8

Table 2 Chemical composition (mass %)

Cr	Ni	C	Mn	P	S	Si	Fe
20	11	0.03	2.0	0.045	0.03	0.75	Balance

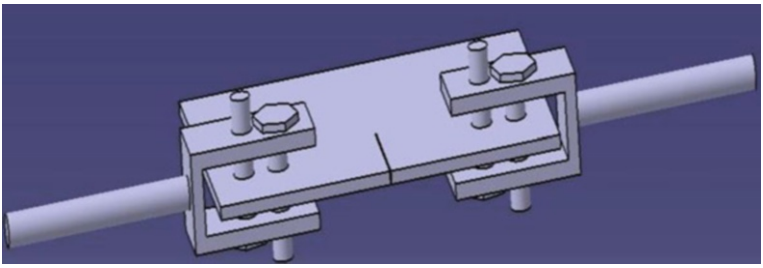

Fig. 1 Assembly of plate and fixtures

specimen width. Specimens have the following dimensions: length L = 300 mm, width w = 200 mm, and thickness B = 8 mm. The experiment was performed with making of hole diameter (d) of 4 mm, 6 mm, and 8 mm at a distance (d) varying from 10 mm to 20 mm from the end of the notch at a load of 4000 N.

2.2 Experimentation

Validation of numerical solutions was experimentally conducted. Tensile loading was given by a universal testing machine. For that fixtures were manufactured and assembled as shown in Fig. 1. Strain gauges were gloved on both sides of the specimen. P3 strain indicator and recorder were connected to the strain gauges. The universal tensile machine offers gradual loading to the plate.

2.3 FEA Analysis

The stress distributions at the blunt crack tip have been computed by the finite element method under critical load which varies with non-dimensional crack length a/W. The load was modeled by a tensile force, which was defined on the inner surfaces of the holes of the specimens. Figure 2 shows that the geometry of the specimen with different input conditions was drawn in Catia software. Then this geometry was imported into the Ansys software was used for analysis by allotting properties of specimen material, boundary conditions, and loading conditions. The output of this is local stress.

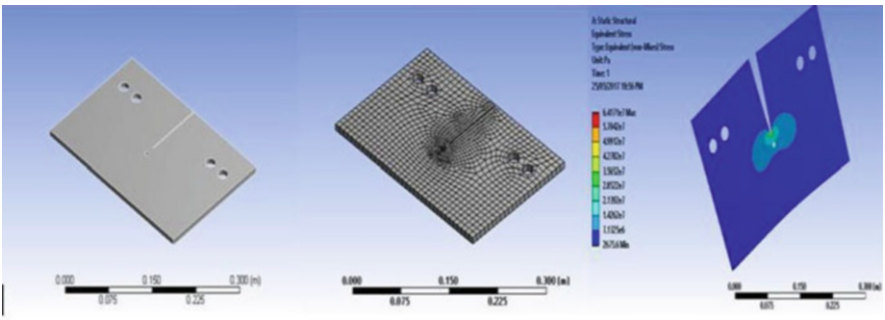

Fig. 2 Geometry and mesh used for FEA method and obtained stress

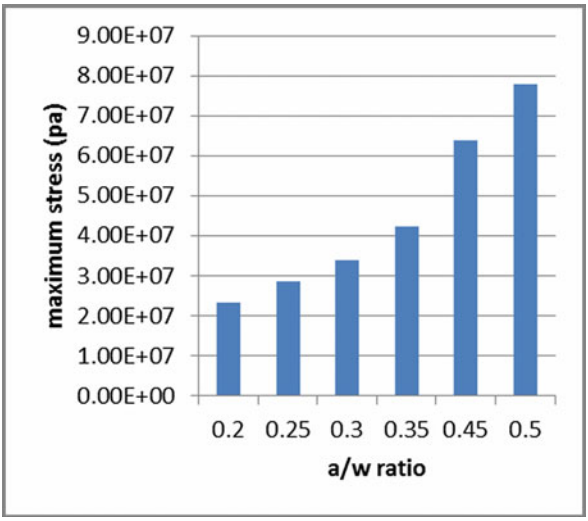

Fig. 3 Maximum stress for different a/w ratio

3 Results

3.1: Changing the ratio of the crack length (a) to the width (w) of the specimen for different arrangements

In this case, the crack length is a variable whereas width is constant. Above graph (Fig. 3), the chart shows a variation of the value of stress concentration with respect to crack length (i.e. a/w ratio) for 4000N load. As crack length increases the stress concentration at the tip of crack increases. For that we have taken a/w ratio 0.2, 0.25, 0.3, 0.35, 0.45, 0.5. Sometimes concentrated stress may be greater than the ultimate tensile strength of material that causes propagation of the crack.

3.2: A single hole of fixed diameter drilled at a varying distance (r) from the crack tip in the crack direction

(a) *Fixed 4 mm diameter drill for different a/w ratio*

In this case hole of 4 mm diameter drill at a distance r (12 mm < r < 18 mm) from crack tip. Above chart in Fig. 4 shows the variation of stress concentration for the same load of 4000N. As a distance of the center of the hole from crack tip increases up to 14 mm, the value of stress concentration factor decreases independently with the a/w ratio. And from 14 mm onward it loses its effect gradually. For different a/w ratio and fixed 4 mm hole, 14 mm distance is optimum (minimum stress concentration).

(b) *Fixed 4 mm diameter drill for different a/w ratio*

In this case hole of 6 mm diameter drill at a distance r (11 mm < r < 16 mm) from crack tip. Above chart (Fig. 5) shows the variation of stress concentration for the same load of 4000N. As a distance of the centre of the hole from crack tip increases up to 14 mm, the value of stress concentration factor decreases independently with the a/w ratio. And from 14 mm onward it loses its effect gradually. For different a/w ratio and fixed 6 mm hole, 14 mm distance is optimum.

(c) *Fixed 8 mm diameter drill for different a/w ratio*

In this case hole of 6 mm diameter drill at a distance r (14 mm < r < 20 mm) from crack tip. Above chart (Fig. 6) shows the variation of stress concentration for the same load of 4000N. As a distance of the centre of the hole from crack tip increases up to 18 mm, the value of stress concentration factor decreases independently with the a/w ratio. And from 18 mm onward it loses its effect gradually. For different a/w ratio and fixed 8 mm hole, 18 mm distance is optimum (minimum stress concentration).

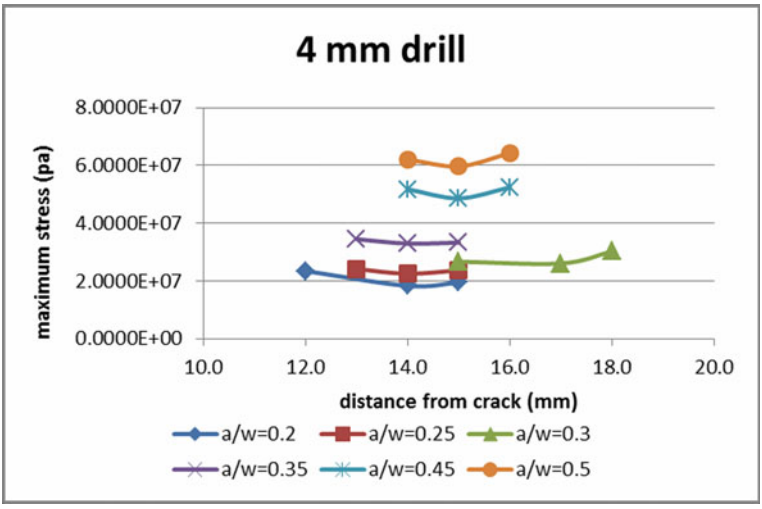

Fig. 4 Fixed 4 mm diameter drill for different a/w ratio

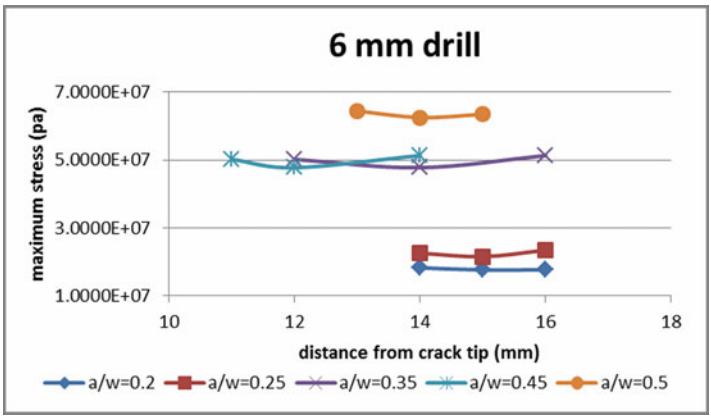

Fig. 5 Fixed 4 mm diameter drill for different a/w ratio

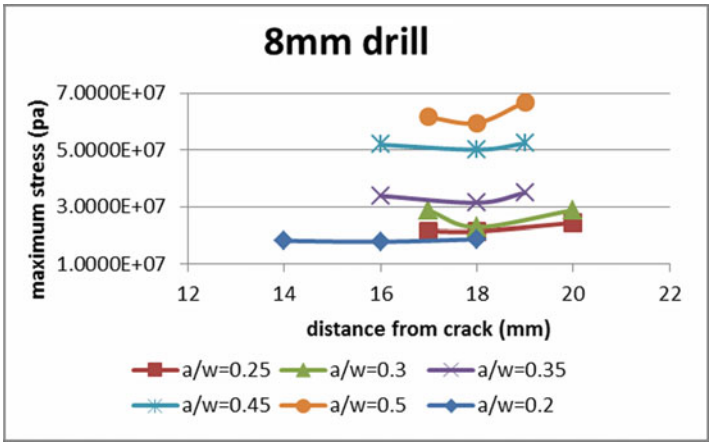

Fig. 6 Fixed 8 mm diameter drill for different a/w ratio

3.3: In this case drilling the hole with a varying diameter (d) at a distance (r) from the crack tip in the crack direction has been studied

(a) *For constant a/w = 0.2*

For constant a/w ratio (i.e. 0.2), for particular hole diameter; effect on stress concentration with respect to distance from the crack tip has been examined. Above graph (Fig. 7) shows that 6 mm hole with 15 mm distance from crack tip gives minimum value of stress concentration.

(b) *For constant a/w = 0.25*

For constant a/w ratio (i.e.0.25), for particular hole diameter; effect on stress concentration with respect to distance from the crack tip was examined. Above graph

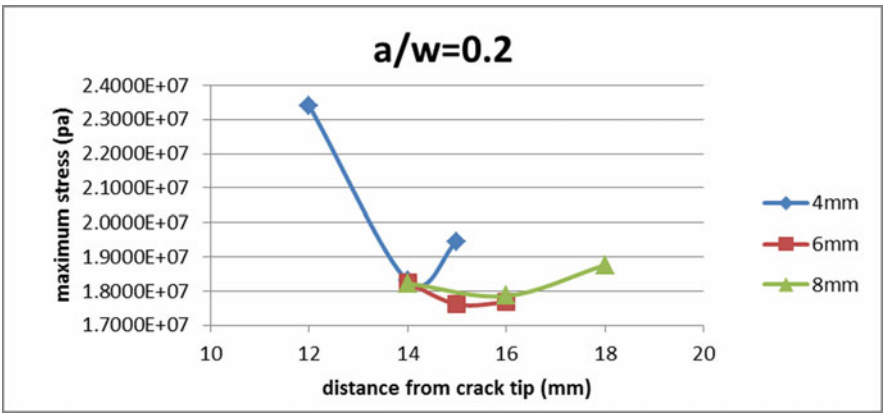

Fig. 7 For constant a/w = 0.2

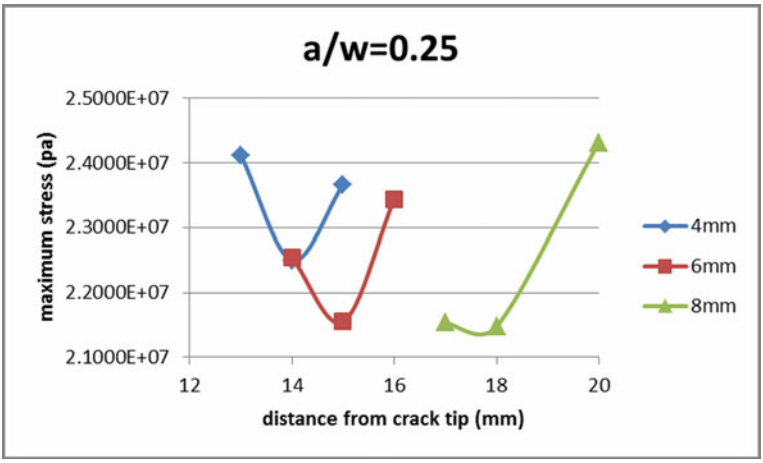

Fig. 8 For constant a/w = 0.25

(Fig. 8) shows that 8 mm hole with 18 mm distance from crack tip gives minimum value of stress concentration.

(c) *For constant a/w = 0.35*

For constant a/w ratio (i.e. 0.35), for particular hole diameter; effect on stress concentration with respect to distance from the crack tip was examined. Above graph (Fig. 9) shows that 8 mm hole with 18 mm distance from crack tip gives minimum value of stress concentration.

(d) *For constant a/w = 0.5*

For constant a/w ratio (i.e. 0.5), for particular hole diameter; effect on stress concentration with respect to distance from the crack tip is examined. Above graph

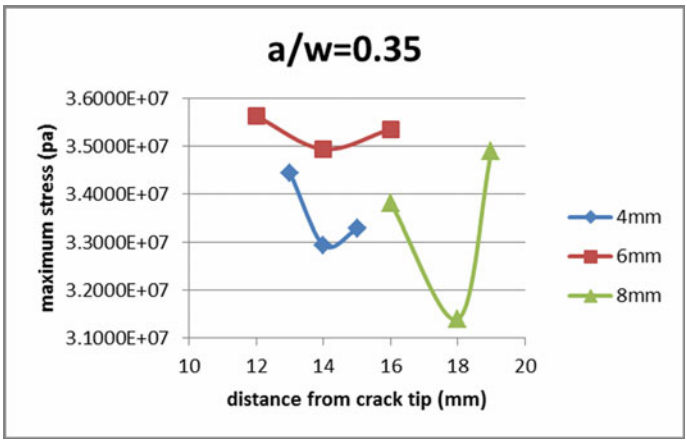

Fig. 9 For constant a/w = 0.35

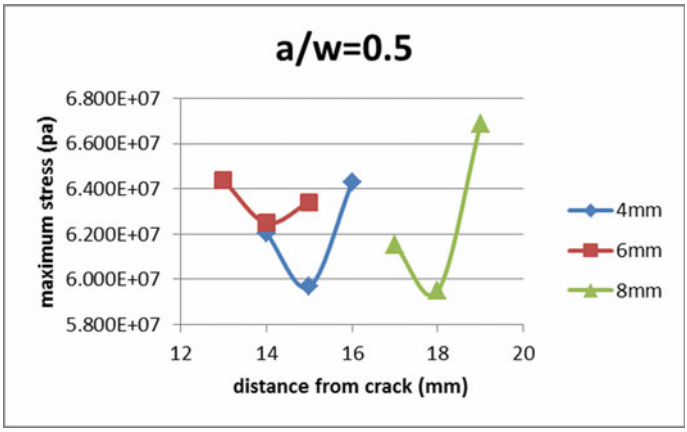

Fig. 10 For constant a/w = 0.5

(Fig. 10) shows that 8 mm hole with 18 mm distance from crack tip gives minimum value of stress concentration.

4 Conclusion

From the analysis of different conditions of hole drilling method, following conclusions have been drawn:

1. As a/w ratio i.e. crack length increases with respect to the width of the specimen, the stress concentration at the notch also increases. With the increase in every 0.05 a/w ratio there is around 22% increase in stress concentration.

2. For fixed hole diameter, a distance of drill hole from crack tip changes, the stress concentration at notch also changes with particular a/w ratio. For 4 mm drill diameter, 14 mm distance from the crack tip is optimum.
3. As a diameter of hole changes for fixed a/w ratio, stress concentration has also changed for the different distance from the crack tip in crack direction. For 0.2 a/w ratio, 6 mm hole at 15 mm distance from the crack tip is optimum.

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CFD Based Analysis of Simple T-Junction and Y-Junction Micro Mixers with Different Obstacles

Ranjitsinha R. Gidde, Prashant M. Pawar, Babruvahan P. Ronge, and Pradeep V. Jadhav

Keywords CFD analysis · Pressure drop · Mixing length · T & Y-junction micromixers

1 Introduction

Currently, Lab-On-a-Chip (LOC) technology has driven considerable progress in the development of micro devices used in microfluidic applications including chemical, biological, and medical applications. Micromixer is one of the key components used in Microsystems or micro devices which are used to provide contact between the reagent molecules for interactions/chemical process for particular mixing applications. In microfluidics systems the dominant mixing mechanism is molecular diffusion due to the laminar flow regime, which is a very slow process [1]. Mixing process based on molecular diffusion requires more time and mixing which is not well-matched with miniaturization concept in micro fluidics systems. Hence to overcome this drawback and to enhance the mixing performance is to increase the interfacial area between two different liquids to reduce diffusion time/distance [2]. Different passive micro mixers depending on the passive mixing mechanism are presented which includes micro mixers with square and circular chambers, rectangular wave micromixer and passive wavy micro mixers with CSAR and ESAR elements, respectively [3–5]. In this paper, the mixing performance in respect of mixing length and pressure drop of two simple T and Y-junction micro mixers, with the combination of three different obstacles have been studied.

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2 Computational Modeling

2.1 Model Description

The basic design of T and Y-junction micromixers as shown in Fig. 1a, b. The dimensions of the microchannel are 0.1 mm (width), and 0.1 mm (height) with 25 mm as a length. The two inlets and one outlet are of same cross-sectional dimensions (W_c = 0.1 mm and H_c = 0.1 mm). The different obstacles such as semicircular (Fig. 1c), triangular (Fig. 1d) and rectangular (Fig. 1e) obstacles are placed on the channel wall. The diameter of the semi-circular obstacle is 0.1 mm. The base length and height of the triangular obstacle are 0.1 mm and 0.05 mm, respectively. The width and height of rectangular obstacle are 0.1 mm and 0.05 mm, respectively. These obstacles are placed at various spacing along the length of the channel. These spacing varied in the range 0.5–2.0 mm with the step of 0.5 mm.

2.2 Computational Methodology

A CFD software COMSOL Multiphysics 5.0 is employed to solve the governing equations in fluids inside the microchannel with the following assumptions and boundary conditions.

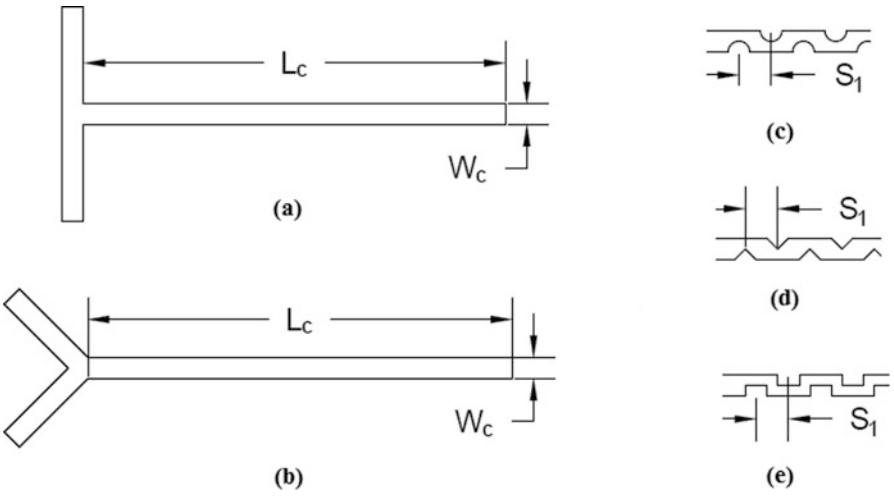

Fig. 1 Schematics of simple T-junction and Y-junction micromixers, and different obstacles. (**a**) Simple T-junction micromixer (**b**) Simple Y-junction micromixer (**c**) Semicircular obstacles (**d**) Triangular obstacles (**e**) Rectangular obstacles

Assumptions:

1. Steady, laminar flow.
2. Constant inlet velocity.
3. Fluid is incompressible, Newtonian, and viscous.
4. No-slip boundary condition at the walls.
5. Effect of gravity is neglected.

Fluid flow inside the microchannel is governed by the incompressible Navier–Stokes equations which include the continuity and momentum Eq. (1) and Eq. (2), respectively [5].

$$\nabla \mathrm{u} = 0 \tag{1}$$

$$\rho\left[\frac{\partial u}{\partial t} + (\mathrm{u}.\nabla)\mathrm{u}\right] = -\nabla \mathrm{p} + \mu\nabla^2\mathrm{u} \tag{2}$$

The convection-diffusion equation which governs the mass transport in the case of the steady state in the three- dimensional micro channel is written as Eq. (3) [5, 6].

$$\frac{\partial c}{\partial t} = \mathrm{D}\ \nabla^2\mathrm{c} - \mathrm{u}.\nabla\mathrm{c} \tag{3}$$

Where u is fluid velocity, p is fluid pressure, ρ is fluid density, μ is fluid viscosity, D is diffusivity, and c is molar concentration. The boundary conditions are a no-slip condition at the walls, zero pressure at the outlet, and inlet flow velocity is 0.001 m/s. Pure water and ethanol enter through inlet 1 and inlet 2, where the mass fractions of water and ethanol are 0 and 1, respectively. Water and ethanol are selected as the two working fluids for mixing. The fluid properties are as shown in Table 1.

A uniform fluid inlet velocity of 0.003 m/s is specified. A no-slip condition is assigned to the channel walls. The outlet is defined as a zero-pressure outlet. Water and ethanol are selected as the two working fluids for mixing. Here water and ethanol are designated as blue and red, respectively. The concentrations of water and ethanol are 0 and 1 mol/m^3. This means that once the water and ethanol are fully mixed, it will have 0.5 mass fraction of water and 0.5 mass fraction of ethanol. The fluids properties are taken at a temperature of 20 °C are depicted in Table 1.

Table 1 Fluid properties at 20 °C

Material	Water	Ethanol	Unit
Density	998	780	kg/m^3
Dynamic viscosity	0.9×10^{-3}	1.2×10^{-3}	Pa. s
Diffusion coefficient	1.2×10^{-9}	1×10^{-9}	m^2/s

3 Results and Discussion

3.1 T-Junction Micromixer

The simulations were performed to study the overall performance of T and Y-junction micromixers with different obstacles. The basic performance parameters such as mixing length and pressure drop are used to study the influence of different obstacles and spacing between the two obstacles on the mixing performance of T and Y-junction micromixers. The diffusion mixing relies on the diffusion coefficients of the working fluids in use. The results of concentration distribution on x-y plane in T-junction micromixer without obstacles and with obstacles spaced at $S_1 = 0.5$ mm along the length of microchannel have been presented in Fig. 2.

The concentration profiles on the y-z plane at full mixing for T-junction micromixer without obstacles and micromixers with obstacles spaced at 0.5 mm are shown in Fig. 3. It is observed that in both cases as the two fluids at different initial concentrations are brought in contact, a diffusive mixing layer is developed at the interface and the width of this mixing layer increases along the flow direction. However, in case of the micro channel with obstacles, as the flow runs into the protrusion region of obstacle, the mixing process is comparatively enhanced. The presence of the obstacles induces advection in the fluid to provide a cross stream component of velocity which leads to better penetration of the fluids into each other to enhance the mixing process. The width of the mixing layer increases much faster and homogeneous mixing is attained rapidly due to the addition of obstacles along with the micro channel. The results of pressure

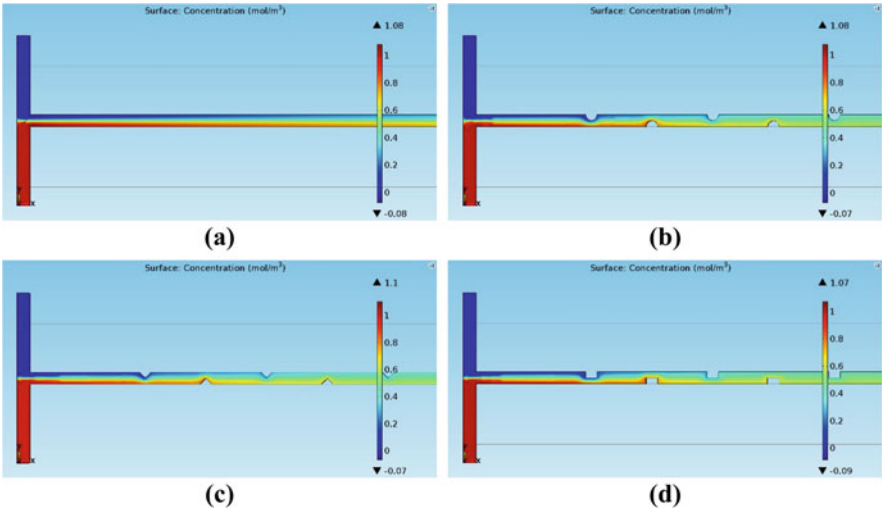

Fig. 2 Concentration profile on x-y plane for T-junction micromixer (**a**) without obstacles, (**b**) semicircular obstacles, (**c**) triangular obstacles, and (**d**) rectangular obstacles

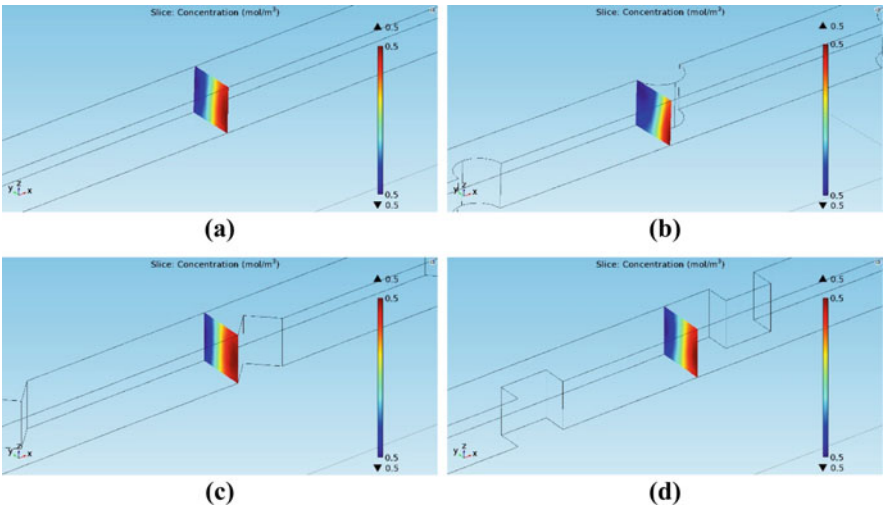

Fig. 3 Concentration profile on y-z plane (**a**) without obstacles, (**b**) semi-circular obstacles, (**c**) triangular obstacles, and (**d**) rectangular obstacles

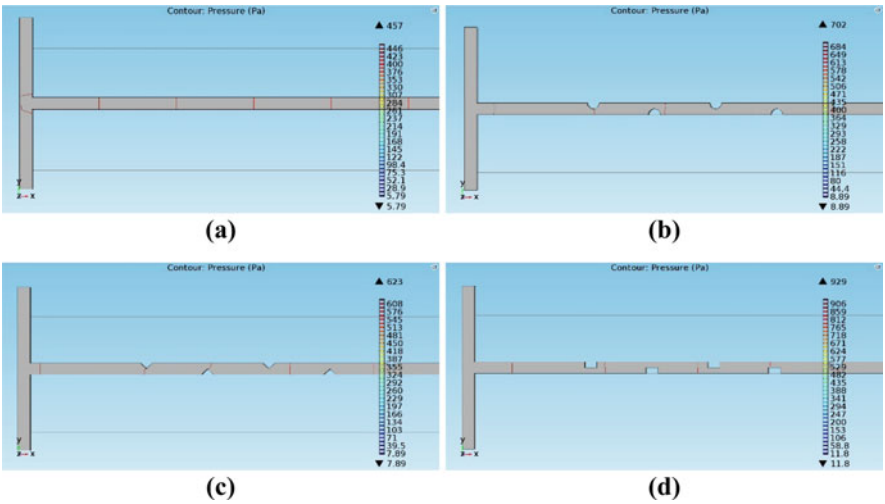

Fig. 4 Pressure drop results for micromixer (**a**) without obstacles, (**b**) semicircular obstacles, (**c**) triangular obstacles, and (**d**) rectangular obstacles

contours for the T-junction micromixer without obstacles and micro mixers with obstacles spaced at $S_1 = 0.5$ mm are shown in Fig. 4. The comparison of the simulation results of mixing length and pressure drop for T-junction micromixer without obstacles and micro mixers with different obstacles has been shown in Figs. 5 and 6, respectively.

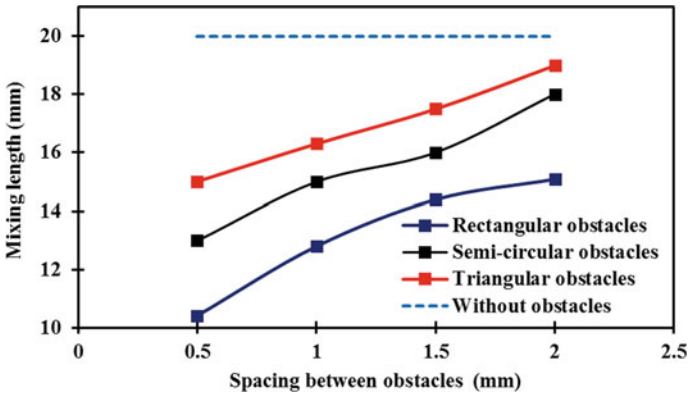

Fig. 5 Comparison of simulation results of mixing length for T-junction micromixer

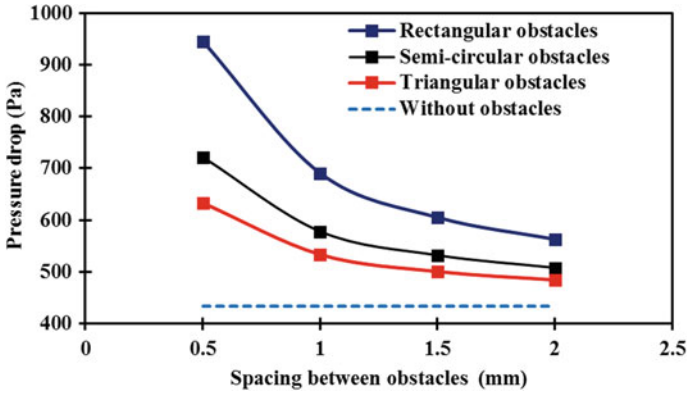

Fig. 6 Comparison of simulation results of pressure drop for T-junction micromixer

It is observed that the mixing performance of the micro channel with rectangular obstacles is comparatively better than that of the channel without obstacles, the channel with semi-circular obstacles, and channel with rectangular obstacles. However, the pressure drop is observed to be significantly higher in case of the channel with rectangular obstacles. The normal T-junction channel shows the worst performance with respect to mixing length amongst the entire remaining channel configuration because of the absence of obstacles which promote mixing in the fluids that flow through it. Hence mixing length for the channel without obstacles is almost twice than that of the channel with rectangular obstacles.

3.2 Y-Junction Micromixer

The ethanol mass on x-y plane for the mixing of two different streams of fluids in Y-junction micromixer without obstacles and micro mixers with obstacles along the length of the micro channel have been presented in Fig. 7. The effect of the different obstacles on the mixing length and pressure drop has been studied for the Y-junction micro mixers. It has been observed that numerical results of mixing length as a function of obstacle type and spacing between the two obstacles are different from that of the results obtained for T-junction micro mixers. Among all the T and Y-junction micromixer configurations, T-junction micromixer with the rectangular obstacles showed excellent performance. In this case, the predicted mixing length for full mixing is less amongst all remaining micromixer design configurations under consideration. Furthermore, using the rectangular obstacles in microchannel, 50% decrease in the mixing length has been observed as compared to the normal T-junction micromixer without obstacles. The results of mixing length and pressure drop for the Y-junction micromixer without obstacles and micromixers with obstacles have been depicted in Figs. 8 and 9, respectively.

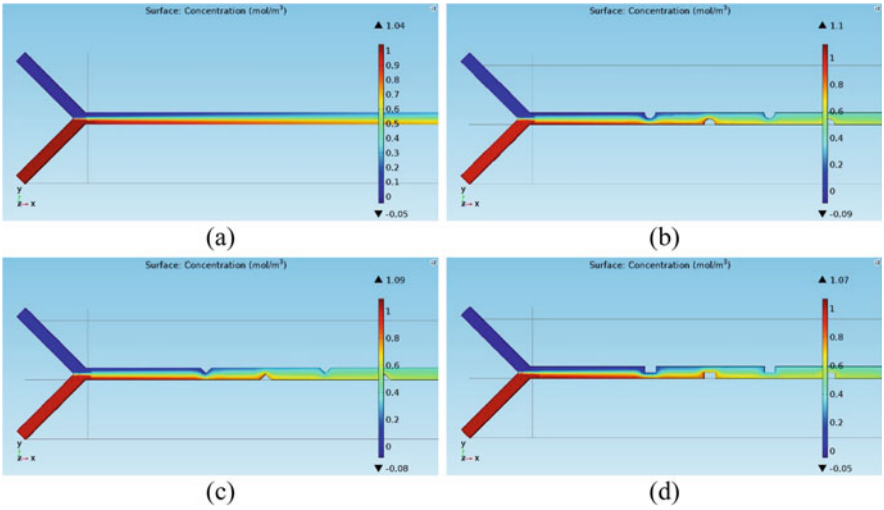

Fig. 7 Concentration profile on x-y plane (**a**) without obstacles, (**b**) semicircular obstacles, (**c**) triangular obstacles, and (**d**) rectangular obstacles spaced at $S_1 = 0.5$ mm

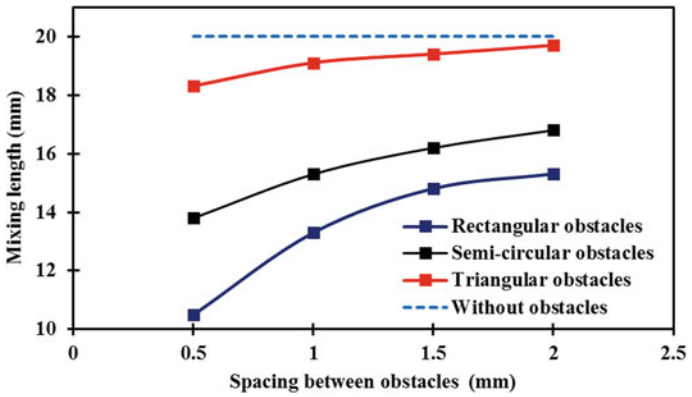

Fig. 8 Comparison of simulation results of mixing length for Y-junction micromixer

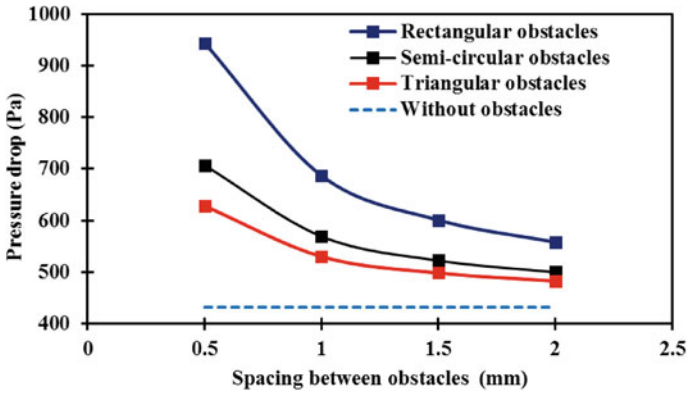

Fig. 9 Comparison of simulation results of pressure drop for Y-junction micromixer

4 Conclusion

A CFD analysis for two simple micro mixers namely T-junction and Y-junction micromixers was carried out in order to obtain micromixer with minimum mixing length by using COMSOL Multiphysics 5.0. The effect of obstacle geometry on the mixing length and pressure drop was investigated. The results reveal that the micromixer with rectangular obstacles gives minimum mixing length as compared to all other micromixer design configurations under consideration.

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Linear Static Analysis and Dynamic Analysis of a Mono-tyre Bike Wheel Inner-Hub Design Using Finite Element Analysis

Akash Sah, Pradeep V. Jadhav, and Manoranjan Singh

Keywords Wheel inner hub · 3D modelling · Meshing · Linear static analysis · Dynamic or modal analysis

1 Introduction

A wheel inner hub is an object which is circular in shape and revolves with the help of an axle. Inner Hub is an essential part of the wheel structure for Monotyre bike as it holds the structure together and absorbs the shocks, giving it strength. It is necessary to have certain properties (Table 2) that the discussed material holds within a certain range in order to perform while the vehicle is in motion over the road. The advancement of Aluminium Silicon alloy ($AlSi_{12}$) wheel has strongly influenced the design, material selection, and manufacturing processes. Benefits of using aluminium alloy wheel are easy to handle because of reducing unsprung mass and allowing the suspension to follow closely along the path [1]. Also, it gives higher operative efficiency in most cases. Linear Static Structural Analysis and Dynamic or Modal Analysis are the two initial tests that are to be followed in FEA so as to ensure the selection of material before fabrication can be understood better through their results. Different materials have different effects like strength, stability, life etc. and care should be taken when designing and analysis of wheel inner hub as a minor change in thickness or pitch can affect the properties drastically [2]. This study focuses on the deformation occurring in the hub due to stress distribution and mode shapes of the same, and displacement when subjected to different types of loading. The FEA result will suggest us whether the hub is safe or not and the selected material can be used for fabrication or not.

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2 Objectives and Methodology

Wheels have one of foremost importance in the safe running of a vehicle (Mono-tyre bike in this particular case). The main objectives stand same as discussed earlier, i.e. Linear Static analysis and Modal Analysis. To perform the tests and confirm the objectives, a certain methodology was followed to understand the upbringing of the performance of the components. There were two methods mainly used in design analysis, which is reverse engineering and finite element analysis [3]. Reverse engineering is a good approach to discover the technological principle of an object. It has been used to model the bike hub in modeling software. The finite element analysis, on the other hand, is an approach to discretely study the effects of loadings and stresses generated.

The proposed work includes the following steps [4]:

1. Constrained 2D sketches (Fig. 1) were made and after that a 3D model (Fig. 2) was created.
2. Thereafter, the meshing was done by selecting a method and new material (AlSi12) was added to the data module.
3. After meshing, the fixed supports and forces were applied in the direction of the actual calculated force.
4. The results obtained for linear static analysis are maximum stresses and deflection.
5. Further, the modal analysis was done and the different mode shapes were compared and displayed as well.

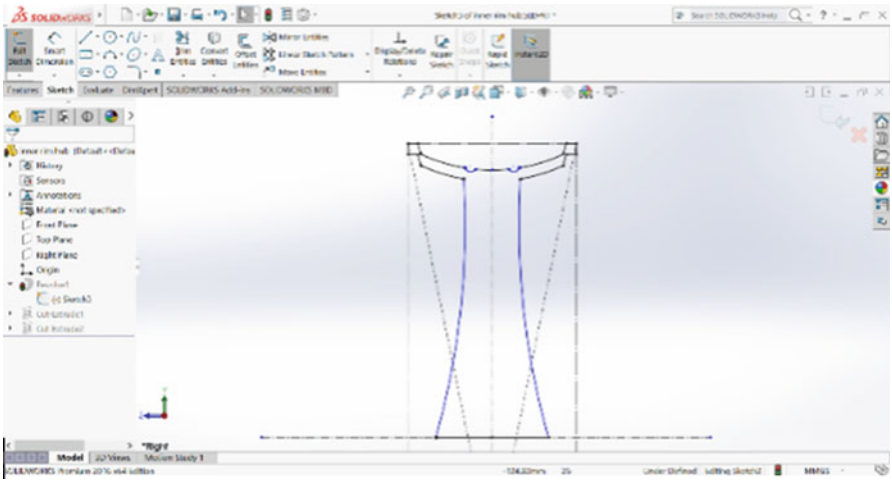

Fig. 1 2D sketch profile of the wheel inner hub

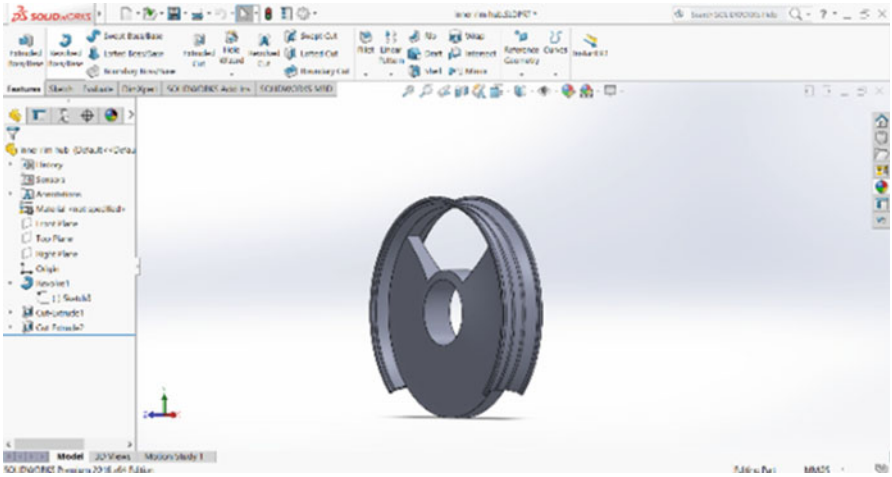

Fig. 2 3D model of the inner hub

3 Modelling of Wheel Inner Hub

3.1 Specification of Wheel Inner Hub

Load Calculations

Weight of the bike (approx.) = 150 kg
Weight of passenger (maximum) = 120 kg
Weight of luggage = 30 kg
Total load = 300 kg
Total weight = 3000 N

3.2 3D CAD Design of Wheel Inner Hub

The specifications (Table 1) were determined for the configuration of the sketch profile of the inner hub that decides how a full revolved 3D model will be formed. The specifications were taken from reviewing different papers on the Monotyre bike and the geometry was studied before the final dimensions were made fixed. As the wheel is the foremost important part in this regard, it was planned to be designed first.

The complete assembly of the wheel has been shown in Fig. 3 so as to understand where the discussed component is to be fitted inside the wheel. Also, it gives a basic idea of how the load is to be applied and how the structure stands.

Table 1 Inner hub specifications

Hub diameter	732.88 mm
Centre bore	105 mm
Centre bore width	100 mm
Wheel load	300 kg (approx.)
Hub diameter	800 mm
Hub width	150 mm
Offset	33.56 mm
Bearing groove(s) diameter	9 mm
Bearing groove(s) pitch	10 mm
Groove offset	15 mm

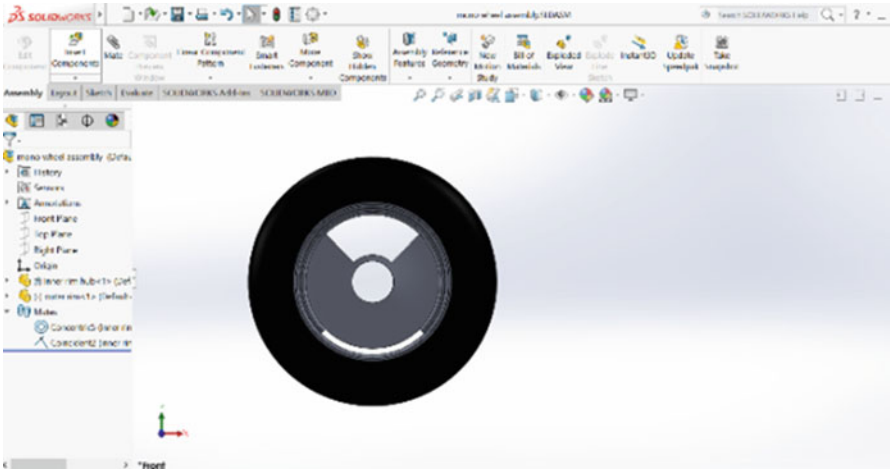

Fig. 3 Assembly of the complete wheel

Table 2 Material properties of AlSi12

Chemical composition	Si-11.2% Cu-0.10% Mg-0.10% Mn- 0.42% Fe-0.45% Ti-0.10% Ni- 0.08% Zn-0.12% Pb- 0.10% Al- ball
Density	2.65 g/cm^3
Elongation	0.4%
Hardness	88 HB
Tensile strength	210 MPa
Ultimate tensile strength	178 MPa

3.2.1 Material Properties of Aluminium Silicon alloy (AlSi12) [5]

The properties have been given in Table 2.

4 Finite Element Analysis of the Wheel Inner Hub

The Finite element analysis of wheel inner hub for Linear Static Analysis and Modal Analysis tests has been done on Ansys 16.0 and the details for the same are layered down in order.

4.1 Meshing

STEP file for the wheel inner hub has been imported to Ansys 16.0. For meshing, the body sizing for the models was selected having an element size of **5 mm**. Body sizing was done to specify precisely the spacing so as to accurately shape the elements and align with the whole meshing at different edges and grooves of the wheel inner hub. The elements selected were Quad & Tri elements and the mesh method selected is Hex Dominant as the geometry is of the circular type having a combination of curves and edges (Fig. 2).

Face meshing (Fig. 4) has been done on the grooves so as to give the fine elements and the results are accurate. This was done because it enhances the no. of elements and confirms a reduction in errors. The total **no. of elements** was **609,448** and **nodes** were found to be **158,423**.

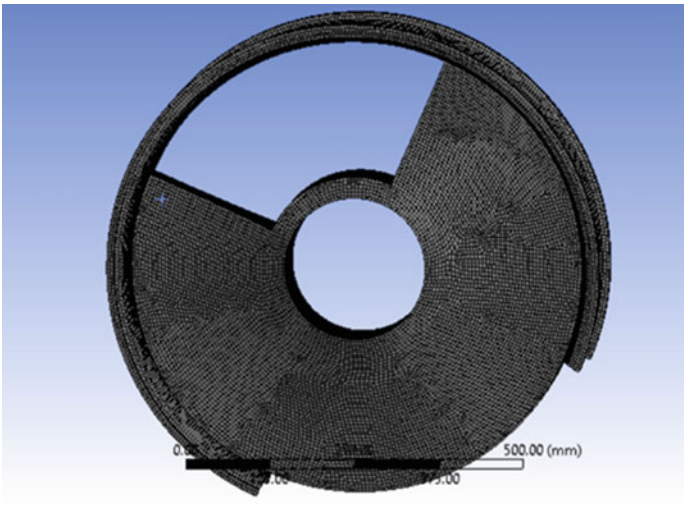

Fig. 4 Meshing of wheel inner hub

4.2 Boundary Condition

The **Centre Bore** inside face has been given **Fixed Displacement** and **Grooves and Edges** for the ball bearings have been applied with a **Force of -3000 N**.

4.3 Linear Static Analysis

This is one of the static analysis methods and here it is done to get a close look into the elastic properties and maximum admissible stress for the structure. Figures for the linear static structural analysis results have been displayed below. Both the structures have been selected for **Shear Stress** (Fig. 5) and **Equivalent stresses (von-mises)** (Fig. 6). Also, the **Total Deformation** (Fig. 7) has been recorded for wheel inner hub.

4.3.1 Dynamic or Modal Analysis

Modal analysis is the study of the dynamic properties of systems in the frequency domain. Modal analysis is important in structures where the engineer should attempt to keep the natural frequencies away from the frequencies of the structure [6].

The modal analysis was carried out for wheel inner hub and the total deformation at different modes has been shown in Figs. 8, 9, 10, 11, 12 and 13.

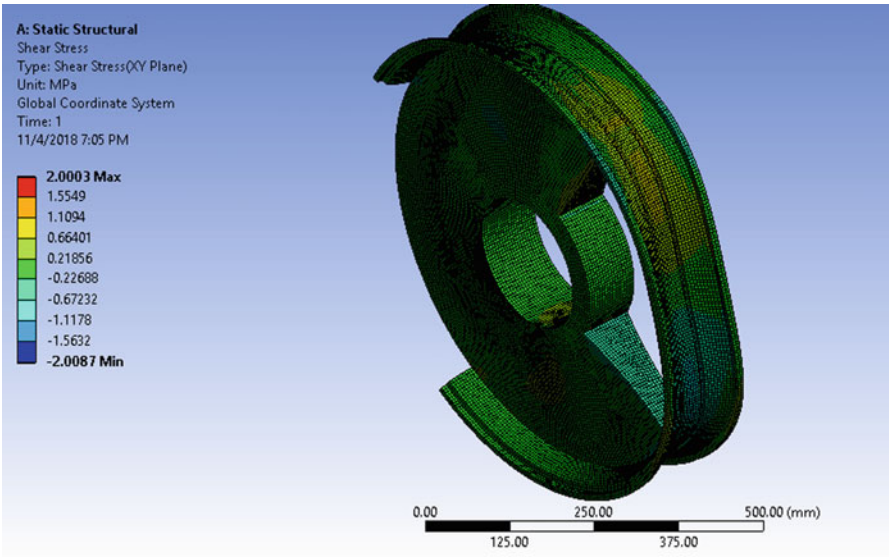

Fig. 5 Shear stress

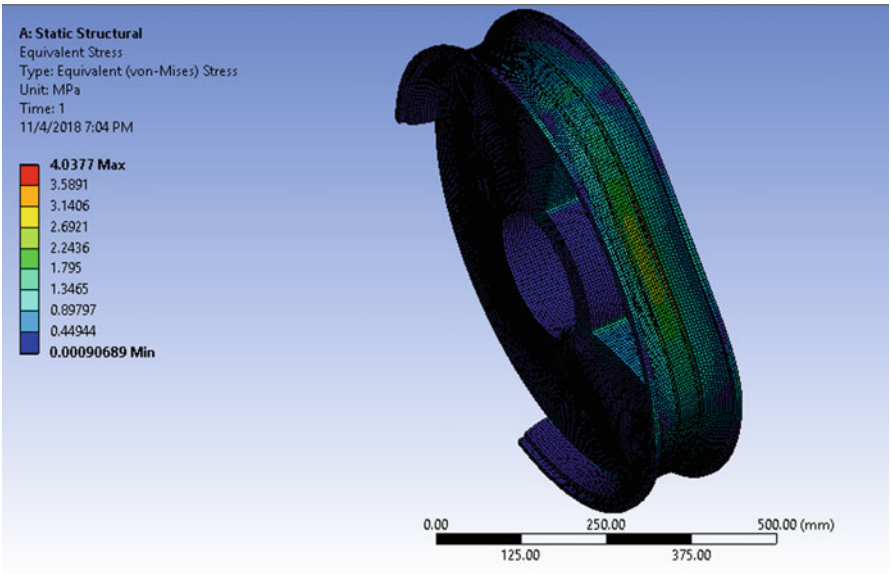

Fig. 6 Equivalent stress (von-mises)

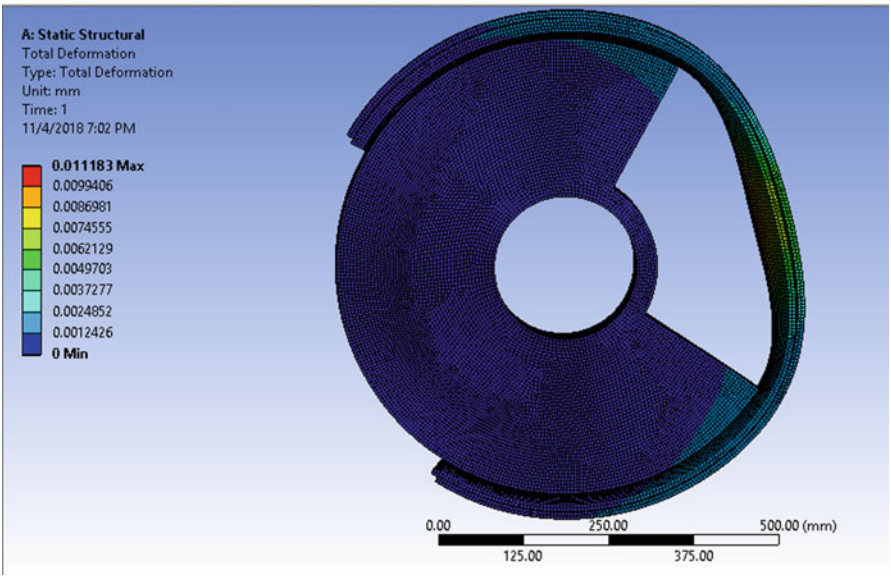

Fig. 7 The total deformation

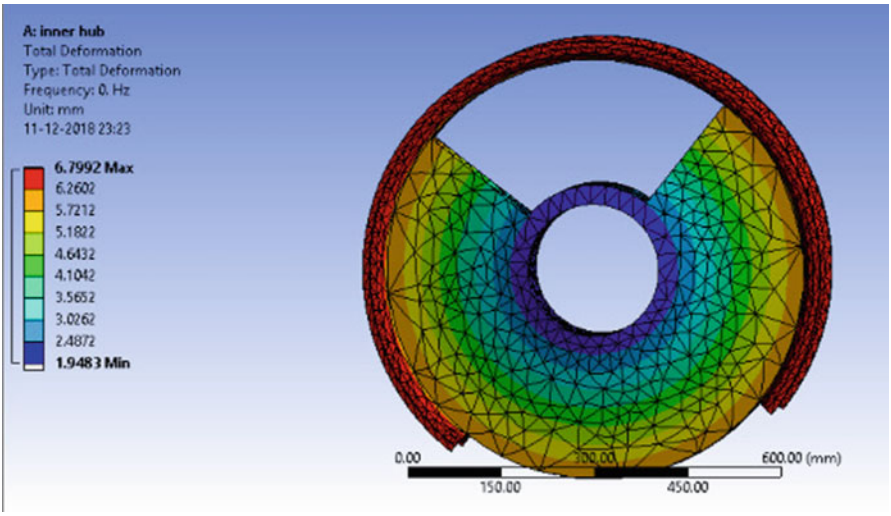

Fig. 8 Total deformation in 1st mode

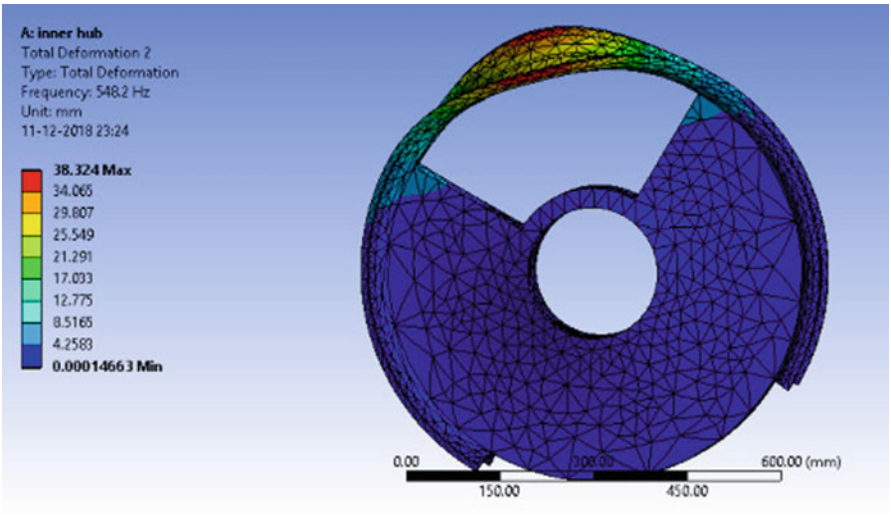

Fig. 9 Total deformation in the 2nd mode

5 Results and Discussion

The FEA results of the inner hub of the wheel have been tested for Linear Static Analysis and Modal Analysis. The linear static analysis results (Table 3) shows that the Equivalent stresses (von-mises) and Shear stress are within the permissible limits of the material and the structure deforms slightly at 3000 N of force. The total

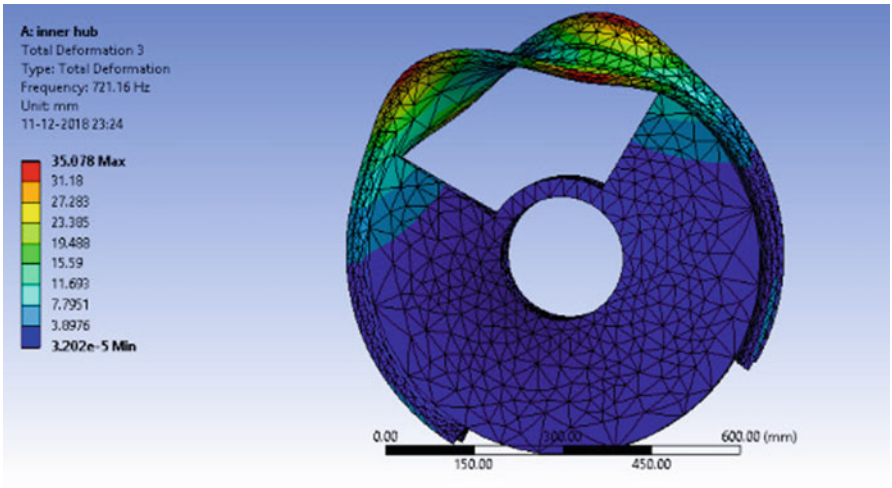

Fig. 10 Total deformation in 3rd mode

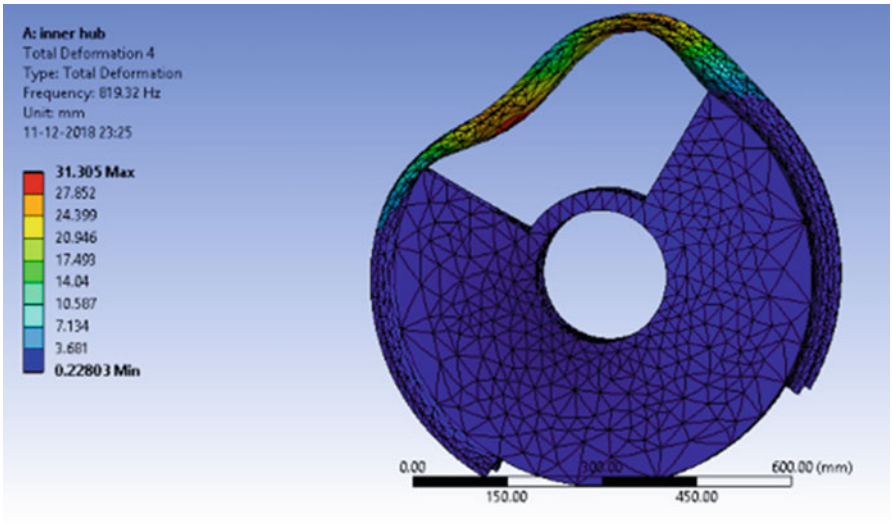

Fig. 11 Total deformation in the 4th mode

deformation shows that the structure can stand the load but should be considered for redesign as well as re-selection of the material.

The modal analysis (Table 4) shows that the different mode shapes at different frequencies will definitely disturb the structure but the structure can withstand the vibration up to 900 Hz natural frequency.

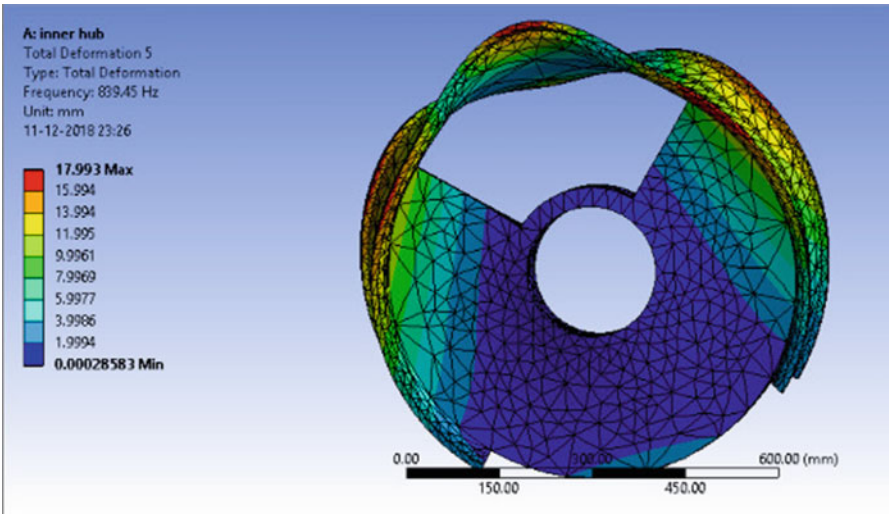

Fig. 12 Total deformation in 5th mode

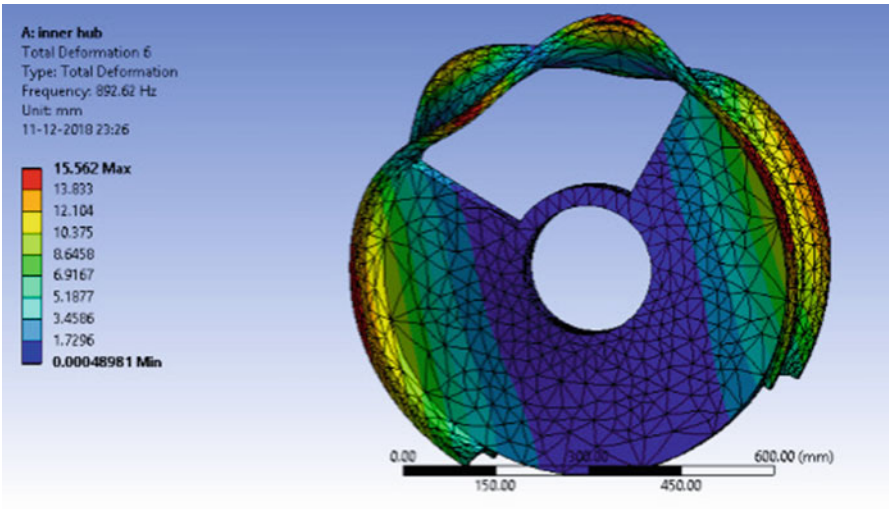

Fig. 13 Total deformation in the 6th mode

Table 3 Linear static analysis results

Equivalent von-mises stress	4.04 MPa
Shear stress	2 MPa
Total deformation	0.01 mm

Table 4 Modal analysis results

Mode number	Frequency (hz)	Total deformation (mm)
1	0	6.79
2	548.2	38.32
3	721.16	35.08
4	819.32	38.31
5	839.45	17.99
6	892.62	15.56

6 Conclusion

1. Linear static analysis was carried out and maximum equivalent stress is 4.04 MPa which was in range with the yield stress of the given material and for applied load, hence the Design is safe.
2. It is further concluded from the linear static analysis that re-designing the critical areas would be beneficial.
3. The Dynamic analysis was done to find six initial modes and natural frequency of the wheel inner hub.
4. The selected material AlSi12 can be used for fabrication of the wheel inner hub of the Monotyre bike.

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Development and Validation of Transportation Methodology by Predicting Dynamic Behavior of Container for Safe Transportation

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Keywords Transportation container · FEA · MAST · Industrial component

1 Introduction

Road transport is playing an important role in the transportation of goods in a safe condition. When a package containing hazardous (especially nuclear reactor) goods is shipped from location to location, it is to regulate by the International Atomic Energy Agency (IAEA) about shielding capability and its structural integrity. The tie down system plays a crucial role from safeguarding the general public from injury, protecting the transporting vehicle and its contents, and ensuring against damage to the package and its contents [1–7]. Two basic schemes generally used for shipping of container can be categorized as the rigid or bolted tie-down, and the tension member tie-down [8] out of which bolted tie down arrangement offers the most promise for compliance with the regulations. In the said research work, the tie-down system is a structural part of the package, and the response of the container for the known acceleration inputs was evaluated on Multi-Axis Shaker Table (MAST). This may be done by using the transportation modal standards and regulations need to be governed to confirm the necessary or recommended package acceleration factors provided by the national and international competent authorities as shown in Table 1

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Table 1 Acceleration factors for various modes of transport [9]

Sr. no	Mode	Acceleration factor		
		Longitudinal	Lateral	Vertical
1	**Road**	**2 g**	**1 g**	**2 gUp, 3 g down**
2	Rail	5 g	2 g	2 gUp, 2 g down
3	Sea/water	2 g	2 g	2 gUp, 3 g down
4	Air	1.5 g	1.5 g	2 gUp, 6 g down

[9]. Through experimentation acceleration factors are determined using low-frequency excitation signals which are generated by vehicles. The obtained results have been compared with FEA results to develop a methodology for the prediction of acceleration factors on transportation container.

2 Literature

To achieve the objective of the research, work done by the various researchers in relation with the field of research has been studied and following inferences are drawn,

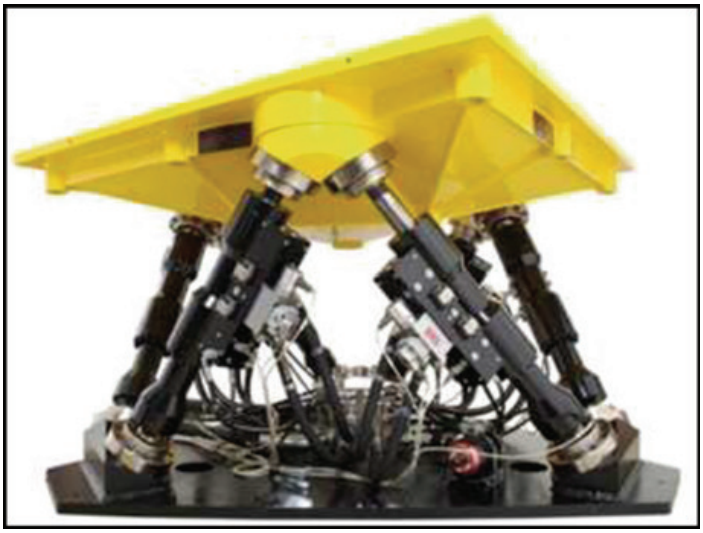
- The composite structure comprises of metal and non-metal, so interaction between them need to be analyzed at the initial stage to develop the transportation methodology. The research helps to study the interaction between the metal and non-metal and identify the bonding between them.
- JSS 55555 helps to describe standard procedures and conditions for Environmental Tests need to be carried out in Laboratory on MAST related to routine road load conditions.
- Also, research helps to identify the use of the MAST system for durability test, i.e. it can be used to replace road load test and to integrate it with FEA tools, which can be used to develop the transportation methodology.

3 Experimental Setup

The container used for transportation of goods is made up of mainly three materials namely IS2062B, SS304L, and Lead as shown in Fig. 1 as IS2062 and SS304L grade material contains carbon and manganese which acts as strengthening elements which govern the optimum mechanical properties and high thermal conductivity [10, 11].

Fig. 1 Actual container

Fig. 2 MAST system [15]



3.1 Testing of Container on Multi-Axis Shaker Table (MAST)

The Multi-Axial Shaker Table (MAST) is used to duplicate the frame motion of the vehicle by using the servo-hydraulic system which is capable of reproducing 6 DOF [12–14, 16–20]. MAST consists of a hexapod platform with a low resonance table on top which can be used to simulate any kind of vibration in all six degrees of freedom having a payload capacity of 1000 kg with a frequency range of 0.1–50 Hz as shown in Fig. 2. For experimentation, the container was bolted to additional Plate which will act as a vehicle base as shown in Fig. 3.

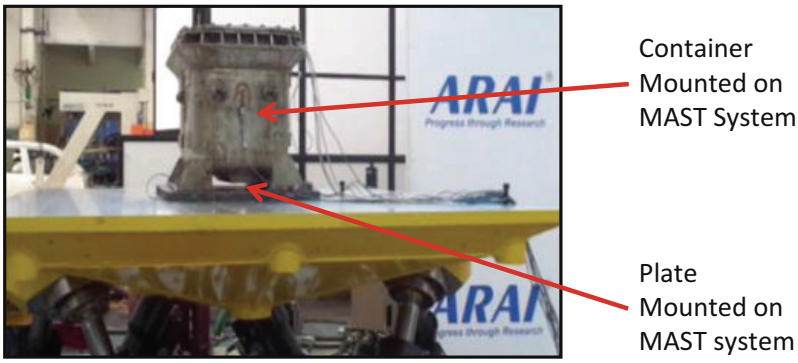


Fig. 3 Instrumented container on MAST

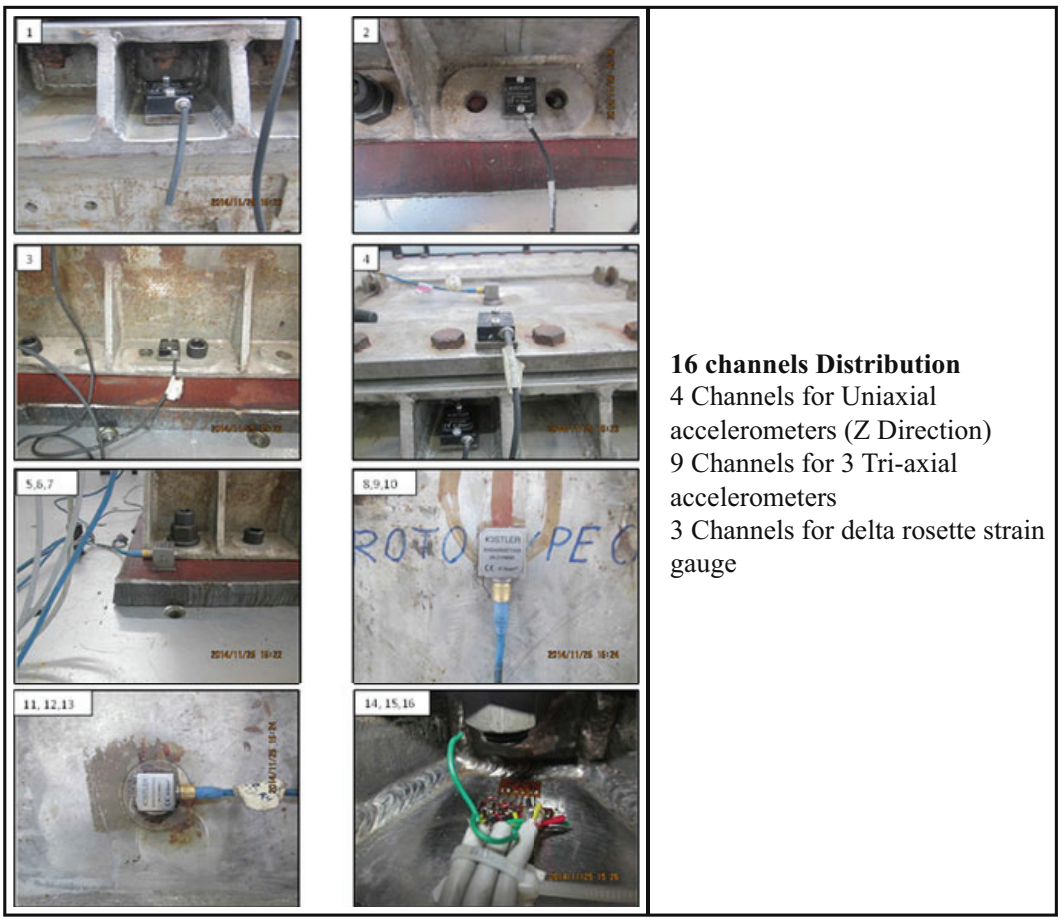


Fig. 4 Transducer locations on container

3.2 Data Acquisition System for MAST

16 channels data acquisition system was used for recording behavior of the container shown in Fig. 4 w.r.t. known input signals of constant frequency constant amplitude

Table 2 Material properties [10, 11]

Sr. no.	Material	Young's modulus (MPa)	Density (Kg/m^3)	Poisson's ratio
1	IS2062B	2.1E+5	7.8E-9	0.3
2	SS304L	2.1E+5	7.8E-9	0.3
3	Lead	1.7E+4	1.17E-8	0.4

Table 3 Weight comparison table

Sr. no.	The weight of build FEA model	Actual weight of container
1	870Kg	872 Kg

and single random signal. An input signal for FE correlation has been given through response of Tri-axial accelerometer was kept very close to and not on the container.

4 FE Modelling

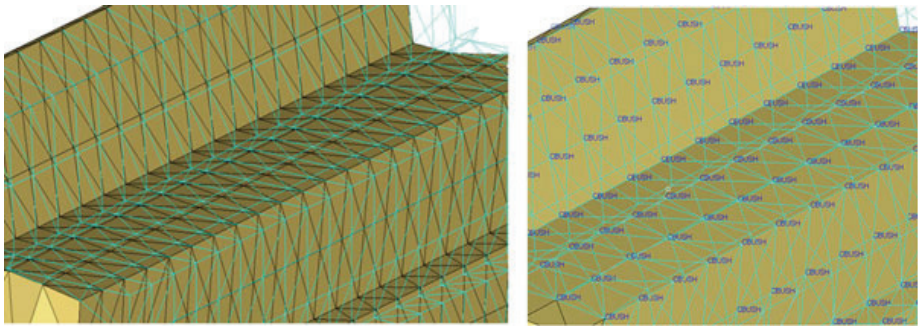
In order to build the FEA model for correlation, following material properties were considered shown in Table 2 and it was found that the weight of the actual and FEA model closely resembles as shown in Table 3.

4.1 Contact and FE Model Detailing

To carry out modal analysis, the interaction between the metal and non-metal must be known for simulation as the container is a combination of metal and non-metal. Considering the complexity and intricate cavities of the container, the correlation was difficult. Thus after carrying out many iterations with varying types of contact which were leading to the deviation, spring elements with varying stiffness were used for defining contacts between lead and steel as shown in Fig. 5. At the end of 15–20 sub-iterations of varying stiffness ranging from 1 N/mm to 1500 N/mm, it was found that with spring elements having stiffness 750 N/mm predicted results were correlating well with experimental results [17].

4.2 Selection of Boundary Conditions for Transient Response Analysis

When external excitation is applied to a system, two types of motion, namely the steady state (independent of time which persists for a long time) and transient motion (temporary and time-dependent) are generated. Most of the cases the steady state is



Contact with nodal Connectivity

Contact With spring Elements

Fig. 5 Contact detailing

preferred, but transient vibration or motion is important in either the cases when the excitation is sudden and unexpected (like road conditions) or continuous excitations [18]. The transient response analysis is a most general method for computing forced dynamic response. The purpose of a transient response analysis is to compute the behavior of a structure subjected to time-varying excitation [19, 21]. All the forces (which is in the form of applied forces and in forced motions) applied to the structure are known at each instant in time which helps in capturing results in the form of displacements, velocities, and accelerations of grid points and, forces and stresses in elements. Depending upon the structure and the nature of the loading two different numerical methods can be used for a transient response analysis: direct and modal. [19, 21]. The build FEA model was constrained at the same location, and the input is same as that of the output of the accelerometer placed near to container will act as a vehicle base input for the container. The correlation was done at the same locations experimental tie-downs to develop the transportation methodology. The schematic of build FEA model for transient response method has been shown in Fig. 6.

5 Results and Discussion

It was expected that to develop transportation methodology, the experimentally observed response (acceleration factors) at predefined locations should correlate with FE simulation response along with trend and the RMS value of the observed responses For experimental testing, as stated in earlier sections, the input signal varied from 5 Hz to 40 Hz excited in each direction namely X, Y and Z keeping 'g' level constant as '1.2 g' along with one random signal which would represent actual road surface excitation signal. All the signals were last for 3 min which will result in 180000 data points. Based on sampling technique 5000 data points taken into considerations, the, i.e. response for 5 sec. was analyzed from 20 Hz frequency range (considered to be the mean value of signal). Output response in the direction of excitation was more focused and expected trend levels which have been shown below:

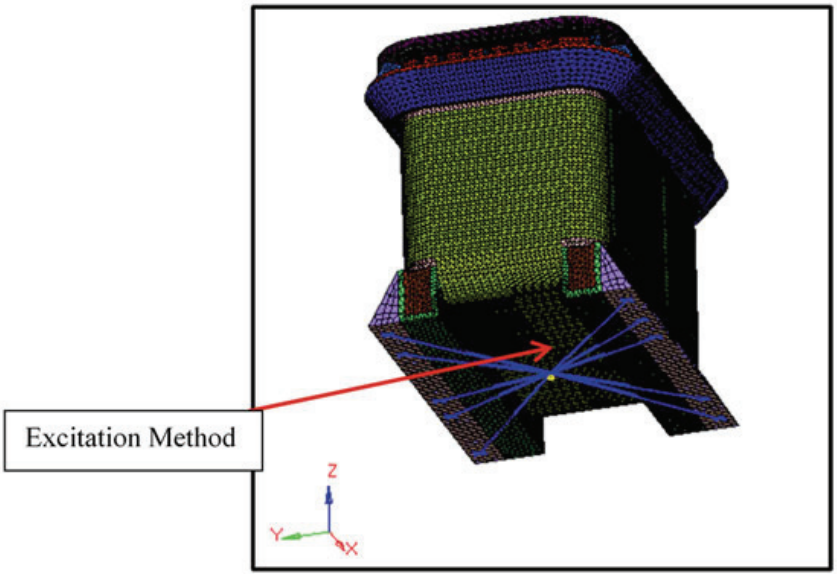


Fig. 6 Excitation location and boundary condition [22]

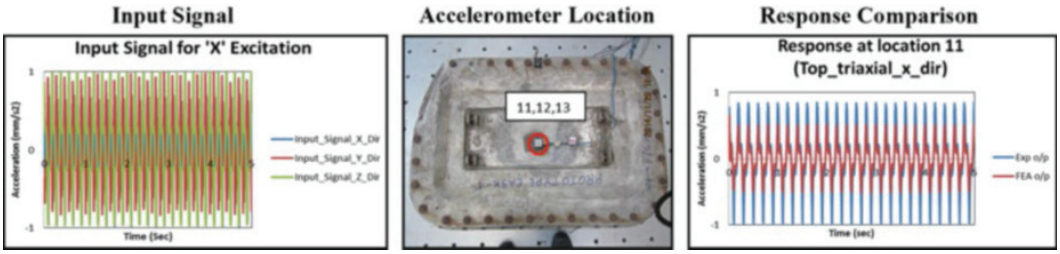


Fig. 7 Input signal and response comparison for excitation in X direction

Excitation in X, Y and Z Direction

- Input Signal band:- 5–40 Hz
- Duration:- 3 min

As prescribed earlier, the input signal given to container was a combination of 'XYZ' response obtained from the Tri-axial accelerometer placed just near to the container and compared output response which is in the direction of excitation, i.e. in 'X' Direction shown in Fig. 7; in Y Direction shown in Fig. 8 and for Z Direction shown in Fig. 9.

Random Signal Excitation

- Input Signal Band:- 0.5–100 Hz

As prescribed earlier, the input signal given to container was a combination of 'XYZ' response obtained from the Tri-axial accelerometer placed just near to the container as shown in Fig. 10.

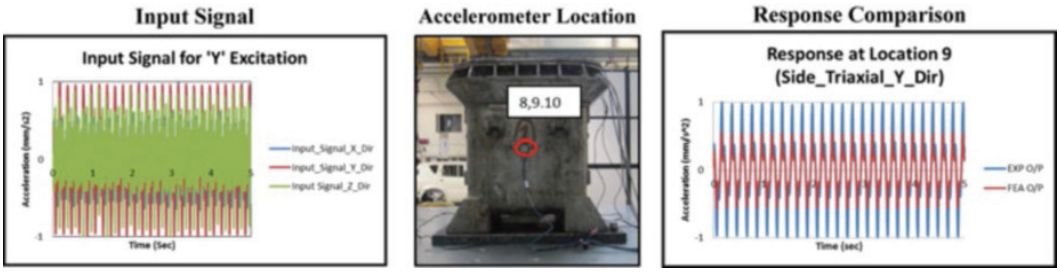


Fig. 8 Input signal and response comparison for excitation in Y direction

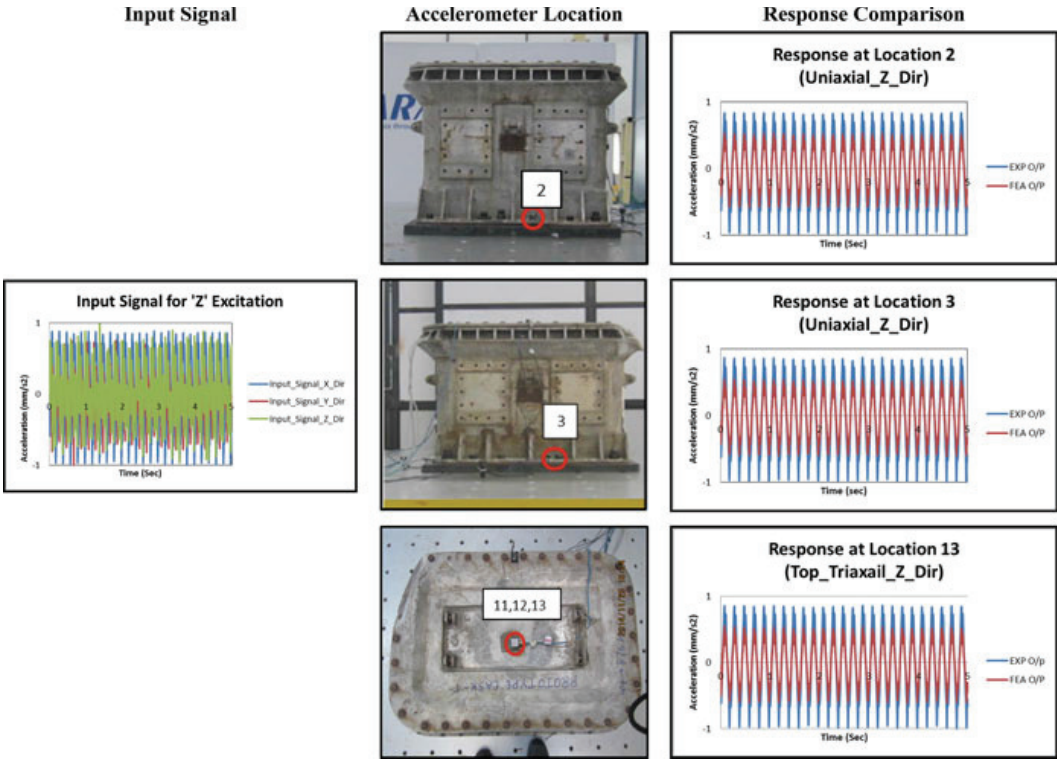


Fig. 9 Input signal and comparison for excitation in Z direction

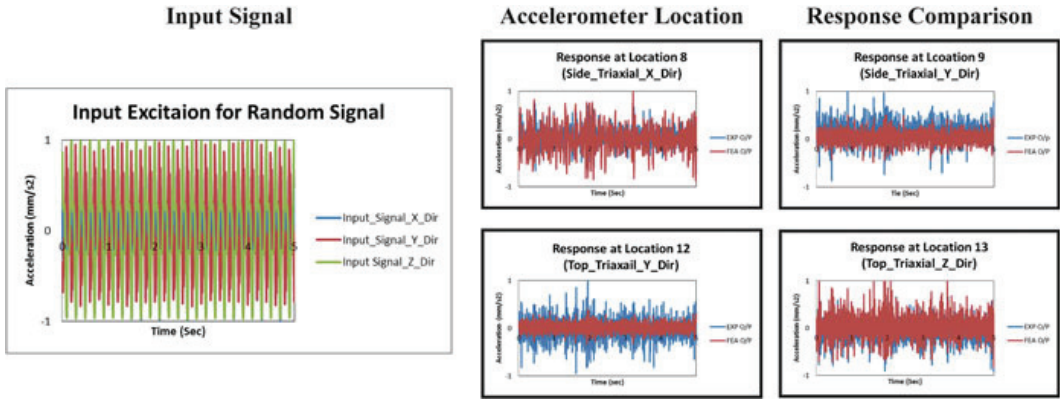


Fig. 10 Input signal and comparison for excitation for random signal

Table 4 Comparison of RMS value for excitation w.r.t. excitations

Excitation direction	Location	Response direction	RMS Value			
			experimental		FEA	
			mm/s^2	g	mm/s^2	g
X direction	8	X	2553.53	0.260	1649.64	0.168
Z direction	10	Z	387.9	0.039	269.75	0.027
Random excitation	1	Z	609.53	0.062	502.58	0.051
	2	Z	472.18	0.048	499.83	0.050
	3	Z	594.62	0.060	505.08	0.051
	4	Z	630.18	0.064	502.18	0.051
	8	X	690.66	0.070	1119.01	0.114
	9	Y	313.43	0.031	173.175	0.017
	10	Z	2028.74	0.206	509.52	0.051
	11	X	2224.35	0.226	1126.46	0.114
	12	Y	455.36	0.046	208.62	0.021
	13	Z	533.25	0.054	521.72	0.053

The observed results clearly state that the output trends closely resemble to each other which are sufficient enough to define the transportation methodology. For correlation, it was expected that the peaks of response along with the trend of response should match with each other for which RMS values were calculated through ADAMS tool for all input signals and was found to be reasonable. The comparison of experimental and FE simulated values have been shown Table 4.

For random excitation signal RMS values calculated are more focused as this type of signals are similar in nature to the signals which are actually received from the on-road vehicles. The RMS value at every location has been taken into consideration irrespective of the direction of excitation, and it was found that the acceleration factor 'g' values were in the limits given by the IAEA regulations shown in Fig. 11.

6 Conclusion

From work carried out to develop transportation methodology for prediction of the dynamic behavior of transportation container following inferences can be drawn;

- Work carried on Transportation Container under the scope of project demonstrated sequence of activities and typical methodology to be adopted for prediction of acceleration levels under transportation conditions for heavy transportation containers.
- Proposed methodology of virtual prediction of the dynamic behavior of the container for the routine condition is validated.

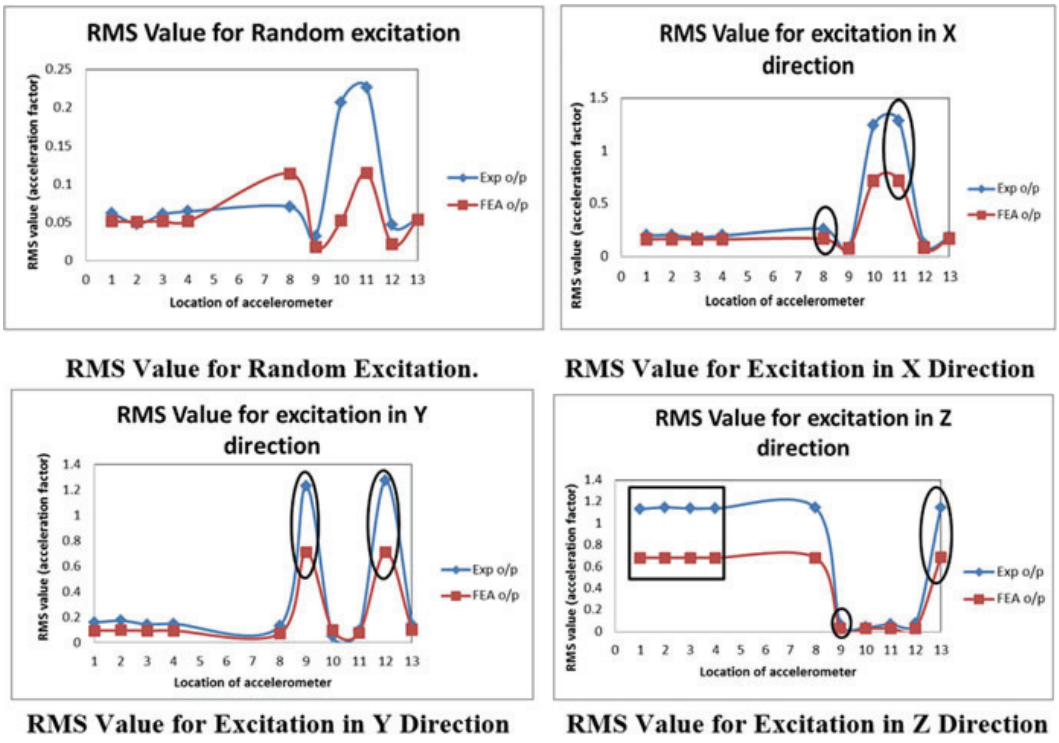


Fig. 11 Graphical representation for comparison of RMS values

- This base can be used for dynamic data acquisition on instrumented long wheel-base vehicle & short base with two different transportation packages on public roads such as National highway, State highway, rough road, city etc. and test track.

Analysis of the acquired data and Implementation of Developed on actual size transportation packages to eliminate redundant Tie-Downs.

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Optimization of Multiple Performance Characteristics of Surface Micro-Textured Journal Bearing

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Keywords CFD analysis · Micro-texturing · Design of experiment · Optimization · Fluid film pressure · Frictional power loss · Overall evaluation criteria

1 Introduction

The study related to the performance of hydrodynamic journal bearing lubrication was started by Hamilton et al. [1] and suggested that micro irregularities on the surface were able to develop sufficient fluid film pressure and hence load carrying capacity. Thereafter study has been carried out on different parameters of irregularities.

Tala et al. [2] studied numerically the effect of cylindrical texture shape location on the performance characteristics of the hydrodynamic journal bearing. They concluded that proper texture arrangement can enhance the performance of journal bearing. Zhang et al. [3] studied the influence of textures on tribological characteristics to get the optimal distribution of textures. They improved the load bearing capacity of a journal bearing through appropriate arrangement of partial texturing on sleeve surface. Meng et al. [4] studied the effect of the compound dimple in the circumferential region of 90–180 on the performances of a journal bearing. They used fluid structure interaction (FSI) method to examine load carrying capacity and coefficient of friction. They concluded that a compound dimple at 90–180 region increases the load carrying capacity as well as reduce the coefficient of friction. Bo-Suk Yang et al. [5] carried out the optimization of the short journal bearing systems to minimize the lubricant temperature rise and lubricant supply quantity using an enhanced artificial life algorithm (EALA). Further optimization of short

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journal bearing was extended by Jin Dae Song et al. [6] who proposed hybrid EALA algorithm in which synthesis of an artificial life algorithm (ALA) and the random tabu search method (R-tab method) is used to solve demerits of the ALA. Hirania and Suh [7] described the optimum design methodology for enhancing operating characteristics of hydrodynamic journal bearings. In the optimization, the design variables such as radial clearance, length to diameter ratio, groove geometry, oil viscosity, and supply pressure are used to minimize oil flow and frictional power loss. A rank-based genetic algorithm method is used to optimize two objective functions under three constraints such as maximum pressure, temperature rise, and minimum film thickness. Tomoko et al. [8] carried out the optimization of groove configurations herringbone-grooved journal bearings. Rahmani et al. [9] introduced an analytical approach to study the textured surfaces in hydrodynamic lubrication region. They employed an optimization procedure to achieve the optimum texturing parameters which increase the maximum load capacity, load capacity to lubricant flow rate ratio and minimum friction coefficient for asymmetric partially textured slider bearings. While Shen and Khonsari [10] extended the analysis of different texture shape for maximum load-carrying capacity by using the sequential quadratic programming (SQP) algorithm and proposed a novel texture shapes which create maximum load carrying capacity for both unidirectional and bidirectional slides motion. Jun Sun et al. [11] developed a multi-objective optimization design of the crankshaft-bearing. They selected crankshaft mass and the total frictional power loss as the objective functions and found that the total frictional power loss and the crankshaft mass are decreased, respectively. Viorel Badescu [12] obtained optimal profiles using direct constrained optimal control techniques for one dimensional slider bearings under technological constraints such as the maximum lubricant pressure, temperature and the minimum lubricant film thickness. Various work have been reported on the performance analysis of journal bearing by Shinde et al. [13–17]

From the literature, it was observed that most of the work has been carried on partial dimple and groove shape micro-texturing on the bearing surface. Also, it is found that fully surface micro-texturing does not enhance the performance characteristics. The surface texturing present in the region of 90°–180° have a positive effect on fluid pressure distribution, load carrying capacity (Tala-Ighil et al. [2], Meng et al. [4] and Vincent et al. [18]) and frictional power loss. The systematic micro-texturing in the region of 90°–180° have considerable influence on performance characteristics. Few systematic types of research have been conducted on optimization of the micro-textured journal bearing for maximization of fluid film pressure and minimization of frictional power loss. Therefore, Taguchi's orthogonal array L_{27}method is implemented to examine the effect of micro-texturing on above responses with minimum numerical runs. For the multi-objective optimization approach, Overall Evaluation Criteria (OEC) method is used to find optimum condition. The input variable factors selected for analysis are groove region, groove depth, groove width, set of grooves and pitch.

Table 1 Parameters set for analysis

Fixed factors			Micro-texturing control factors				
Factor	Value	Unit	Factor	Level			Unit
Journal radius (R)	31.5	mm		**1**	**2**	**3**	
Journal length (H)	63	mm	Groove depth (Δh)	0.015	0.0 20	0.025	mm
Clearance (c)	0.030	mm	Set of grooves (S)	8	10	12	–
Journal speed (RPM)	5980		Pitch(p)	0.2	0.3	0.4	mm
Angular velocity (ω_1)	RPM/ 60∗2∗pi	rad/ s	Groove region (θ_1–θ_2)	90–155	90–165	90–175	deg
Eccentricity ratio (ε)	0.6	–	Groove width (w)	2.4	2.5	2.6	mm
Oil viscosity (μ)	0.0035	Pa.s					
An external force (F)	12	KN					

2 Taguchi Design of Experiment (DoE) Method

Taguchi's design of experiments method is a systematic and efficient approach which involves proper selection of input factors and their interactions. There are various factors like the viscosity of lubricant, journal speed, clearance, eccentricity ratio, length to diameter ratio, surface texturing which are directly or indirectly affect the performance characteristics. Previous research (Tala-Ighil et al. [2, 27], Meng et al. [4] and Vincent et al. [18]) suggests that performance of journal bearing is significantly influenced by micro-texturing parameters like groove region, groove depth, groove width, set of grooves and pitch. Therefore for optimization, five micro-texturing factors each at three levels were considered as shown in Table 1 The proper orthogonal array of $L_{27}$is shown in Table 2.

3 CFD Analysis of Smooth Surface and Micro-Textured Journal Bearing

3.1 Governing Equations

The Reynold's equation is used to explain the theory of hydrodynamic lubrication. The Steady state analysis is carried out to obtain fluid film pressure distribution. The thickness of the lubricant film h and the fluid film pressure at steady state is governed by the following Eq. [2].

Table 2 Orthogonal array L_{27} of the simulation runs with results

Run No.	Input variables					Performance characteristics	
	Groove region (θ_1–θ_2) in deg	Groove depth (Δh) in mm	Set of grooves	Groove width (w) in mm	Pitch in mm	Fluid film pressure in MPa	Frictional power loss in watt
1.	90–175	0.025	7	2.4	0.2	9.1403	639.176
2.	90–175	0.025	7	2.4	0.3	9.1291	639.172
3.	90–175	0.025	7	2.4	0.4	9.1152	639.170
4.	**90–175**	**0.015**	**9**	**2.5**	**0.2**	**10.3624**	**638.047**
5.	90–175	0.015	9	2.5	0.3	10.3292	638.045
6.	90–175	0.015	9	2.5	0.4	10.2923	638.043
7.	90–175	0.020	11	2.6	0.2	9.8084	656.488
8.	90–175	0.020	11	2.6	0.3	9.7986	656.485
9.	90–175	0.020	11	2.6	0.4	9.7857	656.481
10.	90–165	0.020	9	2.4	0.2	8.5238	634.876
11.	90–165	0.020	9	2.4	0.3	9.2513	634.873
12.	**90–165**	**0.020**	**9**	**2.4**	**0.4**	**9.2352**	**634.700**
13.	90–165	0.025	11	2.5	0.2	8.7438	660.428
14.	90–165	0.025	11	2.5	0.3	8.7372	660.424
15.	90–165	0.025	11	2.5	0.4	8.7299	660.420
16.	90–165	0.015	7	2.6	0.2	10.0314	657.295
17.	90–165	0.015	7	2.6	0.3	10.0142	657.291
18.	90–165	0.015	7	2.6	0.4	9.9951	657.290
19.	90–155	0.015	11	2.4	0.2	9.3063	680.110
20.	90–155	0.015	11	2.4	0.3	9.2977	680.105
21.	90–155	0.015	11	2.4	0.4	9.2864	680.100
22.	90–155	0.020	7	2.5	0.2	8.5489	661.611
23.	90–155	0.020	7	2.5	0.3	8.5397	661.609
24.	90–155	0.020	7	2.5	0.4	8.5302	661.605
25.	90–155	0.025	9	2.6	0.2	7.6991	639.937
26.	90–155	0.025	9	2.6	0.3	7.6877	639.933
27.	90–155	0.025	9	2.6	0.4	7.6809	639.930

$$\frac{\partial}{\partial\theta}\left(\mathrm{h}^3\frac{\partial P}{\partial\theta}\right)+\left(\frac{\mathrm{R}}{\mathrm{L}}\right)^2\frac{\partial}{\partial Z}\left(\mathrm{h}^3\frac{\partial P}{\partial Z}\right)=6\mu\mathrm{R}^2\left[(\omega_2-\omega_1)\frac{\partial h}{\partial\theta}\right] \tag{1}$$

In the above equation, P is the fluid pressure; h is the film thickness. The fluid film thickness h is given by Eq. (2) which was used for negative micro-texturing.

$$\mathrm{h}=\mathrm{h_s}(\theta)+\Delta h(\theta,\mathrm{Z}) \tag{2}$$

Where, $h_s(\theta)$= c (1 + $\varepsilon\cos\theta$) for plain journal bearing.

The frictional torque (T_f) on the journal surface is obtained by using (3) equation

$$T_f = 2\pi R^2 H \mu \left(\frac{u}{c}\right) \tag{3}$$

Frictional power loss (P_f) is calculated by

$$P_f = T_f \omega_1 \tag{4}$$

3.2 CFD Analysis Model

A three-dimensional geometric model of smooth surface and micro-textured journal bearing was created by using COMSOL Multiphysics 5.0 software. The better results have been reported by various researchers for analysis of micro-channels using COMSOL Multi-physics software ([19, 20], Wangikar et al. [21, 22]). Figure 1a, b shows journal bearing models with micro-texturing and with a smooth surface. Figure 1c shows the detailed view of the rectangular shape of the groove. Thelist of fixed and variable control parameters used for analysis have been given in Table 1. The micro-textures (grooves) were modeled on the bearing surface in the region of 90–180 as shown in Fig. 1a. Their groove region was denoted by θ_1 and θ_2. The performance characteristics like fluid film pressure and frictional power loss were obtained at different meshing conditions to examine mesh independence. For smooth surface bearing, total 79,468 quadrilaterals (mapped) elements were used with a maximum size of the element is 0.2 mm and minimum size of 0.001 mm. The results were obtained for various sizes of mesh elements for run number 4 as shown in Table 3. From Fig. 2, it is clear that results are same for case number 3, 4 and 5. Simulation results of fluid film pressure and frictional power loss obtained for 27 runs have been given in Table 2. The governing equations were solved without considering gravity force. The boundary conditions of the inlet and outlet were respectively "pressure inlet" and "pressure outlet" with gauge pressure as zero Pascal.

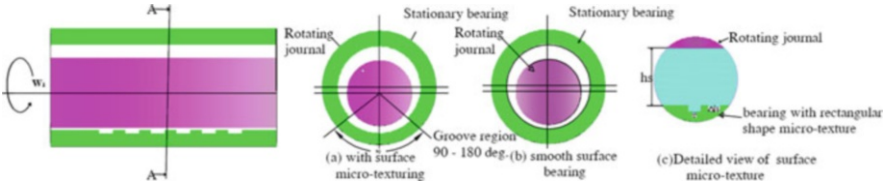


Fig. 1 Journal bearing models (**a**) with surface micro-texturing (**b**) smooth surface of bearing (**c**) detailed view

Table 3 Results for various sizes of mesh and precisions for run number 4

Case	1	2	3	4	5
Max. size of triangular element in mm	3	1	0.05	0.4	0.1
Mini. size of triangular element in mm	0.05	0.02	0.01	0.005	0.001
Max. size of quad element in mm	3	1	1	0.5	0.5
Min. size of quad element in mm	0.1	0.05	0.05	0.02	0.02
Total elements	65,750	128,778	139,472	340,637	911,015
Fluid pressure in MPa	10.3632	10.3626	10.3624	10.3624	10.3624
Frictional power loss in watt	639.568	639.142	638.047	638.047	638.047

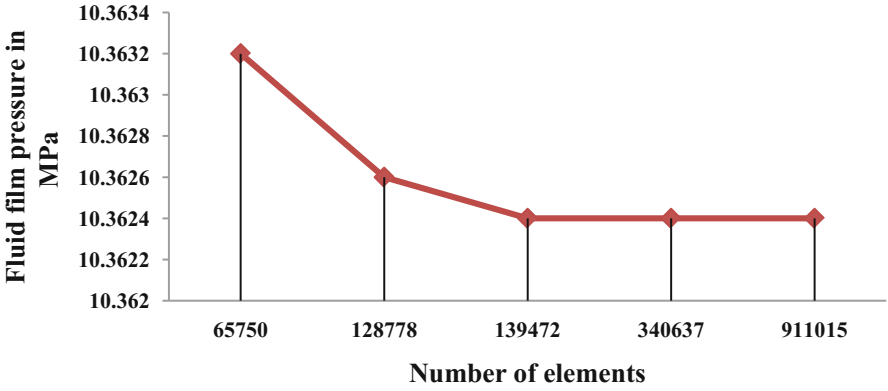


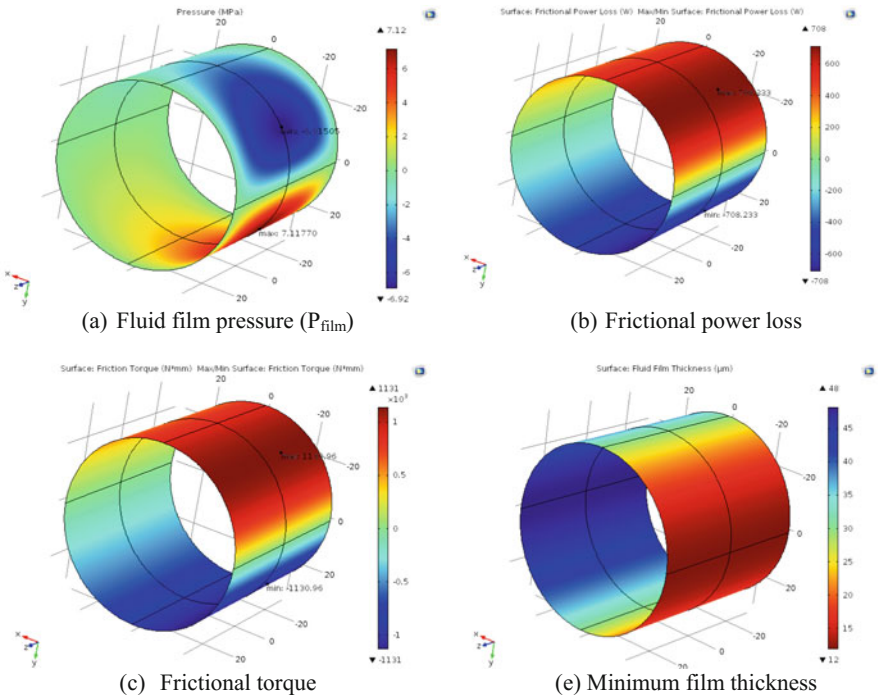
Fig. 2 Mesh independence checking for fluid pressure

3.3 Validation of CFD Model of the Smooth Surface Journal Bearing

The CFD analysis of smooth surface bearing was made and results have been summarized in Table 4. From Fig. 3a, it was observed that the maximum fluid film pressure of 7.117 MPa was developed in the red zone. Frictional power loss value of 708 watts is shown in Fig. 3b. Figure 3c shows frictional torque of 1130 N.mm watt. Similarly, Fig. 3d shows maximum and minimum film thickness of 48 μm and 12 μm respectively. From the Table 4, it can be observed that the values of performance characteristics are showing good agreement with results from literature (Tala-Ighil

Table 4 Performance characteristics of the smooth surface journal bearing

Characteristics	Fluid pressure in MPa	Frictional power loss watt	Frictional torque in N. mm	Minimum film thickness in um	Sommerfeld number
Simulation results	7.117	708	1130	12	0.212
[2]	7.70	708.6	1130	11.96	0.212
[18]	7.00	–	–	12	0.212



(a) Fluid film pressure (P_{film}) (b) Frictional power loss

(c) Frictional torque (e) Minimum film thickness

Fig. 3 Simulation results of the smooth surface journal bearing. (**a**) Fluid film pressure (P_{film}), (**b**) Frictional power loss, (**c**) Frictional torque, (**d**) Minimum film thickness

et al. [2], Vincent et al. [18]). Therefore, this validated model was used for the optimization study of micro-texturing to maximize the fluid film pressure and minimize the frictional power loss.

4 Results and Discussion

The numerical analysis data is analyzed using a statistical method which includes analysis of variance (ANOVA). The contribution of micro-texturing parameters on the fluid film pressure and frictional power loss is given by analysis of variance.

Also, main effects plots were used to see the trend of the variation of micro-texturing parameters on the performance characteristics.

4.1 *Effect of Micro-Texturing Parameters on Fluid Film Pressure*

Figure 4 shows the main effect plot of micro-texturing parameters on fluid film pressure. From Fig. 4, it can be observed that, as groove depth increases from 0.015 mm to 0.025 mm, pressure decreases. The maximum value was found at 0.015 mm of groove depth. As the groove region increases from 90–155 to 90–175, the maximum fluid pressure was achieved at 90–175 of groove region. Atthe set of 7 grooves, maximum fluid film pressure was developed as compared with 9 and 11 set of grooves. The maximum pressure is developed at a pitch of 0.2 mm and a groove width of 2.5 mm.

Table 5 gives information about degrees of freedom, the sum of squares, and mean of squares; f-value and p-value. The percentage contribution of each factor has been shown in the last column. From Table 5, it can be observed that the depth of the groove and groove region are the most significant parameters because their percentage contribution is about 51.88% and 43.56%. The remaining parameters like a set of grooves pitch and groove width having the contribution of 2.3%, 0.15% and 0.1% as shown in Table 5.

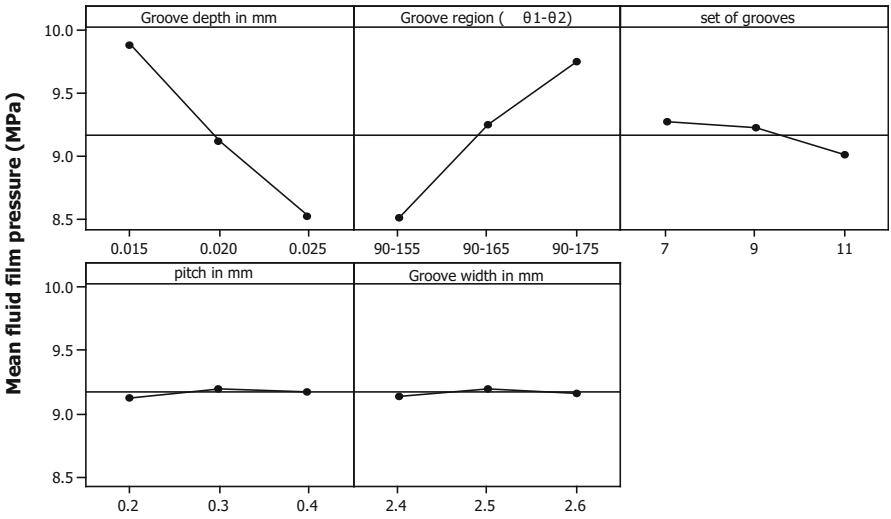


Fig. 4 Main effect plot for fluid film pressure

Table 5 ANOVA table for fluid film pressure

Source	DF	Seq SS	Adj MS	F-value	P-value	% Contribution
Groove region	2	7.0378	3.5189	172.78	0	43.56
Groove width	2	0.0157	0.0078	0.38	0.687	0.10
Groove depth	2	8.3829	4.1914	205.81	0	51.88
Set of grooves	2	0.3721	0.186	9.14	0	2.30
Pitch	2	0.0237	0.0118	0.58	0.002	0.15
Error	16	0.3259	0.0204		0.571	2.02
Total	26	16.158				

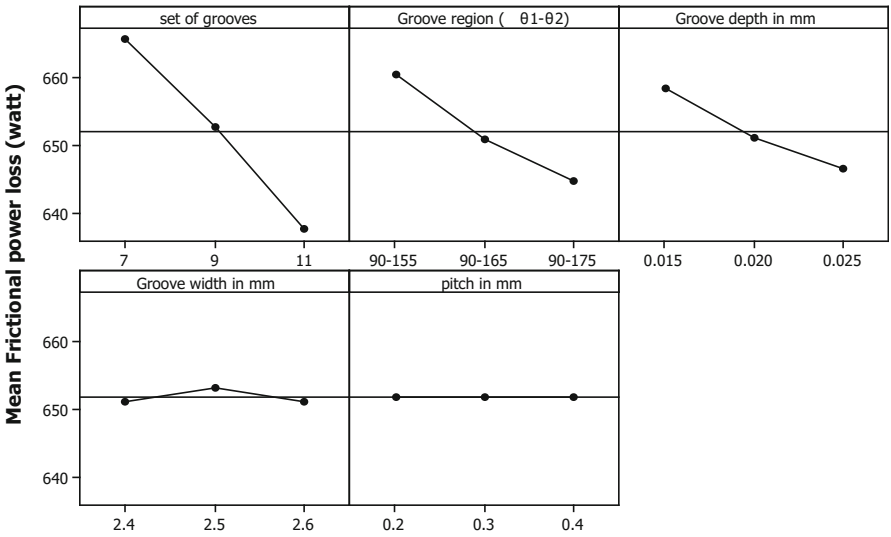


Fig. 5 Main effect plot for frictional power loss

4.2 Effect of Surface Texturing on Frictional Power Loss

The effect of various micro-texturing on frictional power loss has been shown in Fig. 5. It can be observed that, as the groove region increases from 90–155 to 90–175, power loss value decreases, and the minimum value was obtained at the groove region of 90–175. As the depth of the groove and set of grooves increases from 0.015 mm to 0.025 mm and 7 to 11 respectively, frictional power loss value decreases. The minimum value was observed at 0.025 mm of groove depth and a set of 11 grooves respectively. The groove width of 2.4 mm gives less value of power loss as compared with 2.5 mm and 2.6 mm groove width. It was also observed that there is no significant variation in frictional power loss value for pitch between grooves. Power loss value is nearly the same for 0.2 mm, 0.3 mm and 0.4 mm of the pitch.

Table 6 ANOVA table for frictional power loss

Source	DF	Seq SS	Adj MS	F-value	P-value	% Contribution
Set of grooves	2	3547.76	1773.88	9.7744E8	0	65.75
Groove region	2	1166.22	583.11	3.2130E8	0	21.63
Groove depth	2	658.07	329.03	1.8130E8	0	12.20
Groove width	2	25.31	12.65	6.9720E6	0	0.420
Pitch	2	0.000	0.000	1	0.390	0.00
Error	16	0.000	0.000	–	–	--
Total	26	5397.35	–	–	–	–

Table 6 shows ANOVA for frictional power loss. The last column of the table shows percentage contribution of micro-texturing parameters on development frictional power loss. It was observed that a set of grooves is the most significant parameter because it reduces frictional power loss by 65.75% as compared with other parameters. From the Table 6, it is also observed that the groove region and groove depth are significant factors because their percentage contribution is 21.63% and 12.20% followed by the width of groove with percentage contributions of 0.42%. There is no considerable influence of pitch on frictional power loss.

4.3 Optimization Using Overall Evaluation Criteria (OEC)

From Table 2, it is clear that simulation run number 4 gives maximum fluid film pressure value (10.3624 MPa) whereas run number 12 gives minimum frictional power loss value (634.700 watts). Hence it is required to find single surface micro-texturing configuration which will give maximum fluid film pressure as well as minimum frictional power loss. There are various techniques available like GRG ([23], Shinde et al. [13, 16]), OEC, AHP, etc. This optimized configuration was obtained by formulating Overall Evaluation Criteria (OEC). The relative weight percentage for fluid film pressure and frictional power loss is decided. For OEC, the different criteria with quality characteristics (QC) were normalized and weighted with 'bigger is the best' (QC = B). The calculation of OEC for the performance characteristics X and Y with weight percentages Wx and Wy were as given in Eq. (5) (Roy [24] and Wangikar et al. [21, 22, 25, 26]). The QC for X is 'smaller is the best' (QC = S) and for Y is 'bigger is the best' (QC = B).

$$\text{OEC} = \left(\frac{\text{X} - \text{X}_{\text{min}}}{\text{X}_{\text{max}} - \text{X}_{\text{min}}}\right)\text{W}_{\text{x}} + \left(1 - \frac{\text{Y} - \text{Y}_{\text{min}}}{\text{Y}_{\text{max}} - \text{Y}_{\text{min}}}\right)\text{W}_{\text{y}} \tag{5}$$

The analysis was performed to find out micro-texturing parameters, which correspond to higher fluid pressure with lower frictional power loss. To fulfill this condition, different OECs were formulated as OEC1, OEC2 and OEC3 with different weight percentages of fluid pressure and frictional power loss, as shown in

Table 7 Performance characteristics and their weight percentage OEC

Sr. No.	Performance characteristics	Worst	Best	QC	Weightage		
					OEC 1	OEC 2	OEC 3
1	Fluid film pressure in MPa	7.6809	10.3624	B	50	75	25
2	Frictional power loss in watt	680.105	634.700	S	50	25	75

Table 8 Performance characteristics with overall evolution criteria (OEC) values

Run. No.	Fluid film pressure (MPa)	Frictional power loss (watt)	OEC 1	OEC 2	OEC 3
1	9.1403	639.176	72.28	63.35	81.21
2	9.1291	639.176	72.07	63.04	81.10
3	9.1152	639.176	71.88	62.65	80.97
4	10.3624	**638.047**	**96.31**	**98.15**	**94.47**
5	10.3292	638.047	95.69	97.22	94.16
6	10.2923	638.047	95	96.19	93.81
7	9.8084	656.488	65.68	72.51	58.84
8	9.7986	656.488	65.49	72.23	58.75
9	9.7857	656.488	65.25	71.87	58.63
10	8.5238	634.876	84.16	76.43	91.88
11	9.2513	634.876	79.08	68.82	89.35
12	9.2352	634.876	78.79	68.37	89.20
13	8.7438	660.428	41.48	40.56	42.41
14	8.7372	660.428	41.36	40.38	42.35
15	8.7299	660.428	41.23	40.17	42.28
16	10.0314	657.295	68.94	78.30	59.59
17	10.0142	657.295	68.62	77.82	59.43
18	9.9951	657.295	68.27	77.29	59.25
19	9.3063	680.097	30.31	45.46	15.16
20	9.2977	680.105	30.14	45.21	15.07
21	9.2864	680.100	29.98	44.96	14.99
22	8.5489	661.611	36.55	34.46	38.64
23	8.5397	661.611	36.38	34.2	38.55
24	8.5302	661.611	36.20	33.93	38.46
25	7.6991	639.937	44.56	22.61	66.51
26	7.6877	639.937	44.35	22.30	66.41
27	7.6809	639.937	44.23	22.11	66.34

Table 7. The performance characteristics along with OEC values have been presented in Tables 8. The higher values of all OECs which give the condition for optimum performance characteristics have been highlighted in the same table. For all OECs, the optimum condition was observed at Run No. 4 (groove region of 90^0–175^0, the groove depth of 0.015 mm, set of 11 grooves, the groove width of 2.5 mm and pitch of 0.2 mm).

5 Conclusion

This study focuses on optimization of multiple performance characteristics of the micro-textured journal bearing. The performance characteristics considered in this study are fluid film pressure and frictional power loss. The main aim was to improve the performance characteristics by increasing the fluid film pressure whereas by decreasing the frictional power loss. Therefore, the effect of five micro-texturing factors at three levels is studied and multiple objective optimizations of the same are carried out to obtain the single optimal conditions. Based on the CFD analysis, some conclusions have been given below:

- It has been noted that, for increasing the fluid film pressure, groove depth and groove region are the most significant factors followed by a set of grooves, pitch and width of groove respectively.
- It was also noted that for reducing the frictional power loss, a set of grooves is the most important factors followed bya groove region, groove depth, the width of groove and pitch between grooves respectively.
- For obtaining maximum fluid film pressure and minimum frictional power loss, multiple objective optimization methods- OEC has been implemented.
- The single optimum condition is a found at micro-texturing configuration having groove region of 90–175, the groove depth of 0.015 mm, groove width of 2.5 mm, set of 11 grooves and 0.2 mm of the pitch which gave maximum fluid film pressure of 10.3624KN (45.6% improvement) and minimum frictional power loss of 638.047watt (10.96% reduction).

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Continuous Electro Coagulation Process for the Distillery Spent Wash Using Al Electrodes

Manoj Pandurang Wagh, Pravin Dinkar Nemade, and Pradeep Jadhav

Keywords Electro coagulation · Distillery spent wash · Chemical oxygen demand · High- performance liquid chromatography (HPLC) · XRD

1 Introduction

All over the world a large amount of wastewater is generated from the sugar and distillery industry. DSW contains organic, inorganic pollutants, heavy metals, very high BOD, COD, and TDS. High consumption of water is one of the most important environmental apprehensions in the distillery industry. It is the fourth major water consuming process after the primary metals, the chemical industries, pulp and paper industry [1]. Distillery industry generates two types of wastewater. Raw spent wash directly discharge from the distillery industries. Distillery spent wash (DSW) is the intensive dark brown acidic, highly polluted, complex, cumbersome effluent generated during the alcohol manufacturing. Anaerobic treat is the primary treatment accepted all over the world to treat the DSW, however, color components are still persisting due to non-biodegradability. Treated DSW called as biomethane spent wash which was released during the anaerobic treatment. However to full fill the environmental standards and regulations this treatment is insufficient to safely discharge the effluent. Electrocoagulation treatment has an ability to eliminate

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very tiny colloidal particles, as the fine charged particles have a larger affinity of being coagulated because of the electric field that sets in motion and also the advantages of producing a relatively low amount and toxicity of sludge [2]. The mechanism of EC depends on the chemistry of the aqueous medium and conductivity. In addition, the size of the colloidal particle and chemical constituent concentration also influences the EC process [3]. The EC process is generally used for the removal of residual color and chemical oxygen demand (COD) from wastewaters containing natural melanoidin such as molasses, alcohol distillery and yeast processes the removal mechanism associated with EC from synthetic melanoidin [4]. EC constitutes the generation of coagulants by electrolytic oxidation of an appropriate sacrificial anode on the application of direct current (D.C.) The metal ions have generated hydrolyze in the electrocoagulation in order to generate metal hydroxide ions and neutral M $(OH)_3$. The low solubility of the neutral M $(OH)_3$, mainly in pH values of a range of 6.0–7.0, that endorse the evolution of sweep flocs inside the treated wastes and the removal of the pollutants by their enmeshment into these flocs [5]. Generally, a power supply (alternating current; AC or direct current; DC) and electrodes (aluminum or iron) are used during the EC process and anode electrodes are consumed under a potential. Thus, there are three intermediate stages during this process like (i) production of coagulants by electrolytic oxidation of the sacrificial anode electrode, (ii) destabilization of the contaminant, particulate suspension, and fragment of emulsions, (iii) aggregation of the destabilized phases to form flocs [6]. Recently, electrocoagulation (EC) has been suggested to be a promising alternative for the removal of various pollutants such as ions, organic matters, colloidal and suspended particles, dyes, surfactants, oil and heavy metals from water and wastewater [7]. When compared to conventional and advanced water treatment methods, this method has a lot of advantages such as simple equipment, easy to operate, short operating times, cost-effective, reduction or absence of additional chemicals, rapid sedimentation of the electro-generated flocs and lower quantities of produced sludge [8]. In this paper, Continuous EC process was carried out with and without recirculation of DSW. HPLC analysis and XRD were carried out to explore the result.

2 The Experimental Set-up and Analytical Methods

Figure (1a and 1b) illustrates the experiments set up of continuous EC process with and without re-circulation of distillery effluent. Testing section of the EC process is a cylindrical reactor with a hopper bottom (capacity of 2.0 L) made up of Plexiglass materials. EC process with re-circulation was carried out with the same experimental set-up used for a continuous run (without re-circulation) modified for re-circulation. The spent wash was charged to the reactor continuously and the treated sample was re-circulated to the feed tank. For analysis of COD and color, the samples were drawn from the outlet of the reactor. For EC treatment technology aluminum (Al) plate was taken with dimensions of 150 mm × 165 mm × 3 mm were used.

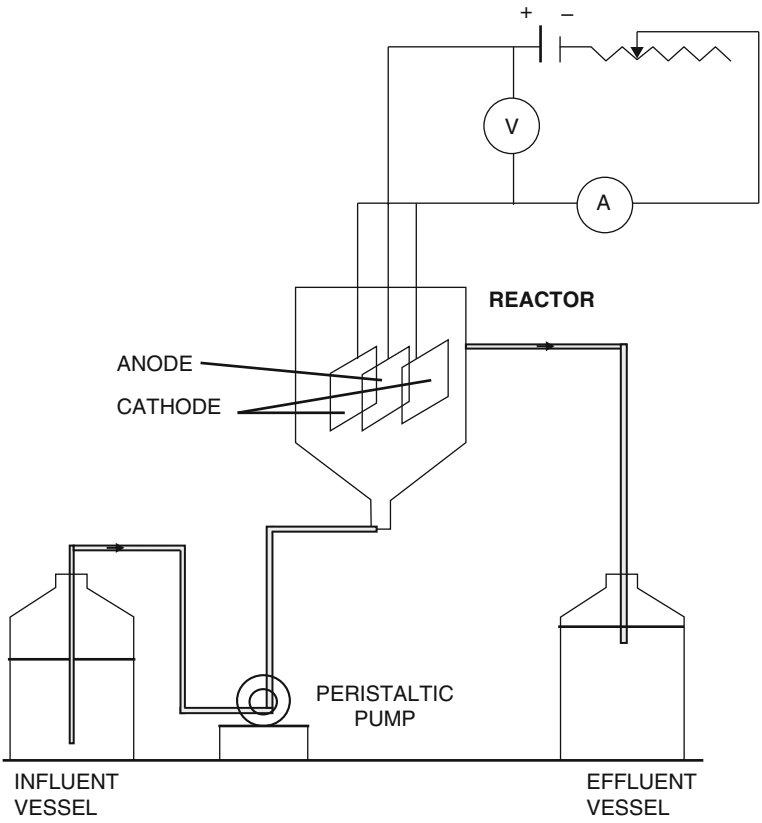

Fig. 1a Continuous electrocoagulation reactor set up without re-circulation

All the EC trials were performed with 2 L of DSW at a constant temperature of 25 °C and 100 rpm. Before every trial, the impurities on the electrode were removed by a hydrochloric acid hexamethylene tetramine aqueous solution and polished by sandstone. The electrodes were then immersed into the DSW up to a depth of 80 mm resulting in a total effective electrode surface area of 138 cm^2. Then, the current was arranged at the desired value and the experiment was started. The samples taken from the EC reactor at different operating modes were analyzed.

3 Result and Discussion

Generally, the basic parameters of untreated DSW and biomethane spent wash is highly polluted [9]. In this study, EC with Al electrodes were implemented to investigate the removal efficiencies of these sacrificial electrodes. Continuous EC process and simple EC process were implemented to treat the distillery spent wash.

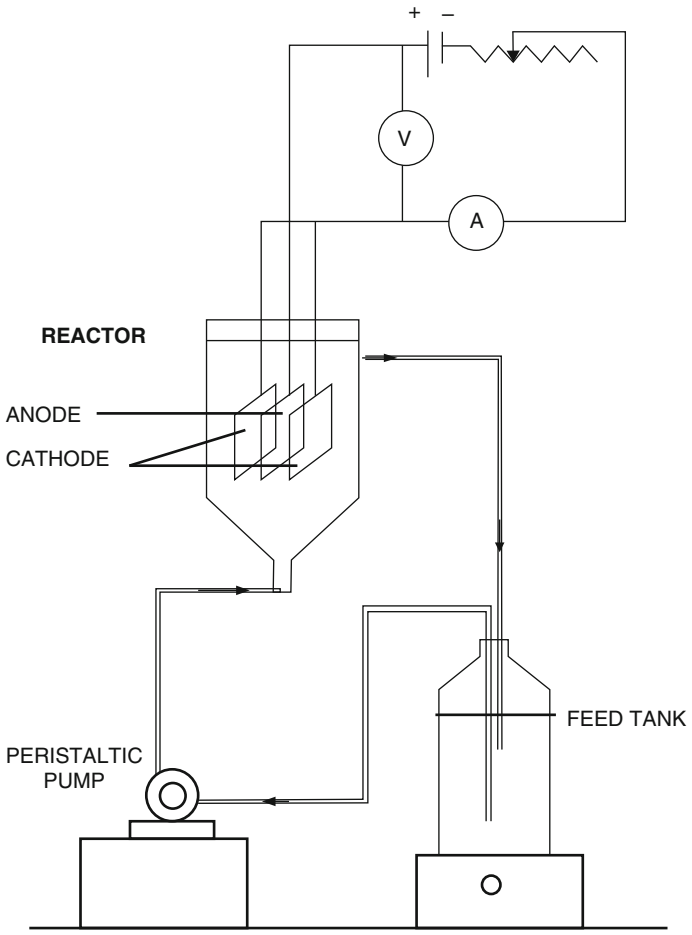

Fig. 1b Continuous electrocoagulation reactor set up with re-circulation

3.1 Effect of Process Parameters on EC

In EC process current density, pH of DSW, initial characteristics of DSW and processing time are the key parameters which influence the removal efficiency of contaminated parameters [10]. Maximum color and COD removal were depended upon the duration and amount of dissolution of electrodes in DSW. During the EC process pH of the DSW were changed rapidly. Effect of Current Density on COD removal Efficiency can be elaborated as per the Faradays law which states that COD removal efficiency directly proportional to current density [11]. During the EC process dissolution of Al electrodes on a large scale which results in higher removal efficiency. The efficiency of EC treatment technology base upon the rate of bubble generation and size of floc formation. Dissolution of electrodes involves the amount

Table 1 Continuous EC treatment to DSW using aluminium electrodes

Time (min)	pH	Temp (°C)	% COD removal		% Colour removal	
			(mg/L)	removal	(Pt-Co units)	
Without recirculation						
0	3.1	24	5803	—	21,191	—
20	3.4	29	4910	15.38 ± 2.35	18,815	11.21 ± 2.35
40	4.1	33	4520	22.11 ± 3.54	16,757	20.92 ± 2.87
60	4.4	41	3715	35.98 ± 1.57	14,015	33.86 ± 3.28
80	4.7	46	3220	44.51 ± 4.24	12,045	43.16 ± 3.73
100	5.1	52	2110	63.64 ± 3.87	10,845	48.82 ± 3.27
120	5.7	58	1770	69.4 ± 1.87	8850	58.23 ± 2.57
140	6.5	62	1610	72.25 ± 1.56	7910	62.67 ± 1.77
160	6.7	62	1614	72.18 ± 2.05	7915	62.65 ± 1.82
180	6.9	62	1620	72.13 ± 2.35	7921	62.62 ± 2.34
Re-circulation of DSW						
180	6.9	43	1620	72.13 ± 2.13	7921	62.05 ± 2.35
200	7.1	51	1537	73.51 ± 2.35	7302	65.54 ± 1.28
220	7.4	63	1411	75.68 ± 3.63	7021	66.88 ± 1.64
240	7.4	69	1203	79.26 ± 3.29	6712	68.33 ± 2.47
260	7.4	69	1207	79.20 ± 2.22	6718	68.03 ± 2.49
Re-circulation of DSW (exchange of anode and cathode)						
260	7.4	49	1207	79.20 ± 1.23	6718	68.03 ± 2.45
280	7.6	55	1035	82.16 ± 1.67	6500	69.35 ± 4.23
300	7.9	61	875	84.92 ± 2.47	6341	70.07 ± 3.98
320	8.1	69	635	89.06 ± 2.56	5965	71.385 ± 3.19
340	8.3	71	515	91.12 ± 2.33	5211	75.41 ± 3.28
360	8.4	71.5	435	92.50 ± 2.18	5075	76.05 ± 3.19
380	8.5	72	297	94.88 ± 2.11	4523	78.65 ± 4.23
400	8.7	72	303	94.77 ± 1.78	4541	78.57 ± 2.11

of sludge formation which improved the elimination efficiencies during sweep coagulation (Table 1).

3.2 HPLC Analysis

On the Jasco HPLC unit, 20 μL of a sample was applied, HPLC analysis was carried out at New Arts and Commerce college Ahmednagar, Maharashtra, India. UV detector (UV 1580 SPD – 10A single) were used to analyze the resultant peak. The evidence for degradation of melanoidin present in DSW has to be noticed by changes in pick length (Table 2 and Fig. 2), a similar result has been noted by [12].

Table 2 HPLC profile of distillery spent wash degradation

Sample	Retention time in min	Area	Height	Concentration
A	5.886	526,863	5.889	100%
B	5.886	428,850	5.889	81.39%
A- spent wash before treatment; B- spent wash after treatment				

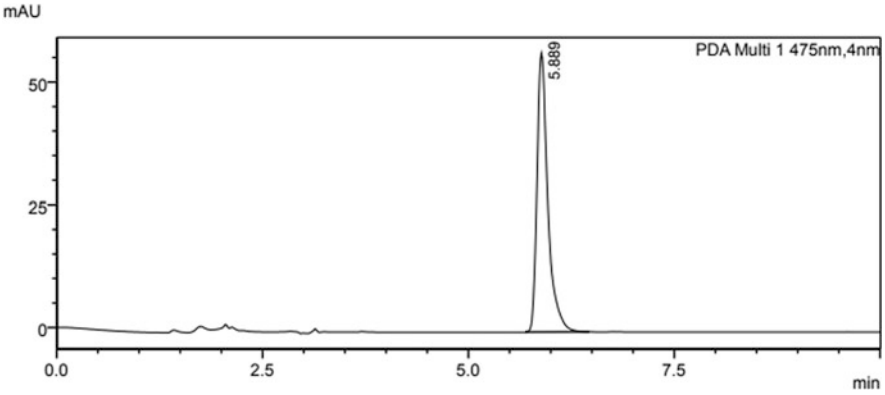

Fig. 2 HPLC analysis of distillery effluent

3.3 X-Ray Diffraction Analysis

X-Ray diffraction (XRD) technique is extensively utilized to investigate and explore the significant characterization of sludge particles formed during ozone assisted electrocoagulation process. The dried powder form of raw distillery spent wash and treated dried distillery spent wash sludge sample was analyzed to investigate the efficiency of removal. Figure 3a) shows analysis of untreated DSW. XRD analysis of powder sample indicates different peak points. Peak profiles designated full-width at half-maximum (FWHM). The intensities graph and the peak position acquired from XRD analysis. The 2 θ values range from 4.1657 to 76.74. It can be seen from Fig. 3b, different main peaks appeared at 2 theta (2θ) of 4.1657°, 4.6652°, 15.24°, 27.045°, 29.76°, 34.026°, 58.72°, and 76.7413° values indicates highest peak value of full -width at half- maximum (FWHM). The height of the pick is changed after the treatment. Figure 3b Indicates variations of heights, the position of 2 theta and the relative intensity. Variation of heights occurs in XRD analysis may be due to nano-scale particles are formed in the EC process. XRD analysis has been procured from Shradhha Analysis, Mumbai, Maharashtra, India. Size of sludge sample formed during EC process can be carried out by using Debye-Scherrer equation [13].

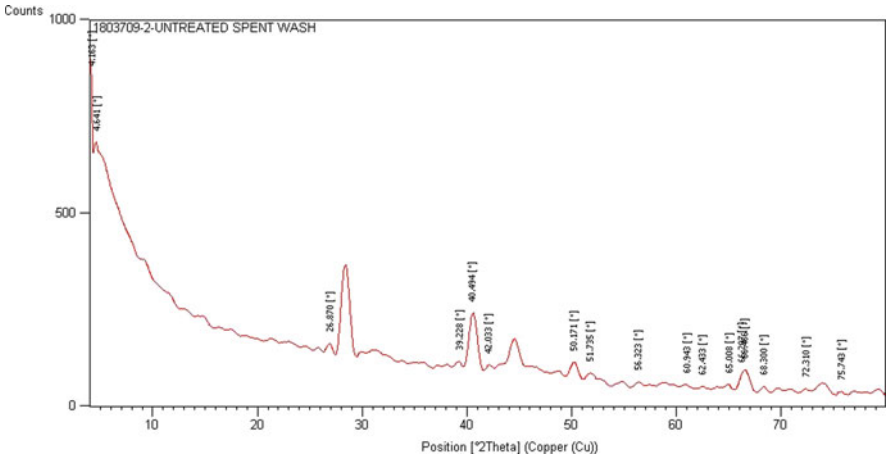

Fig. 3a XRD analysis of untreated DSW

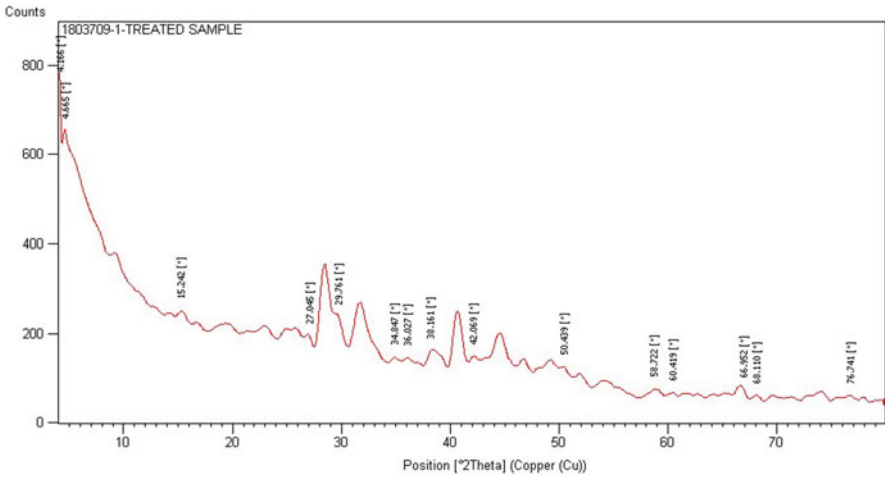

Fig. 3b XRD analysis of treated DSW

$$DP = \frac{0.94 \text{ X } \lambda}{\beta \text{ X COS } \theta} \tag{1}$$

Where

DP = Particle Size (Average Crystallite size),
β = Line broadening in radians,
θ = Bragg angle
λ = X-Ray wavelength = 1.54060 Å

XRD result revolved that nanoscale particles are formed during the process.

3.4 Computation of Operating Cost

Operational cost (*OC*) of the EC method includes the cost of electrodes used and electrical energy costs, as well as maintenance, labor cost, sludge dewatering, and disposal cost. In this paper, electrode material and energy costs for calculation of the *OC* ($/m^3 or $/kg removed COD) were taken into account as major cost items:

$$\text{Operating cost} = a\ \text{Energy Consumption} + \text{b Electrode Consumption}$$

Where *a*, *b*, are India's current market rates assessed as per February 2018.

a = electrical energy cost is approximately 0.084 US $ kWh^{-1}, *b* = electrode material cost is approximately 2.225 US $/ kg for aluminium.

During the EC experiment, electrical energy consumption (EEC, kWh/m^3, Eq. 2) and electrode consumption (ELC, kg/m^3, Eq. (3)) were calculated via Faraday's Law [10]:

$$\text{Energy consumption} = \frac{\text{V I t}}{\text{v}} \tag{2}$$

Terms incorporated in the equation are V is voltage (Volt), I – current in Ampere, t is the time in seconds and v the volume of the distillery spent wash (m^3).

$$\text{Electrode consumption} = \frac{\text{I t Mm}}{\text{Z F}} \tag{3}$$

F – Faraday's constant (96,485 C/mol), Mm – The molar mass of iron and aluminum are (55.84 g/mol and 26.98 g/mol), and Z is the number of electron transfer (for Al electrode Z = 3). I = Current density in A/cm, t = time in second.

4 Conclusion

In this research, treatment of biomethanated distillery spent wash was studied using Al electrode, the effect of the assorted operating parameter has been studied comprehensively for the COD removal of the distillery spent wash. From the analysis, it was clear that the EC process having the ability to degrade the COD. Continuous EC process with re-circulation of DSW enhances the rate of degradation of chemical oxygen demand and decolorization than the simple EC process. Chemical oxygen demand removes up to 94.88% and color 78.65%.

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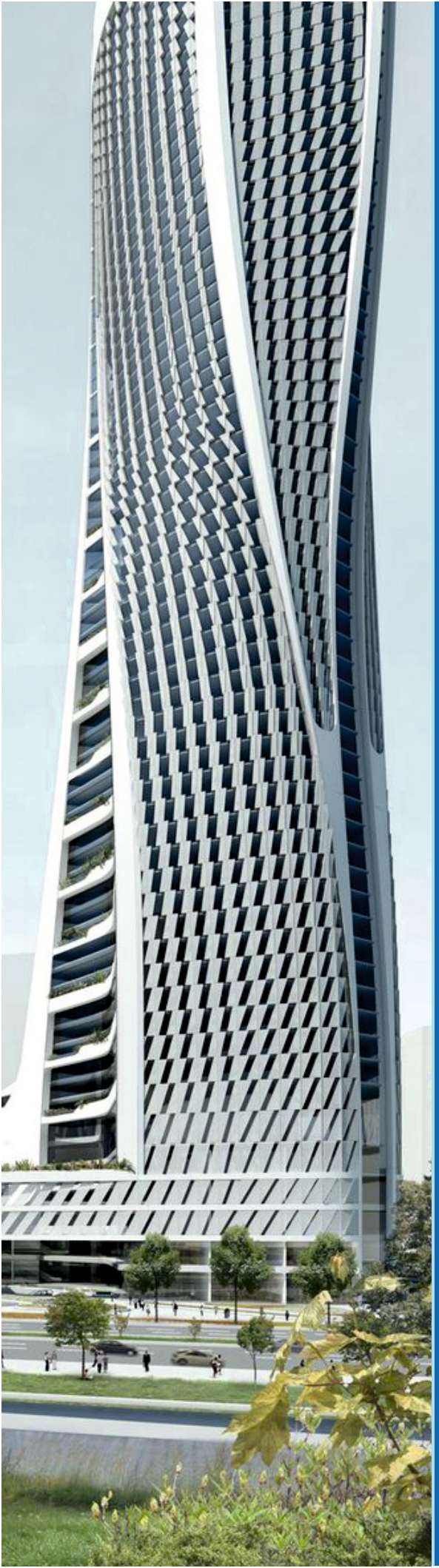

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Editors
Prof. Aparna Mhetras
Prof. Prathama Jhaveri
Prof. Nikita Pawar

Message from Chairman

I am pleased to know that D Y Patil School of Architecture is organizing the 2nd Edition of National Conference on "Research in Architecture" on 28th and 29th February 2020.

The conference will provide an opportunity to the student and teacher researchers to exchange ideas and learn about the developments in Architectural field. I hope the conference proceedings will go a long way in dissemination of knowledge of this noble profession.

I congratulate the Management, Principal, Convener and organizing committee, staff and all students on this occasion and I wish the conference a great success.

Dr. Ajeenkya D Y Patil
Chancellor
Ajeenkya D Y Patil University, Pune

Message from Advisor

I am delighted to welcome you all for this second edition of student's conference on "Research in Architecture" to be hosted by D Y Patil School of Architecture, Lohegaon, Pune.

I have been associated with the school of Architecture since 2011 and I am proud to see their progress and growth since the beginning.

This conference is another milestone for the school which is synonymous with their ethos and goals which focusses on the overall development of the students.

As the conference advisor I can witness the growth of this conference in these two years and feel proud to be a part of this.

I am sure it will be a grand success as the first edition hosted by the school last year.

My Best wishes to everyone associated with the conference.

Dr. Sushant Patil,
Advisor,
Ajeenkya D Y Patil University, Pune

Message from MASA President

Maharashtra Association of Schools of Architecture (MASA) works extensively to promote meaningful activities for students of Architecture. These activities are meant to support the core education of architecture and to widen their knowledge by exploring avenues for research like the Fellowship Program of MASA and the soon to be published biannual Research Journal. This kind of Students Conference for Research in Architecture, in Pune, is one such initiative where MASA is happy to be a Knowledge Partner.

We congratulate D Y Patil School of Architecture, Lohegaon for organizing and successfully conducting this conference and look forward for the third edition.

Best Wishes!

Dr. Ujjawala Chakradeo,

President, MASA

Message from Principal

It is my pleasure to write down my thoughts on the second edition of student's conference on Research in Architecture. After successfully hosting the first of its kind conference for the students last year, this second edition has been even more successful. We received an overwhelming response from students across the country.

The variety of topics that have come to light shows the broad range of thinking of students .This also shows the curiosity and enthusiasm of the students to go beyond Architecture and surely this bodes well for the profession. It was heartening to see students encouraging and supporting each other, a lot of camaraderie was visibly evident.

I congratulate the convener Prof. Aparna Mhetras and her team of dedicated faculty and students on successfully hosting this event. I thank all the paper reviewer and the panel of judges who gave their time and valuable inputs for the National Students Conference on Research in Architecture. I thank all the students from various institutes for contributing their research papers and making this conference a grand success.

The overwhelming response from the students has given us a lot of encouragement and we look forward to expand the reach and invite students at the National level as also Research Scholars from various universities in the future.

Best Wishes

Prof . Shubhada Chapekar,
Principal,
DYPSOA, Lohegaon, Pune

Message from Convener

It gives me immense pleasure and honour to be the Convener for the National Conference on Research in Architecture 2nd Edition hosted by the team at D Y Patil School of Architecture, Lohegaon, Pune.

The response received for this second conference from the fraternity, schools of Architecture, students and faculty was overwhelming and beyond description.

The first flier of the conference was sent during 2nd week of November 2019 and here began the journey of hard work for four months. The first detailed poster was sent to various colleges in December 2019. And we started receiving the abstracts as per the given date of 28th January which was extended to 30th January on request of many colleges.

This year we received 110 abstracts for B Arch out of which 90 were selected for full paper submissions.50 for M Arch and 47 were selected for full paper submission. This edition of the conference also included abstracts from research scholars and we received 6 abstracts from them.

A paper reviewing committee was appointed to review the abstracts and full papers. The committee consisted of eminent experts in the field of Architectural research from practice as well as academics.

Full papers received were 67 for B Arch and 36 for M Arch. Out of which 40 were selected for presentation for B Arch & 22 for M Arch for the final days of conference. The total papers selected for publication are 59 for B.Arch and 26 for M.Arch.

The two days of the conference consisted of total 11 sessions with 7 sessions of B.Arch and 4 sessions of M.Arch. A special session for M.Arch students and faculty on" Guidance for prospective research scholars" was conducted by our eminent chief Guest Prof Tej Karki PhD.

I am sure each one of us has got enriched with the knowledge, guidance & insights shared by all the panel members as well as the paper presenters.

No idea can be executed without a dedicated team to work for it success. Three people who have worked behind the scenes tirelessly since the first flier was sent out in November 2019 and whom I cannot thank enough are our Principal Maam Prof Shubhada Chapekar ,the core faculty team, Prof Prathama Zaveri & Prof Nikita Pawar.

All my colleagues who were part of different committees and all the dear students, special mention Ms Arunima K, Ms. Manasi Kalyankar and Mr Naresh Sharma from 4th year B Arch for getting the student volunteers and helping in the smooth conduct of the conference.

All the members of Advisory committee, paper reviewing committee, panel members for all the sessions, we cannot thank enough for giving their valuable time and enriching all of us by their expert comments.

We are very grateful to MASA -Maharashtra Association of Schools of Architecture for being our knowledge partner and sponsoring the prizes this year too.

Last but not the least all the authors for taking out their time to write the research papers ,all paper presenters, participants and faculty of all the colleges for gracing the occasion by their presence.

Prof Aparna Mhetras,
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Physical Factors Affecting Quality of Public Open Spaces In Residential Neighborhood: Case of Wanowrie, Pune

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Abstract: Open spaces in a Residential Neighborhood provide scope of social interaction, an opportunity to engage with the society and a gateway from daily routine. These areas cater to various activities like social gathering, leisure activities, markets etc. The activities happen in different open areas such as street edges, community open grounds, public parks etc. Hence open spaces can be termed as formal and informal in terms of their character and activities. These spaces become the essence of a neighborhood and make it livable. The Research focuses on analyzing physical factors affecting the quality of these areas in terms of its user response, their social behavior. Methodology followed is case studies, activity mapping and photographic documentation. These cases have been analyzed based on parameters like furniture, lighting, vegetation. The research concludes by identification of status of such spaces as it is critical for a cohesive design.

Key words – Open Spaces, Residential Neighborhood, Formal and Informal Spaces, Desirable, Livable.

I. INTRODUCTION

In India out of the total population of 1210.2 million as on 1st March, 2011, about 377.1 million are in urban areas. The net addition of population in urban areas over the last decade is 91.0 million. (Urban Growth) In terms of absolute number of persons living in urban areas, Maharashtra continues to lead with 50.8 million persons which comprise 13.5 percent of the total urban population of the country. (Level Of Urbanisation) Hence, the process of urbanization has intensified in recent years and has affected cities in terms of its spatial organization. The existing land use, various changes due to urbanization has brought different characters to each neighborhood. These factors being dynamic change land use constantly. This process has happened without adequate attention being paid towards the planning of urban open spaces, a key element affecting the quality of life of the urban dwellers. (Dulcina QUEIROZ) Open spaces in these areas have their own character and form basis for human interaction, activities and behaviors.

Depending upon the area and scale of the space, activities take place. Hence these open spaces can be termed as formal and informal in nature.

1.1 Formal Public Open Spaces

Public parks and gardens can be termed as formal open spaces, as they have dedicated space, area and functions. People visit these places for a specific purpose, may it be leisure, relaxing etc. Sports centers, community gathering places, community halls have an open area along with a built functional space. Designation of such spaces is required to magnify its purpose and value.

1.2 Informal Public Open Spaces

A Street with small eateries, cafes with spill over spaces ending on the footpaths, weekly farmers market on open grounds, retail shop foregrounds are some of the informal public open spaces. These spaces are spontaneous and dynamic in nature, the place of activities change constantly.

1.3 Factors Affecting These Spaces

- Social factors
- Environmental factors
- Physical factors

1.4 Importance of Physical Factors in Governing The Quality Of Public Open Space

Basic physical elements are necessary for any kind of space to function. These elements are the fundamental factors either making the space vibrant or completely destroying its character. A user uses a certain space based on the environment, visibility, spatial aspects etc. Poor spatial Organisation may not be understood by the user but it can be sensed and is reflected in their social behavior, hence physical elements define a certain area, making it habitable or inhabitable.

1.5 Case of Wanowrie

Wanowrie is an affluent neighbourhood in Pune, India. It is located in the eastern part of Pune. It consists of historic temples and structures like Shinde Chhatri temple. Modern structures include Mahatma Phule Cultural Centre, Armed

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Force Medical College and Hospital (AFMC), Shivarkar Garden. (Wanwadi) The State Reserve Police Force campus (SRPF) is situated in Wanowrie, due to which the area has many Open Grounds and Maidan. Hence, the spaces studied are significant landmarks of the Neighbourhood.

II. METHODOLOGY AND LITERATURE REVIEW

In the past several researchers have studied the significance of open spaces. Hadiseh baghi mentions in the research paper that open space can be categorized into undesirable, moderate and desirable based on social, physical parameters. The paper also mentions access to residential open spaces, its impact on the surroundings and users. (Hadiseh Baghi).

Methodology used for the research was case studies, interviews and activity mapping with supporting photographic documentation. The cases chosen are different types of opens spaces in Wanowrie, one being a street, an open ground a public park. Photographic documentation was done at various hours of the day, on weekdays and weekends. Understanding the context, the scale, the surroundings in each cases became important to study the activities happening there. Three various types of public open spaces have been taken for case study, a park, a street and an open ground. The case studies have been analyzed on the basis of some parameters-The furniture including seating, installations and various equipment, the lighting pattern of that particular area and the vegetation of the space have been chosen as the study parameter of each case study.

IV. Case Studies

4.1 Open Ground

This open ground has been a private property converted into joggers track and Maidan for community festivals, fairs, exhibitions, flea markets and sports activities. It is located in the vicinity of residential complexes with eateries, restaurants and commercial plazas around it. It was observed that nearly half of the site has dense tree cover, used for dumping garbage and primarily occupied by stray animals, hence not being used to its optimum potential. Activity mapping of the informal and formal functions in and around the ground taking place on a weekday and on weekend was done in the evening hours. Use pattern of the space, with respect to the number of visitors, age group of people visiting and different activities taking place was studied.

Figure 1 exhibition at the ground
Source : Author

Figure 2 farmers market the ground
Source: Author

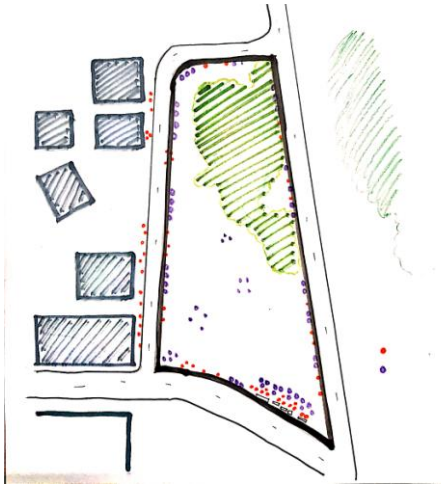

Figure 3 Activity Mapping on weekend(evening)
Source: Author

Fig 1 mentions the exhibition area on the ground, these type of larger activities attract small scale leisure, shopping activties in the surroundings. These activties become aid for large scale functions and provide a vibrant social atmosphere. Vegetable venders, fruit sellers were seen during the early morning hours and late evenings on weekdays, they mainly install their stalls at corner junstions and near the seating area where visiotrs gather for various activities like yoga, meditation, sports etc (fig 2). Weekends were priarily occupied by sports enthusiasts till the evening.

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The peripherals and part ground have been in use, however The rest of the area remains a dumping ground which also has an unpleasant impact on the footpath adjacent it. The Acitivity Mapping (fig 3) suggests that the corner part of the ground being used frequently and concentrates major activities.

4.2 Shivarkar Garden

The Front portion of the garden has dense tree cover around the play area and the central ground. The rear area of the garden consists of open gym, jogging track and playing lawns. The jogging track and open gym is used by frequent or regular users, majorly consisting of senior citizens and middle aged people. The lawn having two mounts and seating around usually see yoga, meditation groups in the early hours of the day. Occasional visitors comprising of families and children mainly use the children play area and the spaces around it. Weekdays see regular visitors and weekends are crowded with all sectors of users, the street along the garden also sees small eateries during the weekends.

Figure 4 View Of The Lawn And Tree Cover
Source : Author

Figure 5 View Of The Garden
Source : Author

Figure 6 Activity Mapping on weekend (evening)
Source: Author

(Fig 6) The mapping explains use pattern of the garden, senior citizens and daily visitors are seen near seating on the edges, whereas, families, children use open lawn and gazebo area (fig 5). Tree cover at various places helps bring down the scale of the large lawn, while dividing it visually. This naturally creates segregation of spaces and provides variation (fig4). Change in paving material from paver blocks to red soil separates the area keeping the purpose same and enhancing the experience as well. Users tend to use the spaces towards the edges of the lawns in day light and the central portion is primarily occupied by children and their caretakers.

4.3 Salunkhe Vihar Street

This street has mixed typology of buildings, from residential, commercial to office buildings as well, it has eateries, health care facility and working spaces. It attracts young crowd due to the environment and activities.

Figure 7 View Of The Street In The Evening
Source :Author

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Figure 8 Eateries And Spill Over Space
Source : Author

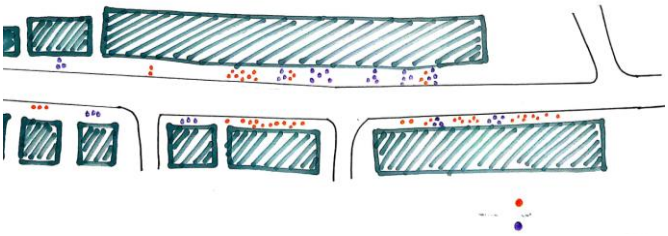

Figure 9 Activity Mapping on weekend (evening)
Source: Author

Regular visitors were seen near the commercial and smaller grocery stores whereas major concentration of activities happened near the eateries, users happened to visit places with vibrant lighting, it enhanced the character of the space as well as the street. Lighting, smaller peaceful areas tend to change the essence of an area, it is reflected in the social atmosphere of the space.

V. DISCUSSION

The study of open spaces different in scale, character and form provides an idea about its requirement, value and current status. This also highlights the fact that open spaces in a surrounding hold important purpose as they cater to various user demands. A neighborhood has certain landmark, they may be notional as well. Therefore open spaces can make an identity of a neighborhood. These spaces are necessary for fundamental functions.

VI. CONCLUSION

This research attempted to study how physical factors of an open space affect its quality. The presence of various forms of open spaces is required for easy, active and appropriate functioning of a neighborhood. The research suggests need of sensitive, conscious design approach towards various types of open spaces, be it abused, underused or densely crowded zones.

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Site Selection is Vital : Importance and Different Criteria of Site Selection For Airport

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Abstract : Aviation plays a significant role in modern socio economics, providing connectivity and accessibility and facilitating commerce. Airports are critical nodes of air transportation system with this its user friendly designing is also important, starting with the preliminary stages of design that include site selection. There are various criteria that need to be followed, while selecting a site for airport construction. This include land use planning, characteristics of wind and weather conditions, interference with the existing road network, environmental and socioeconomic impacts. Study of these criteria for different sites provides us with the data of the most suitable site. This research aims to study the document of CIDCO with the other documents on airports and analyse the different criteria of selection by doing a comparative analysis on the different airports. This research is to describe such multicriteria approach of various existing airports and their role in designing an airport with the different criteria of site selection.

KEY WORDS : Airport, Site Selection, Criteria, Planning and Design , Comparative analysis.

INTRODUCTION

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. In any construction or design of a building the primary step is to select a site which is most suitable for that building typology specially for public buildings like airport. The site selection process includes a detailed evaluation of project needs, which are then measured against the merits of potential locations. Site selection of an airport is the comparative evaluation of alternative airport sites for their suitability. This site selection process is crucial in case of airport as it depends on multiple criteria which are to be considered, and then from the selected sites the most suitable in terms of accessibility, topography, area population , environmental issues and other specifications is selected. Understanding this is an important part of designing an Airport. Metropolitan city Mumbai in Maharashtra, India and Griffin city in Georgia ,USA are in need of new airports due to the increase in the economic activity and the increasing population. The case study on the two airport site selection will help us in understanding the criteria of site selection and the method they follow in the two completely different places.

Site Selection Criteria

Criteria can change with the purpose and the type of the airport. Although they can be changeable, there are certain criteria which are important for the authority.

- **Topography:**Topographical considerations that should be taken into account are:

(1) the grading that will be required to meet the standards for maximum runway grades, which vary from one percent to two percent depending upon the class of the airport

(2) selection of a site which departs sufficiently from thedead level to allow adequate natural drainage, but does not have portions sosteep that serious erosion may result (3) selecting an location where thesoil is pervious, yet has a suitable amount of natural binder, and where the watertable (ground water table) does not come too close to the surface.

- **Environmental Impact:**This impact can be categorized more than 3 subtitle such aspollution impacts, physical impacts, ecological impacts and historical resources.Wetlands, water quality, floodplains, historical sites, pollution impacts and wastefacilities are in this assessment. Several

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categories are considered under pollutionimpacts. The potential for noise impacts must always be evaluated for any airport.Other areas include air pollution, water quality, and solid waste. Physical impactscategory evaluates potential physical impacts related to physical factors ofconstruction of the airport. Included in this evaluation are impacts such as floodhazard, light emissions, and the airport's effect on energy supply or other naturalresources. Ecological impacts category evaluates the potential impacts on the natural and historic environment. Biotic communities, endangered species, and their habitat areas are included under this category. Historical resources category evaluates the potential impacts to historical or cultural resources that may be of national, state, or local significance. This includes impacts to properties eligible for the National Register of Historic Places, as well as the archaeological potential of each site.

- **Land and Development Costs**: The land and development costs of the airport should not be excessive. In addition to grading, drainage, and construction charges, the development cost is affected by the availability of suitable construction materials near the site and the nearness of necessary utilities.
- **Obstruction and Airspace:**An analysis of the relationship with the airspace requirements of the existing airport system is essential. It is also necessary to review the envelope area of each site for the presence or absence of potential obstructions to aircraft activity. Certain obstructions may be considered immovable or too expensive to move when other options are available (e.g., large land forms, tall communication towers, major power lines, water towers, etc.). Others, such as smaller power lines, trees, buildings, and roads, impose a cost of removal or relocation that must be considered.
- **Accessibility:**One of the most important factors influencing the selection of an airport site is its accessibility to the destination and source of the passengers and cargo. This is a particularly vital consideration for commercial airports since one of the great advantages of air travel is its advantage of shorter travel time over other means of transportation. To provide maximum service to an area, an airport should be located in reasonable proximity to the population centre it is to serve. The location in relation to business and industry should also receive attention. Preferably, the airport should be located adjacent to and visible from a major highway route. It is easy to access by using local and transient roadways. Driving time and distance to the centre should be maximum sixty minutes.
- **Residential Impact:**This factor examines the magnitude of property to be acquired for each candidate site. The airfield layout, the size and shape of existing parcel ownership, and other impacts to neighbouring parcels can affect the amount of property necessary to be acquired. Also included for consideration under this category will be residence acquisition. The sites should be eliminated if there is more than 10 households due to decrease cost of expropriation.(Gokgalay, 2014)

Case Study On Site Selection Of Navi Mumbai Airport &Griffin-Spalding County Airport

CASE STUDY ON NAVI MUMBAI AIRPORT

Mumbai metropolitan region is experiencing rapid economic growth which is increasing the air travel demands in the region. The existing airport is not able to fulfil the increasing needs of the region due to which there is a need to propose a new airport building. This will be done by analysing different suitable sites for the airport and then providing with the most suitable one.

In case of this new airport there were three different sites that were considered and analysed for the purpose which should have obstruction free approach, operational suitability, minimum disturbance to population, availability of land, accessibility and availability of physical and social infrastructure. The sites which were then considered are :

i)Mahapan in Sindhudurg District
ii) Rewas-Mandwa in Raigad District

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iii) Navi Mumbai Airport
(Centre of Environment Science & Engineering, June 2010)

Among these sites Mahapan in Sindhudurg is about 350km away from Mumbai due to which it is not easily accessible.

The comparative analysis is now restricted to RewashMandwa and Navi Mumbai sites.

Figure 1RewasMandawa Site

Figure 2Navi Mumbai Site

These sites are ranked on the basis of the following topic study :

a. Accessibility
b. Land Acquisitions
c. Displacement of population
d. Land reclamation
e. Sensitive location nearby
f. Loss of environmental aesthetics
g. Social culture
h. Air pollution
i. Water pollution
j. Construction material
k. Project cost
l. Drainage pattern

COMPARISON OF ATTRIBUTE SCORE

Table 1

ATTRIBUTTION	REWAS – MANDAWA SCORE	NAVI MUMBAI SCORE
a. Accessibility	24.0	4.93
b. Land Acquisitions	58.33	13.33
c. Displacement of population	70.0	52.50
d. Land reclamation	58.33	40.33
e. Sensitive location nearby	0.00	18.75
f. Loss of environmental aesthetics	30	22.5
g. Physical infrastructure cost	23.43	7.5
h. Social culture	18.75	11.25
i. Air pollution	35	52.75
j. Water pollution	12.5	30
k. Construction material	6.25	6.25
l. Project cost	60	28.20
m. Drainage pattern	63	42
TOTAL SCORE	459.59	330.29

(Centre of Environment Science & Engineering, June 2010)

Thus the overall environmental impact of constructing Airport at Rewas – Mandwa is higher than that at Navi Mumbai.

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Therefore the site at Navi Mumbai is more suitable for construction of new airport in Metropolitan city Mumbai and is less sensitive to environment.

CAE STUDY OF NEW GRIFFIN – SPALDING COUNTY AIRPORT

Griffin is a city in Georgia USA. There is an increase in the turbine aircraft activity at the existing airport due to which there is a need to expand the airport. The feasibility of expanding the existing Griffin – Spalding county airport in the existing location is impractical due to the encroachment of residential and commercial land uses surrounding the airport. Due to this reason the cost of building a new airport will be less expensive than expanding the current facility. For this there were 8 sites which were considered on the basis of the preliminary evaluation criteria which included population centre accessibility, proximity to nearby NPIAS airports, state roads, future land use, airspace, population density, streams, wetlands, floodplains, landfills, railroads, transmission lines, obstructions, and terrain. After further evaluation two sites were selected which : Site 6 , Site 7.

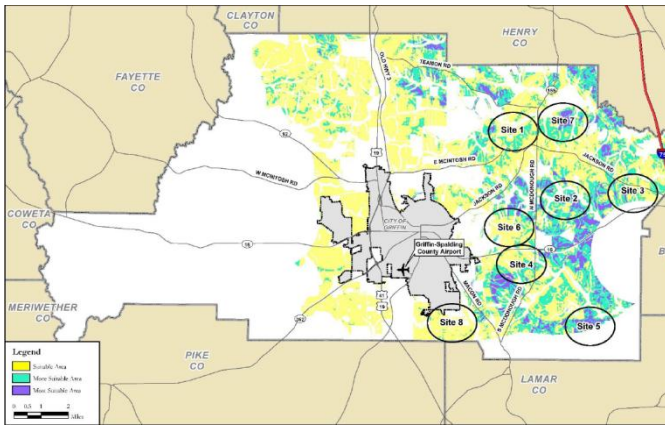

Figure 3 suitable site for new Griffin-Spalding County Airport

These two selected sites were further evaluated on the basis of the following criterias :

a. Infrastructure and land acquisition
b. Environmental considerations
c. Constructability
d. Operational capability
e. Industrial compatibility
f. Project cost

Rating score was giving on the following basis:

- 1 – criteria are not desirable
- 2 – criterias are neither desirable nor undisirable
- 3 – criterias are desirable

COMPARISON OF ATTRIBUTE SCORE

ATTRIBUTION	SITE 6	SITE 7
a. Infrastructure and land acquisition	1.83	2.83
b. Environmental considerations	2.40	2.10
c. Constructability	1.67	1.5
d. Operational capability	2.00	2.00
e. Industrial compatibility	3.00	1.00
SITE AVG. SCORE	2.18	1.79

(Consultant, 2009)

Project Cost of Site 6 is 4 billion and that of Site 7 is 5.2 billion.

Thus, the overall impact of constructing airport at Site 6 is lower than that of constructing it on Site 7. Therefore Site 6 is more suitable for constructing a new Griffin – Spalding county airport.

COMPARITIVE ANALYSIS OF THE TWO CASE STUDIES

- The two case studies are completely diffreent in terms of location. One is in the state of Maharatra, India and the other is in the state of Georgia, USA.
- Inspite of there location the two case studies used mostly the same criterias to compare the site that they have selected to attain an end score for the most suitable site.

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- Scoring criteria is different for the two case studies.
- Both Navi Mumbai and Griffin Airport use the criterias that are important to the authority which include land and development cost, environmental impact, assessibility, topography and residential impact.
- Navi mumbai airport has a detailed study on site selection criteria which includes criteria like drainage pattern and construction matreial on the other hand Griffin Spalding airport end scoring did not include such criteria study.
- In both the cases site location makes a huge difference in the project cost which shows the impotance of proper site selection.
- Criteria used for site selection of Navi Mumbai airport are mostly based on their sensitivity towards the environment on the other hand criteria for Griffin airport are not only focusing on environment they are also based on contructability of the siport inthat loaction.

CONCLUSION

With the study on the two case studies for Navi Mumbai airport and Griffin – Spalding County airport we got to know the criteria that are considered while doing site selection for an airport. It is a long procedure which is followed by going through merits and demerits of the different sites by evaluating the needs of the project. This multicriterian approach of various existing airports helps to design an airport which is both environmentally friendly and cost effective.

ACKOWLEDGEMENT

I would like to express my special thanks of gratitude from the bottom of my heart to my guide Prof. Prathama Javeri for her valuable guidance and encouragement. Her conistant supervision and assistance helped me to reach this level.

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Architecture of Traditional Ali in Pune, A Case Study of Tambat Ali

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Abstract: ***Pune, the cultural capital of Maharashtra, has a long legacy of Alis. Alis are the craft skill by lanes. During the Peshwa rule in 18th century, Kasba Peth was the centre of Pune, where the supporting trades like Tambat, Burud, Kumbhar, Kasar, Badhai, etc. got located. Tambat Ali (an Ali named after Tambat community) is an area where copper and brass items are manufactured. It has been observed that, in Pune these trade practices, which carry heritage value are undergoing rapid changes. For example Pagadband Ali where Pagadbands used to make Pagdis (caps), which had great importance particularly in Peshwa period, is now on the verge of decline. In order to avoid the loss of such significant heritage skill, it has become necessary to record the existing picture of Alis. The aim of this paper is to give analysis of changes in the evolution of the Tambat Ali. This paper attempts to document, the existing working craftsmen's in Tambat Ali, along with a set of recommendations that would help to preserve the character of this area.***

Keywords: Tambat *Ali*, Pune, Architecture, Craft skill, coppersmiths, building typology,

Introduction:

Pune is a historical city and Kasba Peth is the oldest part of the city. Down the centuries, Pune has been ruled by several dynasties. In 2003 some artefacts were found in Kasba peth area from the Satvahana period which evidences the settled life in that area around 200BC. One can find the references to the Pune region in copper plates dated 758 and 768 A.D. issued by Rashtrakuta ruler, in these copper plates Pune is referred as 'Punya vishay' and 'Punaka Vishay' respectively (i). Punya meaning 'holy' and Vishaya meaning 'region'. It was so described because the city has a confluence of two rivers Mula and Mutha, which is considered holy in the Hindu religion (ii). From 9th century Pune region became the part of Yadava Empire, which was defeated by the Mughals in the 11th century. During the 12th and 13th century, Pune was under the rule of Allaudin Khilji and later Muhammad Tuglaq, for a long time Pune was under Muslim ruler (ii).During 1600-1817 v AD Marathas ruled Pune. Pune city was the seat of Peshwa, the prime minister of Maratha king from 1713-1818 AD, Nine Peshwas ruled Pune city during this period. In 1735 Peshwa I shifted capital city from Satara to Pune which increased the political and economic importance of the Pune city. Over 18 Peths were established during the 18th century. The Maratha power ended in 1818 and the British set up an empire in the Pune city (ii).

According to the author of the Gazetteer, the starting point of the settlement in Pune was near the river bank of Mula-Mutha, he reasons that the presence of river attracted the settlement. According to the local tradition, there were three original villages-'Kasarli', 'Kumbharli' and 'Punewadi' (iii). It is more likely that they were small hamlets rather than villages. We can still find these three villages as Kasar *Ali* (Tambat *Ali*), Kumbhar wadi and Kasba peth respectively. By the time of Peshwa rule these small hamlets had grown and became a Kasbe Pune.

The Bara Balutedar system was a hereditary village servant system of twelve trades which existed at the time of Peshwa rule. The Balutedari system was important part of socio-economic life of city of Pune. Kumbhars (potters) and Tambats (copper smiths) were one of the important members of Balutedari system. Peshwas invited people with specialised skills from different areas to come and settle in Pune. People of one community carrying one trade lived together and their area of residence were named on the basis of the trade they carried out, like Tambat *Ali*. This neighbourhood settlement gave rise to very typical cell-like formation of Indian urban life. The cell like localities were further emphasise by their shrines and temples for the worship of community deities, like the Goddess Kali temple belonging to the Twasta Kasar community(3). Kumbhar *Ali*, Tambat *Ali* and other trade

basedAlis such as Bhoi *Ali*, Shimpi *Ali* and some other are all a few minute walk from each other. This shows the compact placement of Kasba Peth. The streets named after profession or trade still exists. The documentation of existing workshops is done by site visit along with survey method.

Tambat *Ali*:

*Ali*s are the craft skill by lanes - places where groups of people with special skills lived together and carried out their trade. These *Alis* were named after the trade or profession they carried out. All the *Tambats* (coppersmiths) used to live together in *Tambat Ali*. The name '*Tambat'* came from the Marathi word '*Tamba*' which means copper and hence people working in copper are called as *Tambats* and place where they live together is called as *Tambat Ali.* Peshwasinvited *Tambats* some 400 years backfrom Konkan region of Maharashtra to come and settle down in Pune (v).

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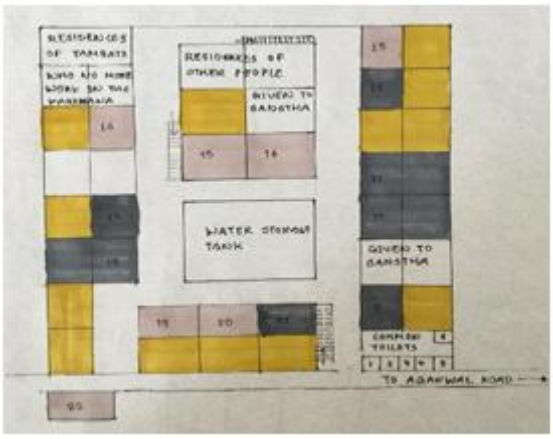
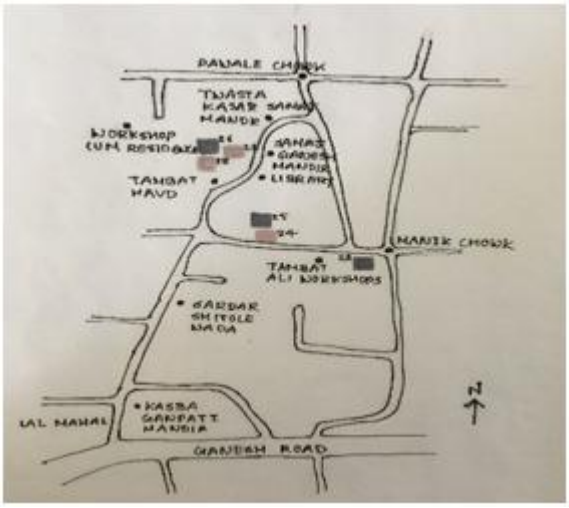
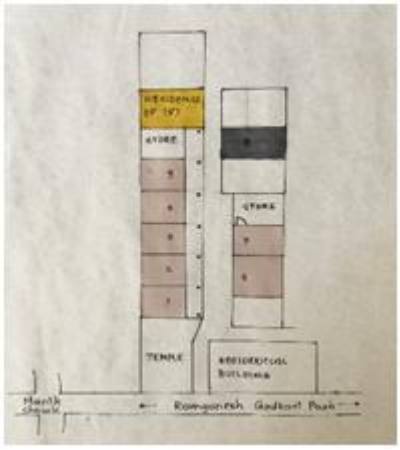
Tambats settled in Kasba Peth. Before Tambats this neighbourhood was occupied partly by *Bramhins* and jewellers. Initially there were 200 houses of *Tambats* in *Tambat Ali* who used to work and live in the same premises of *Tambat Ali* in Kasba peth (v). These people still practice as coppersmiths in their old workspace where their generations had worked and this can be referred as a living heritage of Pune. During Peshwas period, *Tambats* used to manufacture variety of copper products right from swords to fight in battle to copper utensils used in kitchen. Tambats experienced boom in their profession till late 19th century but when stainless steel and plastic utensils got popular among the people, demand for copper products decreased.







Map 1: Location of existing workshops.

Expanse of Tambat Ali:

Ali is situated in the Kasba Peth of Pune city, which is the oldest part of the city. Tambat Ali lies between Manik chowk and Pawale chowk, well known chowks in Kasba Peth (refer map 1). Tambat Ali can be access from Agarwal road which leads to Pawale chowks and also from subsidiary road from Kasba Ganpati (Gram daivat of Pune). Initially there were 200 houses of Tambats and around 810 people were working in *Karkhanas* (workshops) as *Tambats* (coppersmiths) (v). Now in year 2020, survey done in *TambatAli*shows that there are only around 100 craftsmen's who are working in28 *Karkhanas,*which are still practicing in the same profession. Location of these existing *Karkhanas* (workshops) is shown in the map1. This shows decrease in the number of *Karkhanas* and craftsmen's due to lack of demand of copper products, Introduction of new materials such as stainless steel and aluminium.

Building typology and Existing condition of Building:

The earlier residences of the Tambats were not built as per their requirements, hence they purchased new plots and built houses which were suitable for them. Later on, increasing family size and the business made the available space inadequate and the need for new work place was felt, but further extensions was not possible because of lack of funds and lack of space (v). So the extensions become more open to sky and temporary. This has led to formation of an interesting pattern of open spaces interlinking roads and work places (v). But now many of the buildings are not in good condition (refer picture 4).

Types of *Karkhanas* (workshops):

Initially when the manpower was easily available and demand for copper products was more all the *Tambats* (coppersmiths) used to craft the utensils from raw materials in their own *Karkhanas* (workshops) itself. At this time 3-4

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craftsmen from the family along with 3-4 other craftsmen used to work in one workshop. The Tambats engaged themselves in melting copper, beating the molten mass into sheets and preparing utensils. But, later around 1910, metal sheets began to arrive from America which was used for the manufacture of the utensils (iv). These craftsmen eventually decreased in number due to lack of demand, low returns and now only one craftsmen from the same family work in their workshop. During the late 19th century due to technological advancement some craftsmen who were economically capable bought their own spinning machines which helped them increase their production in less time with less manpower. Now there are mainly two types of workshop present here; one where the complete work is done i.e. Right from crafting the copper utensils to finishing and then selling to customers; other one where only the finishing work is carried out. The Craftsmen's who belong to type one workshops get more returns as compared to type two workshops as they have their own spinning machines. Location of workshops of both the types is shown in the map 1.

Picture4: Craftsmen working outside the workshop on roadside, as workspace is not in good condition,and doesn't have enough sunlight.

Planning of workshops and residences in *Tambat Ali*:

This typology of workshops further leads to the different plan form of workshops and residences. Picture 2 and 3 shows the layout of workshop type-1 and workshop type-2 respectively. Area of type-1 workshop is more as compared to type-2 as it need to accommodate the spinning machine. Type-2 workshops consist of a single room which has a *Bhatti* (kiln) where melting work is done and extended shade acts as their main working area where they do all the polishing, finishing and *Matharkam* (Engraving pattern on copper utensil using hammer (refer picture-1)). As all these workshops are placed next to each other, the only way from where sunlight can enter is door, which is also shaded by the extended G.I sheet, hence only diffused light enters in the workshop which is not enough to do a detailing work and hence craftsmen's preferred to work outside in daylight. Materials used for construction are bricks, G.I sheets, wooden battens, teak wood.

Picture1: Craftsmen's engraving pattern on copper utensil using hammer

In the area near Pawale chowk Tambats were residing in wada where the dwelling units were constructed around a central open space with a verandah separating the dwelling unit and open space. The central open space in addition to providing light and ventilation, houses the common amenities like water storage and adjoining washing place was used as a working area. Earlier all families used to stay in small house of just two rooms. The outer semi covered room which was used as a karkhana and the inner room was used as a house, which included kitchen, living area and a small bathing area (*mori)*(for plan refer picture-2 and picture 3). The only way of ventilation for that room was through door and a small window. Common toilets in the wada were used by the families residing in that wada. Their children studying in schools and colleges found themselves disturbed by the beating noise and also the space requirement of other member from family increased, due to this from last few years many families moved out to some other places in the city as the living conditions here were uneasy. Though some families shifted to other places, their workshops still function from the same old karkhana and both rooms are used for the purpose of crafting utensils only.

Tambats had formed a 'sanstha' named as 'Twasta kansar samaj sanstha' for the benefit of *Tambats,* they had started a library and a study hall for 25 students as the noise level in this area is quite high (for location refer map 1).

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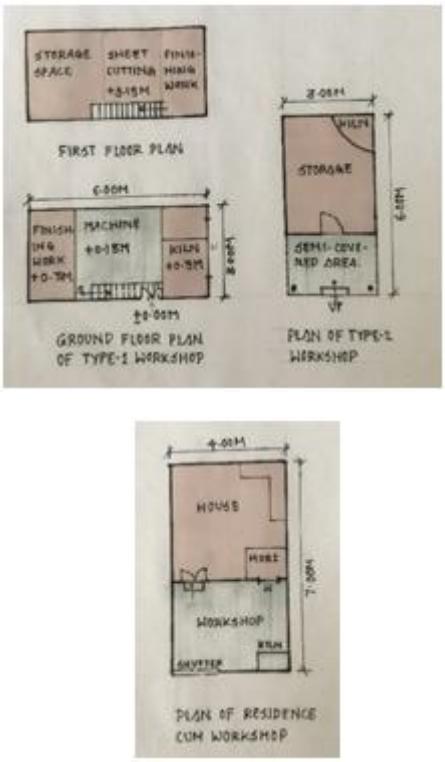

Picture-2: typical layout of workshops and residences.

Picture3: Workshop cum residence.

Conclusion:

Because of the lack of demand and invention of alternative materials like plastics aluminium etc. this profession is on the verge of decline. As it involves hard work and returns are very less next generation of coppersmiths is not ready to take forward the legacy of Tambats. The size and condition of their residences is not good enough. Now it is the high time when we can promote this craft kill and improve the lifestyle of craftsmen's and preserve this living heritage of Pune.

Recommendations to preserve the living heritage of *Tambat Ali*:

If the current generation of coppersmiths will not pass on this legacy to their next generation, then this traditional craft skills will stop here only, and it will be huge loss of our heritage. Here are some recommendations which might help to conserve the character of Tambat Ali.

- Economic help can improve their present condition.
- Promoting the benefits of using copper utensils will increase the demand and hence production and supply.
- Better infrastructure will increase the efficiency of craftsmen.
- To pass on this legacy of craft kill to next generation workshops and training camps should be arranged.
- As the beating noise is one of the major problem, for this use of sound absorbing materials could prove a better solution.

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Note: All the pictures are taken during the site visit.

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Architecture as a Tool to Restore Identities in The Regions Of Warfare

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Abstract : In the regions of conflict, the damage as a result of war can be seen in the form of destruction of structures. Wars also have long-term social and cultural consequences. The research paper aims to study the impact of war on architecture and its occupants. A question needs to be raised as to what should be the future of these affected structures. The study attempts to find appropriate strategies by analyzing events in warfare regions through archival data, book case-studies and photos. Architecture can be a tangible tool to restore the identities of individuals and communities.

Keywords: War, architecture, community, impact, strategies, restore

I. Introduction

"War, painfully enough, is good for architecture".

- Rem Koolhaas, during the 2nd annual lecture on 'Warchitecture', Amsterdam.

War is a state of armed conflict between different nations, states or armed groups. Architecture is a target of war where an attack is done to destroy settlements and cities resulting in loss of life, loss of home and loss of identity, thus the loss of culture. The impact of war on a building is not just physical but also has a perceptual impact on our memory. Building is memory. [1] As a result f war, within instants the spaces of dialogue and living become fragments of volumes where these fragments and remains of the buildings become the determinants of that space. The images of scarred facades and volumes of rubble make one to relive the moments one had associated with the

"War and architecture have a long and often parasitical relationship; the building and the unbuilding of urban centres, the making of enclaves, walls and segregated

residential city zones has been fundamental to urban form and human experience. The destruction of buildings and cities has therefore always been an integral part of winning and losing wars." [2]

Buildings are the targets of high priority as they are the shelters of human beings, the primary targets causing the inception of conflict. The result could be seen in the late 20th century and the last two decades where a study stated 90% of the people directly affected by wars were civilians. [3] A question has to be asked as to what should be our approach towards such structures. Should we use the fragmented volumes and remains to our advantage to create something new or should we continue to let the past being destroyed?

The study aims to analyze the post-war strategies of the affected buildings with the objective to understand the impact the war had on the architecture. As this impact on architecture can result in the loss of culture, it is relevant that architecture itself can be an impetus to restore or preserve a culture.

"There has always been another war against architecture going on-the destruction of the cultural artefacts of an enemy, people or nation as a means of dominating, terrorizing, dividing or eradicating it all together." [4]

The scope of the research is limited to study architecture as a casualty of war where a war is waged specifically to target architecture and to destroy it intentionally.

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II. Theoretical Framework

In past, researches have been done studying the causes and the effects of war on architecture of particular regions. There have been researches published on the housing of the migrants and the refugees of the war affected regions. This research paper refers the article published by Ar. Lebbeus Woods on War and Architecture: Three Principles which discusses the approaches for the architecture of a post-war world.

Principle 1: Restore what has been lost to its pre-war condition.

Principle 2: Demolish the damaged and destroyed buildings and build something entirely new.

Principle 3: The post-war city must create the new from the damaged old.

III. Methodology

The research applies thematic sampling as a method to study case specific structures through secondary data sources like books, archival data, articles and tries to apply these principles as to what must been their post war-approach. They can be a guideline for what approach a war affected structure can have, if any, in future.

IV. Data Analysis and Results

Principle 1: **Restore what has been lost to its pre-war condition.**

The idea of this principle is to restore normalcy where war is only an interruption in the ongoing flow of normal.

Credit: Joe Ravi

Fig.1. The Taj Mahal Palace Hotel, Mumbai

Credit: Khaled Desouki/AFP

Fig.2. Eliyahu Hanavi Synagogue, Egypt.

The 26/11 attack on The Taj Mahal Palace Hotel (Fig 1) Mumbai shook the whole nation where terrorists intentionally targeted the 117 year old hotel built in the revival style. Great efforts were taken to restore the scarred facades of this splendid hotel and revive it back to its original glory.

Egypt unveiled the newly restored Eliyahu Hanavi Synagogue (Fig 2) on 10 January, 2020 in the Egyptian coastal city of Alexandria. One of the largest synagogues in the Middle East, it is also one of Egypt's oldest Jewish temples. It was rebuilt in the 1850s after the original building, which dated back to 1354, sustained extensive damage during the 1798 French invasion of Egypt.

Inferences:

- Restoring the architecture to its original state might help in erasing the memory of war from the minds of the people.
- The attempt of trying to forget the past might lead to the loss of identities of the victims affected by the events of war.

Principle 2: **Demolish the damaged and destroyed buildings and build something entirely new.**

Building on the past for the future.[5] The new can be something radically different from what existed or something more to that of pre-war normal. A new modified normal can only be created with consent and partition of the people.

5. Reem Al-Rawi (2010). The Architecture of War

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Courtesy: Japan Monthly Web Magazine

Fig.3. Hiroshima Peace memorial, Japan

In August,1945 the city of Hiroshima became the first city in the world to be targeted by an atomic bomb by America and within instants the whole city was transformed into rubbles and killing 1,40,000 people. In fig. 3 we can see the Hiroshima Peace memorial where a lone partially destroyed building stands as a testament to the attack whereas at the backdrop we can see the transformed skyline of Hiroshima trying to forget the past by adapting to the new technology of the world. Though the city strives to forget the past and honor the dead, the effects of the attack are still experienced by the people affected by the radiation.

Inferences:

- The principle tries to forget the trauma/psychological effect on a person caused by violence and destruction.
- If the proposed 'entire new' is not thoughtfully planned then that might destroy the local culture of the place entirely.

Principle 3: The post-war city must create the new from the damaged old.

As the finances are depleted by war, salvage the building stock to build the 'new city'.

"The spatial volumes are not meant to fit within their surroundings, but to stand as proof of old and new, safe and dangerous, past and present."

- Vrilio, Paul, Bunker Technology, Princeton Architectural Press

The re-construction of old buildings will enable new ways and ideas of living and thinking. This can be well implemented into workspaces and be a constant reminder to the future youth and a message to the world.

Courtesy: Daniel Libeskind

Fig.4. One World Trade Centre, USA

Credit: Ninya Regalado

Fig.5. Mansion in Talisay City, Philippines

America and the entire world was shaken after the 9/11 attacks on the World Trade Centre(WTC). In fig 4. we can see the proposed One World Trade Centre which opened in 2014 on the same site as WTC making a mark on the skyline of New York.

To honor the people who lost their lives on that day, landscaping was done in place of the footprints on the 2 existing buildings. The basements were restored and a museum was proposed in its place to depict the history of the attacks. In the museum we can see the original structure of the old towers which was destroyed.

Talisay City in the Philippines features a mansion (fig. 5) built by a sugar magnate at the turn of the last century that was twice destroyed during the Second

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World War in order to prevent Japanese forces from using it. Once on their way out of the Philippines, the USA air force bombed and strafed the home, and Philippine rebels burned it down to keep it from falling into Japanese hands**.** Currently only the facades remain and the mansion has been converted in a museum for visitors.

Inferences:

- This principle embraces the war by retrofitting the two objects, destroyed but usable old and developed new, to transform the damaged structure.
- Architecture will act as a constant reminder to it users about the war. Though it may in a way honor the memory of the lost ones, it might also act as a fear causing element if not implemented in the right sense.

- **V. Conclusion**

• As opposed to the dignified wars fought on battlefields outside cities, modern warfare has taken a devastating toll, unwillingly dragging people and architecture to its death.

• While war can result in destruction of a culture, architecture can be a tangible tool to restore the identity of an individual.

Discussion

The research paper can further its study by physically visiting few of the cases mentioned in the paper and attempt to understand people's take on the applied approaches on the buildings, observations, etc to gain more information helping strengthen the research paper.

Acknowledgement

I am thankful to my guide Dr. Abhijit Natu for his valuable encouragement and guidance which allowed me to further develop the research. I also offer my sincerest gratitude to all those who gave their valuable insights throughout motivating and guiding me for the research.

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Study of Bazar on Street

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ABSTRACT: The bazaar is a place for the exchange of economic and social-cultural activities; that include selling, buying, eating all with variations in their spatial attributes. This research aims to study the Placemaking of a bazaar on the street through spatial attributes in architecture. Hence, the objectives include studying the evolution; with reference of secondary data and secondly, to study spatial attributes; physical mapping is done through the various layers. The expected outcome of this study would give an insight into the reasons of why a bazaar on the street is the focus of amalgamation of activities and how spatial attributes and spatial organization influence its Placemaking.

INTRODUCTION:

The bazaar is a place with a varied display of commodities intended to be sold to costumers and earn money. Hence a space is dedicated to thisfunction. Bazaars in the past were located around a religious place for the strategic importance of trade, accessibility and its location. The bazaar was not only a trading place, but also had residences on the top storey of shops. Thus, the streets along these developed a character different from normal streets.In Indian context, the bazaars were located around temples, as it attracted trade and various socio-cultural activities. The spatial organization of the streets changed, depending on seasonal changes, types of selling items and also during various festivals

Likewise, a bazaar on the street is lively because of the people in them.Hence, a street which is normally used for commuting from one position to another is lively because of mixed use happening there, due to the presence of the bazaar, the spirit of place changes.

The people define the street, Thatis, any street has a certain character that is given to the street by the people example eatery on the road wouldn't have sustained until people visited them, hence every space is converted to a place when a certain activity or set of activities is tied to it. Thus, the spatial attributes that define a place are a reason to attract people and are hence given a certain identity. By the people, for the people and of the people. Social and spatial structure are partially related to an intervening factor of human. (Lynch k.)

AIM:

To Study the place making of bazaars on the street through spatial attributes in architecture.

OBJECTIVE:

1. To study the evolution of bazaar on the street
2. To study the spatial attributes of the bazaar via place making and spatial distribution onthe bazaar.

Spatial attributes include study of the parameters that include selling items, reference to space, changes in patterns during different seasons, types of displays and variety in them any and any aesthetics added. The spatial distribution includes study of architectural features like roofing style, sellingspace, display,scope of interaction for shoppers, sellers and visitors, materials used, volumetric analysis

RESEARCH QUESTION:

1. How do the spatial attributes and spatial distribution influence the place, making of Bazaars on street?
2. Do spatial attributes and spatial distribution attract the people to bazaar and what impact does it have on them? Have architectural features also added to the focus of attraction to bazaar?

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RESEARCH METHODDOLOGY:

The research is a qualitative as well as descriptive type research where in case studies are used to study the response of the people to the spatial attributes and spatial distribution is analysed. Literature reviews are used to study the evolution of bazaar on the street that include secondary data like earlier research, literature references like books, articles etc. and oral history is also relied on.To study the spatial attributes of the bazaar like types of commodities sold, primary data collection through case studiesare done through activity mapping via, observations, opinions and behaviour of people are accounted on the basis of their responses on each spatial attribute. Hence, these are evaluated by questionnaires, opinions and experiences. Spatial distribution to be studied via graphical mapping through the various layers.

SCOPE AND LIMITATION

The area of study for research is limited to Tulsibaug, Pune and Mahal, Nagpur. The area to be studied is selected in a range of 50m radius. The reasons to limit the study area being a detailed spatial studyare needed for the expected outcome.

LITERATURE REVIEW

Paper 1: Role of bazaars as unifying factor in traditional cities of Iran: The Isfahan Bazaar. In this paper cities are regarded as valuable cultural, technological and social achievement over centuries. Urban places like bazaars are the integrating factor of cities like Iran. The bazaars have evolved over history, creating a place for economic, social, cultural, political, and civic activities of people. The main body of the city can't be defined without bazaars. Over the year's bazaar has evolved from a place of importance around a Masjid and then a continuous street linking the ends of the city with various other spaces as well. Thus, making it the spine of the city. Thus,the paper concludes saying that bazaars are central to the idea of the traditional Iranian city and they integrate different parts of cities like residential as well as social political and trade centers. (Pourjafar, 2014)

Paper 2:The Sustainable Architecture of bazaars and its relation with social, cultural and economic components.:This paper talks about how sustainable architecture when integrated within the public spaces enhances the design and its response to its physical environment. The climate responsive design not only makes the space sustainable, but also ensures comfort of visitors and shoppers. Hence making it a good place for interaction, social activities etc .Thus the design becomes socially, ,culturally and economically dynamic .Also how types of goods sold influence the architectural elements of the bazaar; for example: The lane selling silk is covered with roofs covered with roof and as the size of goods change the lane width also changes in proportion leading eventually to a public gathering space like courtyard .This helps to keep the heat as well as protect from cold weather during winters .Thus, learning from past and importance of traditional cities is important and inculcating that in modern contemporary architecture is important. (Kalan & Oliveira, 2015)

Paper 3: Traditional Markets in Islamic architecture: successful past experiences: The paper stresses on traditional architecture of Islam and how it effectively responds to its physical environment. It explains bazaar as a place of social, economic and cultural attraction and hence how these parameters were important back then and how they can be practiced in today's contemporary architecture. The case study explains how various architectural elements were influenced that is their design was responsive to the type of goods sold, the climate of the place and the surrounding context. For example, the lane selling silk was covered with the roof and every change in lane was the indication that type of goods sold also changed hence a varied rhythm was developed. As you reach the end there is a huge courtyard rather a public common square which explains the importance of scale and proportions. Talking about the climatic aspects the roof is that of vaulted dome and skylights are made in the domes. Which responds to the extreme weather conditioned of Isfahan. (Hmood, 2017)

Paper 4: The qualities of Tabriz historical cities of Iran: The Tabriz bazaar: The paper again talks about how a bazaar is responsible for social-cultural integration of the urban life and how this parameter has continued over a period of time and how these

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parameters can be included in designing of current day megamalls. So these are the physical and functional potentials of a bazaar that can be integrated into the planning of megamalls. Thus, for physical parameters the spatial distribution is studied which derives upon a model wherein there are multiple bazaars and a city centre, which would cater all the people around the city and no one have to travel to the centre of the city to bazaars, thus reducing load on it and at the same time retaining its identity. (Ahour, 2011)

CASE STUDIES:

Mahal, Nagpur

Brief History: The heart of any city, with a rich history and culture, is often regarded as the. The same is the case of the old part of Nagpur that is Mahal. Founded by the Gond king BaktBuland Shah the city evolved after the fall of the Gond Kingdom the Bhosles took over Nagpur and are one of the Historical families of Nagpur. The residence of the Bhosleswas located in the present-day Mahal area.Hence, the area has a rich cultural and heritage importance.

Area of Study:The Radius selected for Study is the 50m radius around the 400 years old Kalyaneshwar Temple, Nagpur. The history says that the area currently a bustling market place was the Nagarkhana of the Bhosles living in the proximity of the temple. The temple complex belonged to the soldiers who resided in the quarters in the Complex. Thus, the area around temple developed as a place for meeting, gathering for their families and had shops of basic needs like utensils, grocery, vegetable etc. A vegetable market "Mandi "was also present. But there are no changes as far in the typology of shops. It's basically a common man's market where everything froma pin to cloth to electronics everything is available at reasonable rates.Over the years the area evolved as a market place. A few shops in present daywere modified in the year of 2001, as NMC gave official permission to the shops outside temples. Currently the place is one of the busiest marketplaces in Nagpur with a variety of goods sold from wholesale to retail, with street shops to small eateries and hawkers, vendors etc, selling a variety of stuff. The area of study also includes the Temple precinct hence the typology of shops change. The spatial organization varies according to the type of shop or the selling items. As narrated by PurushottamGulabraoChikhale.

Tulsibaug ,Pune

Brief History**:**Tulsibaug as the name suggests was a garden of Tulsi(a plant).Balaji Bajirao,the third, was the person who had built temple. The complex is built on one acre of land and has three temples in it, the central and major being the Ram Temple, while others being Ganapati and Mahadeva temples on either side. The surrounding courtyard of the temple complex was once landscaped with flower beds but in present day it is paved with stone.

Since women living in the temple's vicinity had to go far away to shop, a small number of shops were set up in the compelx. Which were two storey buildings , where lower storey was the shop and upper storey usually had residence of the shop owner.

Present day the shops are still there with the same character and new generation handling the shops, while the temple precinct immensely developed with more commercial buildings, street shops.

Area of Study:The area selected in Tulsibaug is the radius of 50m from the Kaware Cold Drink house.the radius includes the Tulsibaug Ganpati, mandir. all the streets are bustling with various activities of buying,selling and eating.infact all the streets are identified as major shopping destination amongst all the age groups.with variety of selling items from clothing, jewellery to gocery,plasticstore, Poojaitems, utensil stores etc.

Figure 1:street view of kalyaneshwar temple

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Figure 2: A busy street in Mahal,Nagpur

Figure 3: A busy chowk in Tulsibaug,Pune

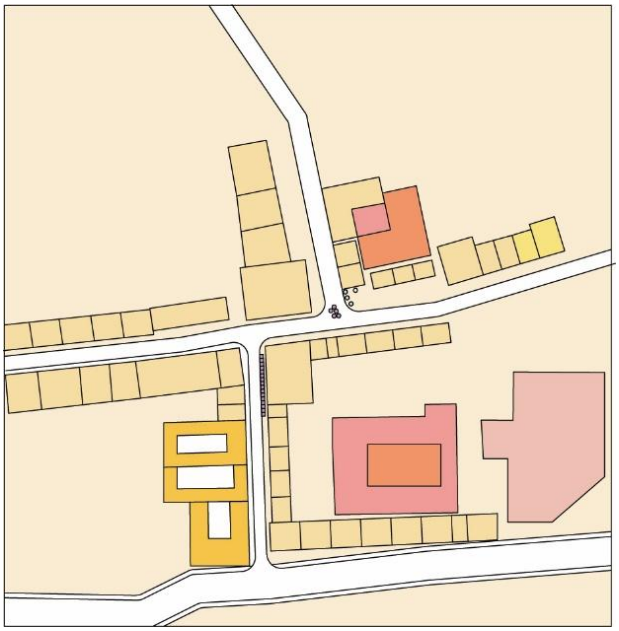

Figure 4:Base Map of Tulsibaug,Pune

Source: Author

(Rasterized Google earth map)

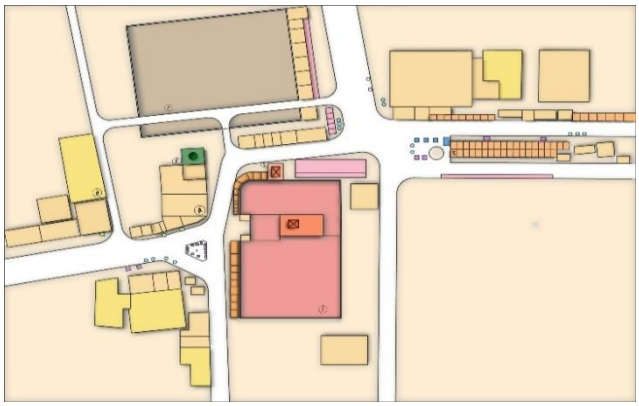

Figure 5:Base Map of Mahal, Nagpur.

Source: Author

(Rasterized Google earth map)

COMPARITIVE ANALYSIS

The parameters selected for analysis were spatial attributes that contribute to the placemaking of a street. The activities associated with all the shops and areas around it explains that:

- Similarities: Both Tulsibaug and Mahal are the core areas of the city from where they evolved hence both have a status of cultural and heritage importance.
- Both of them have Temple precincts in the area studies which also adds to the variety in the spatial attributes as well as the activities associated in the area studied. Differences: The character of streets change in different ways in both areas depending on the festivals.
- doesn't need a large space for display compared to the kiosk selling plastic items which also uses the space in its forefront for the display.
- Thus, the placemaking of the bazaar on a street is influenced by its spatial attributes.

ANALYSIS AND RESULT

For The case studies done in both the areas, the parameters were selected for analysis were the spatial attributes, that contribute to the Placemaking of a street. The activities associated with all the shops and areas around it explains that:

- The streets have a certain spatial organization because of the way a place or a shop is associated or identified with an activity.

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- The selling items and display are correlated with each other as they also define the type of shop or the architectural features necessary for the selling items to be protected or displayed. Fore.g. The kiosks selling jewellery doesn't need a large space for display compared to the kiosk selling plastic items which also uses the space init's forefront for the display.
- Thus, the placemaking of the bazaar on a street is influenced by its spatial attributes.

CONCLUSION

The bazaar on street is made up of various components but the major component being the people itself and the spatial attributes like selling items, types of displays, aesthetics etc. are designed or rather have the character or certain identifying features to attract people .hence, they influence the spatial organization along the street. People hence they influence the spatial organization of the street. Thus, placemaking of any space is important as it defines the way a [place is identified and moreover it is designed for the people that use them and create a sense of belonging to the place, that is what attracts the people to the bazaar.

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I would hereby, like to thank all the faculty members ;Dr.Banani Banerjee, Ar.Anita Kavathekar,Dr. Priyamvada Chitale,Ar. Ashwini Yadav for their guidance at every stage and also all the people who narrated their experiences and added their contribution to the paper, specially Mr.Purushottam Gulab Rao Chikhale,Mane sir for their contribution.

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Table 1: Spatial attributes Mahal

Type of Shop	Description	Architectural Character	Selling items	Display	Aesthetics	Activity happening
Permanent	The shops are typical ones with window shopping and the type changes depending on the selling item. Usually a ground or G+1 structure	The shops have a typical rcc structure in rectangular plan with a single entrance and racks placed linearly for display. Some of them are G+1 structure while some have a few seatings for customers. Spread across the whole area	Copper and brass utensils clothes, plastic items, jewelry, footwears, eateries, grocery, Pooja items,	The items are either displayed on a rack or just stacked upon one another and kept at the entrances or hung from the ceiling on the main door. In the case of clothing the clothes are displayed on mannequins or on the display rack	The sound of copper and brass utensils being beaten, the bright display of colourful items	Buying, selling,eating Some just come to sit and chat in the temple precinct.
Temporary	The permanent shops also have their temporary stalls built up in front of their shops to attract more crowd and at the same time prevent	They are usually tables with roof cover of plastic sheets and arranged in a U shaped pattern.	Clothes,small jewellery (bangles,earings etc.),utensils and crockery	Usually stacked up in a definite pattern or hanged by strings across the stalls.	The selling items itlsef add to the aesthetics and also the bright LED lights used to enhance the display.	Buying, selling
Hawkers	Usually active during peak hours of shopping	Have a moving cart.	Eatables, toys	Usually stacked up or in case of eatables covered in utensils	Brightly coloured carts	Eating ,buying selling
Kiosk	They come under encroachment and usually have common characteristics	A small stall of an average area of 2 Sq.M. with roof cover of plastic sheet and an average height of 2.5 m.	Jewellery, foot wear	Usually displayed on top or hanged by strings in a definite pattern	Brightlly coloured cloth for backdrop and lights to enhance the display	Eating,buying
Vendors	Usually they roam on the roads or sit down for selling.	Not any	plastic items, small jewelry, clothes	Usually carry along with them	Not any	Buying, selling

Table 2: Spatial Attributes Tulsibaug

Type of Shop	Description	Architectural Character	Selling items	Display	Aesthetics	Activity happening
Permanent	The shops are typical ones with window shopping and the type changes depending on the selling item. Usually a ground or G+1 structure	The shops have a typical rcc structure in rectangular plan with a single entrance and racks placed linearly for display. Some of them are G+1 structure while some have a few seatings for customers. Spread across the whole area	Utensils, clothes, plastic items, jewellery, footwears, eateries, grocery, Pooja items,	The items are either displayed on a rack or just stacked upon one another and kept at the entrances or hung from the ceiling on the main door. In the case of clothing the clothes are displayed on mannequins.	Bright lighting, in some cases just the arrangement of selling items has been itself attractive.	Buying, selling, Some just come to sit and chat
Temporary (NMC)	The shops were first temporary structures and came under encroachment but eventually acquired permission from NMC.	The shop is a plinth level structure in timber and roofing of patra. The shop layout is 2x2.5M. Each shop has a main double leaf door covering its front face. With the provision of a forefront where the rest of the items are displayed as the space within the shop.	Footwear, Jewellery, beauty items, orchestra items (one line of shops is only the orchestra bands)	The items are usually displayed on small racks or displayed with stacked arrangement on the forefront or in some places hanged from the ceiling.	Display items itself. Their arrangement itself attracts the buyers.	Buying, selling,
Temporary (Temple)	The shops were first temporary structures and came under encroachment but eventually acquired permission from NMC.	The shop sizes vary, but has an average area of 5sq. m.	Pooja items, plastic items, clothes, grocery, paan shop, flower shop, hardware,	The items are displayed on the forefront with stacked arrangement or hanged in the roof.	The bright colors of the items are on display with varying textures.	Buying, selling, chatting, eating
Encroachment	The illegal stalls are set up	These are temporary arrangements done, like a kiosk, stalls	Seasonal clothes	A simple arrangement of tables arranged linearly across the road fringe. With roofing of sheets when necessary.	The backdrop white cloth along the trees have clothes displayed on it.	Buying, selling, chatting, eating
Kiosk	Varying in sizes and display again depends on the selling item	A platform /top raised to a certain height with the help of bamboo posts and covered with plastic sheets as roofing.	Plastic items, small jewellery, vegetables, fruits, flowers	Usually displayed on the platform or hanged across the roof.	The display of selling items itself.	Buying, selling, chatting, eating
Hawkers	They have no place fixed and usually	A cart	Fruits, vegetable,	Displayed in the cart	Not any	Buying, selling,

	own a cart for selling purpose.		plastic items, small jewellery, clothes			chatting, eating
Vendors	Usually they roam on the roads or sit down for selling.	Not any	Fruits, vegetable, plastic items, small jewellery, cloth	Usually carry on themselves or just have a cloth on which items are displayed	Not any	Buying, selling, chatting, eating

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Construction Technology in Hilly Areas: Western Ghats

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Abstract : Architecture on hills offers advantages like views and cool breeze. Hilly regions have variations in topography, geology, altitude and climate. Unpredictable geological and climatic conditions make construction conditions unfavourable. Various factors are considered like landslide-prone areas, slope, existing subsurface water and study of geological maps before constructing on a sloping site. Construction techniques play an important role in helping the structure sustain. Vernacular construction techniques include use of timber, mud, stone, etc. Contemporary construction techniques include use of green building materials like steel-framed construction, cement-wood boards, etc. This research paper deals with construction techniques which will help sustain the structure.

Keywords –Sloping sites, Topography, Geology, Landslide, Vernacular architecture, Contemporary construction techniques.

I. INTRODUCTION:

Hills are landforms that rise above the surrounding terrain. Hills are formed through geological activity such as faulting or erosion. Earlier settlements were built on hills, to avoid floods, densely forested areas, for defense and good views. Lack of picturesque views, fresh air and accessible flat lands in the cities, people have finally started to resort to hilly regions. With increasing population and construction demands, construction in hilly regions, on sloping sites have taken place.

Challenges faced during construction in hilly areas:

Hilly regions have wide variations in topography, geology, altitude, geomorphology, material resources and climate. Unpredictable geological situations, precarious climatic variation, hydrogeological conditions, deep gorges, rivers, high winds, high altitude, landslides and mud flows make construction conditions unfavourable.

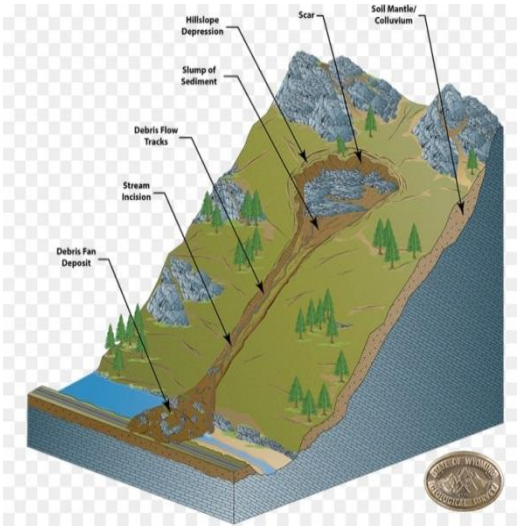

Fig 1.Landslide

Building consideration for construction in hilly regions:

1) Site Selection:

1.1Check for Landslide-prone areas: Landslides are most prevalent disaster in hilly regions, which are caused by gravity acting on weakened rocks, debris, etc. which constitute a sloping area of land. A landslide hazard map shows the areas susceptible to landslides.

1.2Check for Slope and sequence of rock structures: Study of sequence of rock structures beneath help analyze the stability of land, and whether the land is suitable for construction or not.

1.3Check for existing subsurface water: The presence of subsurface water in an area may lead to the formation of cavities therefore inviting landslides.

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2) Comprehensive Planning:

2.1 Topographical data: It involves study of geological maps, analysis of geomorphological features, previous and present land use, previous slope failure and landslides, underground services, etc.

2.2 Site Investigation: For construction on a hill-site, site investigation should be executed in two stages. First stage consists of boreholes and geophysical survey which includesdepth of soft soil, hard stratum and bedrock.Soil samplesshould be collected from boreholes for laboratory tests, which help in designing slopes, foundations and retainingwalls.In addition, the ground water profile should also be examined.

3) Design of Slopes:

Designing of slopes plays an important role while constructing on a sloping site. Improper design creates environmental impact leading to slope failures.Therefore, for slope design, detailed information about soil properties,geology of the site, groundwater regime is necessary.The structure design should fit the natural contour and reduce cut and fill of earthworks.

4) Sustainable development:

For sustainable development, construction technique should be developed with locally available and easily workable materials like timber, stone, mud, etc. that have good climaticresistance and have less impact on environment of hill settlement, and, green building materials like cement wood boards, aerated concrete panels, gypsum plasterboards, etc.

I. MATERIAL AND METHODOLOGY:

1)Case study of weekend home in Sahyadri hills:

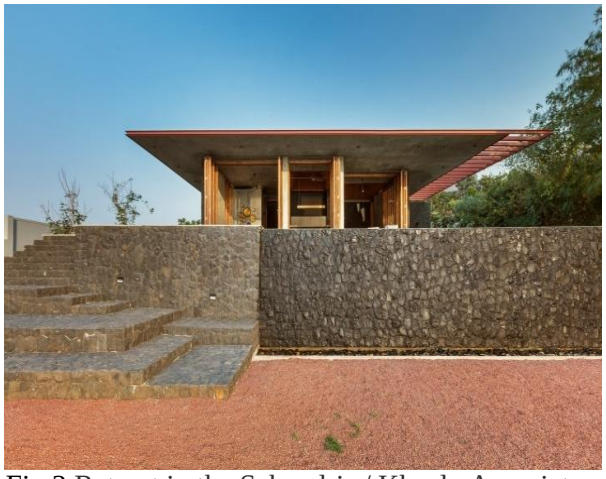

Fig 2.Retreat in the Sahyadris / Khosla Associates

The weekend home is built with the help oflocally available material of Deccan Plateau: black basalt stone. The stone is used as a random dry pack cladding along the entire extent of the exterior walls, on a few internal accent walls and for retaining walls. Doors are made of sustainable Accoya wood.Angular shaped skylights are provided for natural lighting. Retaining wall created at the periphery and a ramp alongside it to arrive at the entrance 3''-6" below.[vii]

2) **Case study of Hotel Dalhousie in Himachal Pradesh:**

Fig 3.Study of Building Structures & Construction Techniques in Hilly Regions: Hotel Dalhousie

Construction technology used: Kath-Khuni. Kath-Khuni technique has the characteristics to be, sustainable, aesthetically pleasing and seismically sound. Materials such as stone, wood and slate are used. The walls and retaining walls are made of stone and wood which are stacked up alternately. Wood

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from deodar tree is used for flooring, partitions, door and window frames. Slate,a material which is cut into thin sheets from the heavy metamorphic rocks, is used for roofing.Slate is a sunlight reflective material, heat absorbent, frost resistant and moisture barrier as it is contains high quartz content.

3)Green building materials for sustainable design in hilly areas:

3.1 Steel construction: Light steel-frame building consists of structural wall frames and roof trusses made from cold-formed galvanized or Zinc Aluminum structural steel sections. Less wastage, low transportation and storage costs reduced time of construction offers cost savings up to 15%.[v] Steel can be reused and does not rot or sag over time.

3.2Cement-wood-boards: These are made from cement and wood (eucalyptus and casuarinas). Due to special manufacturing process, the panel gains the durability andstrength of cement and easy workability of wood. These sustainable boards are weather resistant, termite resistant,fire resistant and provides good sound insulation. They can be used for wardrobes, false ceilings, partitions, etc.

3.3Sandwich panels: These panels are pure dry fixing system comprising two thick boards (fiber reinforced cement sheets).These are light weight, durable, water and termite proof, provides thermal insulation and fire resistance. This factory made panels have semicircular tongue and groove jointing system which provides rapid installation. False ceilings, wall paneling, structural glazing, etc. are some of its applications.

3.4Aerated concrete panels: These are made from a mixture of fine fly ash, with cement, gypsum and lime as binding agents, aluminum powder and water acting as foaming agent, and can be used in high rise claddings.

3.5Gypsum plasterboards: Gypsum plasterboard for walls is also called dry wall which implies no water usage. They can be used for walls, lift shafts, stairwells, etc.in residential, schools, hospitals, etc.

3.6Roofing and cladding: Corrugated tiles are made from bitumen combined with resin and single layer of organic fibers. A coating of zinc-aluminum provides corrosion resistance. These sheets are ideal for roofing and cladding.[v]

4) Type of construction according to slope:

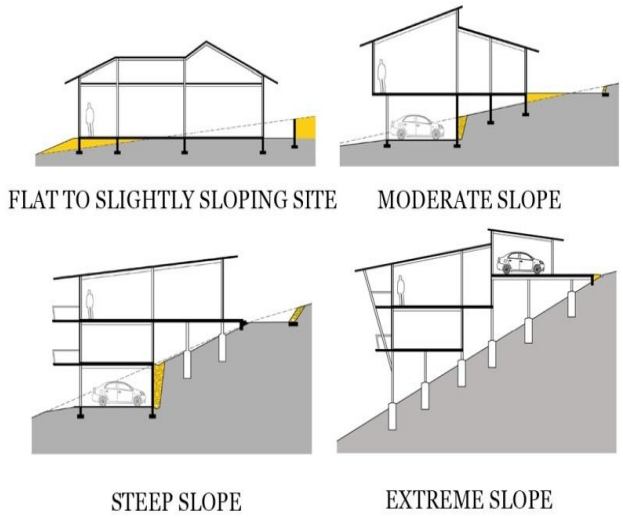

Fig 5. Matching building design to suit the degree of slope

Slope	Type of construction
Flat to slightly sloping sites(site slope upto 7%)	Single slab on ground construction
Moderate slope(slope between 7-20%)	stepping two or more slabs or using part slab/part post or beam construction
Extreme slope(slope more than 33%)	suspended or pole construction techniques
Steep slope(slope between 20-33%)	post and beam construction should be used which steps with the site.

Table 1. Matching building design to suit the degree of slope

5)Example of good hillside construction practice:

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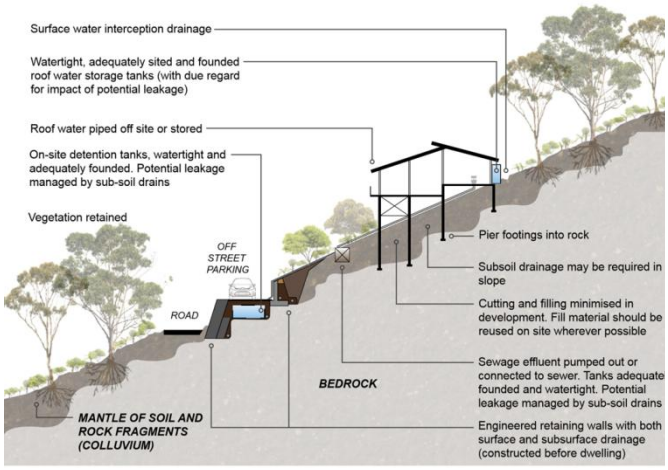

Fig 5. Guidelines for building on sloping sites

II. RESULTS:

1) Weekend home in Sahyadri hills:

- Locally available material black basalt used in construction of walls and retaining walls.
- Accoya wood used for doors which is a timber modified through a process called acetylation which enables it to resist rot, and durable up to 50years.[xi]
- Construction done considering natural topography of the site, creating negligible impact on the environment.

2) Hotel Dalhousie in Himachal Pradesh:

- Kath khuni construction technique used which consists of use of stone, wood and slate.
- Outer layer involves laying of random rubble masonry of granite stone stacked up alternately with deodar wood. Wood (good in compression and tension) is interlocked in the corners with other wooden members. This technique provides good seismic and thermal response.
- Slate, which is asunlight reflective material,is used for roofing. It is heat absorbent, frost resistant and moisture barrier as it is contains high quartz content.

3) Green building materials:

- Steel construction: Lightweight steel-framing systems are reusable, offer similar environmental performance to that of conventional double-brick construction technique and eliminate wet masonry work on site.
- Cement-wood-boards: Due to unique manufacturing process, these boards are fire resistant, weather resistant and have good insulation properties.
- Sandwich panels: These panels are an alternative to masonry walls. Being fire, weather and termite resistant, these panels also offer rapid installationwith minimal disruption of work, due to its light weight.
- Aerated concrete panels:These can be used for high rise claddings totackle masonry difficulties such as, plastering,curingandbrick by brick construction.
- Gypsum plasterboards: These boards offerhigh level performance in terms ofmoisture resistance, acoustic and thermal insulation, and fire rating.
- Roofing and cladding: Corrugated sheets are designed to give aesthetic look, while at the same time being extremely light weight. Thus, it helps reduce transportation cost.

III. CONCLUSION:

With increasing population and construction demands, construction on sloping sites has taken place. Considering the factors affecting natural topography of the site, it is important to build structures using vernacular construction techniques and contemporary construction techniques which include use of green building materials that have negligible impact on the environment.

ACKNOWLEDGEMENT

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To Study the Symbolism of Mount Meru and its representation in the Architecture of the Angkor Wat Temple

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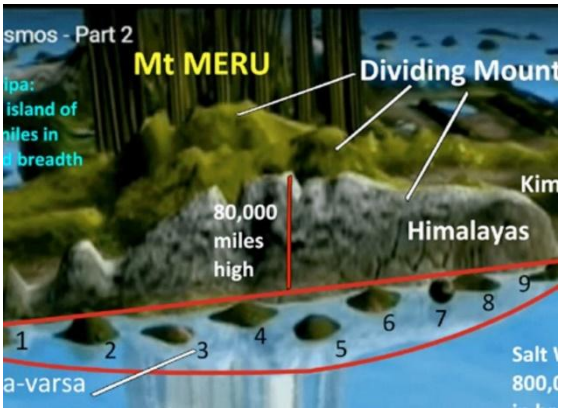
Abstract: ***Art speaks about the metaphorical meanings in context to the shapes, patterns, ornamentations and planning implemented in creating it. This nature of it is symbolism. In Hindu religious architecture the shapes and patterns depict the archetypal manifestation of nature and its attributes therefore contributing in religious significance depicted through the means of the construction of the structure. Mount Meru is believed to be the centre of the universe it is a representation of the central axis theory of the sacred Hindu Cosmos. Angkor Wat Temple located in Cambodia symbolises the peaks of Mount Meru all of its original religious motifs are derived from the Hindu Cosmos and Hinduism . This research paper speaks about the study and interpretation of the symbolism of ancient Hindu Mount Meru and its representation in the architecture of the Angkor Wat Temple. It also aims to study the significance of the Angkor Wat Temple and the relation between the temple and Mount Meru. The paper aims to draw a comparison between the symbolism of the two with the interlays in the historical and cultural time periods and also understand why it is necessary to do so, to scrutinize and draw inference of the existing data on the topic.***

Keywords - Hindu Cosmos, Central Axis Theory, Mount Meru and Hindu symbolism, Angkor Wat Temple, Mount Meru and Angkor Wat Temple comparison, Conclusion.

INTRODUCTION

Mount Meru is believed to be the highest point of the universe in ancient Hindu texts. It is also regarded as the earth's navel, the point at which the creation began in other words '*the centre of theuniverse.***'** The mountain is said to be separating the heaven and earth.



(**Image A- Mount Meru and the depiction of cosmos.)**

It is commonly said that the mountain is the centre of the universe its symmetry is vertical and horizontal, surrounded by the waters of life which is surrounded by seven concentric seas each diminishing in size from the centre if we see this technically it is the entire landmass of the earth surrounded by the mountains and sea.**(Image A)**

Mount meru is believed to be the part of the sacred Hindu cosmos, Hinduism believes that universe is created, destroyed and recreated in an endless series of repetitive cycles where Brahma is the creator, Vishnu the sustainer and Shiva the destroyer. This holy trinity as referred to combines to form '*Parmeshwar Purusha,'***(Image B)**the supreme being who is the manifested form of the whole of infinity. It is a philosophy of Hinduism that the human being is said to contain within itself the entire cosmos *'Aham Bhramosmi'* which reinforces the idea of part in whole and whole in part. It has been stated that the ancient Hindu cosmos is inspired from the human anatomy. To maintain harmony all man-made objects and structures were enjoined to be fashioned with the same measurements and principles with which the cosmos is made and thus the underlying order and symmetries of the cosmos manifest themselves in the designs and representations made by man. Thus, stating the Hindu philosophy of the whole cosmic

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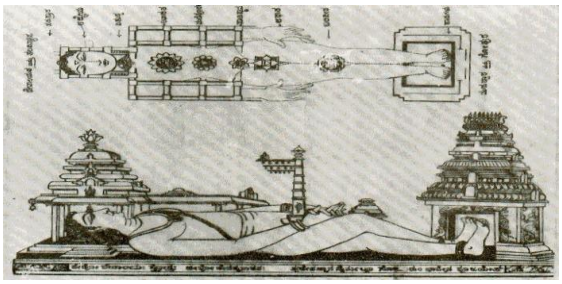
principle replicates itself again and again in even smaller scales.



(Image B- Parmeshwar Purusha)

Angkor wat temple located in Cambodia is a gigantic temple complex which was built by King Suryavarman II in the early 12th century in order to serve as the king's state temple and capital city, over a period of 500 years from the seventh to the twelfth century successive rulers sought to build sacred spaces that bore witness to the presence of gods and the legitimacy of the kings. Since its been constructed it has maintained religious significance for nearly 900 years all of its original religious motifs are derived from Hinduism and the temple is dedicated to the holy trinity of Hinduism Shiva, Brahma and Vishnu, the 5 central tower of Angkor Wat symbolises the peaks of Mount Meru, since Mount Meru is surrounded by the ocean with the same context the temple complex has the central shrine with enormous moats which represent the oceans at the edge of the world.

Thus, studying the significance of Mount meru and Angkor Wat individually and understanding their co-relation and significance to establish the symbolism of the mountain in the architecture of the temple.

METHODOLOGY

This research paper aims to study and interpret the concepts and religious philosophy pertaining to the Hindu Cosmos of which Mount Meru is a symbolic and also to understand the representation of the symbolism of this mountain in the architecture of the Angkor Wat Temple. To analyse and establish that Angkor Wat Temple is considered as the miniature replica of the Mount Meru and the Central Axis theory associated with the mountain

HISTORICAL BACKGROUND AND ORIGIN OF ANGKOR WAT TEMPLE

The Angkor Wat Temple was built by King Suryavarman II at the height of the political power of the Cambodian dynasty namely Khmerin between years 1113-1150.

Khmer civilisation flourished between early 9th century A.D. and mid-15th century A.D. It was founded by King Hiranya Varman in the year 1080. There has been an inscription of King Suryavarman II discovered in "Phnom Rung" located in North-Eastern Thailand which contains a detailed description of the royal family lineage and the native place of stay of the Khmers. This description also contains information about Hiranya Varman being a descendant of **'**Aditya' -the Sun God and 'Lakshmi'- the consort of Vishnu thus establishing a relation of the empire with the divine Brahmanical Hindu ideologies. Thus **'**Aditya' and'Lakshmi' were also used as suffixes to characterize the members of royal family. The most notable rulers of this dynasty were Suryavarman II and Jayavarman II.

Like his predecessors King Suryavarman II decided to build his own royal sanctuary and thus constructed The Angkor Wat Temple facing it towards the West, since it was dedicated to Lord Vishnu -the great Brahmanical God of the holy trinity as believed in Hinduism.

It was a popular belief of the Khmer civilisation that the Kings were regarded as an incarnation of deities like Shiva, Vishnu and Brahma -all to whom the well-being of the realm was confided, thus all the Kings were considered at an equal stature with God. This was regarded as the 'Cult of Devaraja' where the word Devaraja meant **'**God-King' which was centred around a **'**Sacred Lingam (Pillar)'and this pillar was a symbolic representation of 'Lord Shiva'. This would be installed in the Temple Mountain that was located in the centre of the capital and the empire.

The sanctification of Devaraja cult resulted in it becoming a ritual for the future Kings to build their own distinctive temples which would also serve as their royal sanctuary. They also made it a priority to build public reservoirs and canals along with public utility services with the focus being the security of the state and to ensure the essence of their Kingship. This ritual can be traced back to ancient Indian dynasties, where a number of them had a sacred mountain of worship and inspired by this for several centuries it became a duty of Khmer Kings to construct temples in the form of mountains which

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preserved the royal pillar that was an expression of the kings sacred ego and it was this ritual which lead to the construction of great temples in the Angkor region with Angkor Wat being the one that was designed inspired by the sacred Mount Meru.

HINDU COSMOS

Hindus believe in creator -an immanent and transcendent supreme being who has no form, no beginning and no end. This entity represents the highest truth of the universe and everything else is said to be a reflection of it. This divine entity is referred to as 'Parmeshwar Purusha', the supreme being who is the manifested form of the whole of universe. The Gods and Goddesses in the Hindu pantheon represent fewer abstract notions that are easier to connect with and grasp. However, each deity is a representative of the divine ,as in Hinduism it is believed that our bodies are the houses of the divine and deep, which means that each human being is said to contain within itself the entire cosmos 'Aham Bhramosmi'-which reinforces the idea of part in whole and whole in part, Connecting the individual soul to the world's souls which is termed as the Cosmic connection.The ancient Hindu cosmos has been inspired from Human anatomy the reason for it being the ancient philosophy of maintaining harmony between nature and man-made objects. As it is believed that the deeper association between the person and nature spirit results in a divine connection which transcends the boundary of space and time. The Hindu texts and philosophy have been derived to ease the burden associated with human existence.

CENTRAL AXIS THEORY

In Hindu Cosmos the central axis or the Axis Mundi is around which the cosmos turns. This centre serves as a communication link between Heaven and Earth. In ancient Hindu texts Hindu lifeworld is a pilgrimage which is an act to cross from one world to another and "to cross" means to transform, it is a spirit guiding force that is a sacred journey to discover the wholeness of oneself and in this journey each stage has a significance- a message and a meaning. Thus, there exists a genius locus which inter-connects the varying niches of the levels and this deeper association between man and the nature results in a divine connection which transcends beyond the boundaries of time and space and creates a world of meaning, feeling and revelation. This field where man meets divinity is regarded as "Faithscape" which is an embodiment of sacred time, rituals, places and meanings. In terms of architecture it is to be used in the form of planned human construction, the designing of the holy spot is essentially a specific transformation of human creativity which is often interpreted in the terms of signs and symbols and the hidden meaning preserved on them all. This presentation of wholeness is a representation of the cosmos which forms a cosmic geometry referring to a sacred and stereotypical dimension ofpattern/relationship, order/sequence and temporality/changes. This forms a harmonic bond between man and its surroundings. In symbolic form analogy if human body has been accepted as a representation of the universe. Thus, drawing parallels between the macrocosms (universe) and microcosmos (temple/human body) and this interlinkage is represented in the Axis Mundi or the Central Axis Theory.

MOUNT MERU AND HINDU SYMBOLISM

Mount Meru in Hindu Mythology is believed to be the highest point of the universe. In ancient Hindu texts it is regarded as the Earth's navel, the point at which the creation began- the axis of the world. It is the golden mountain that stands in the centre of the universe separating the Heaven and Earth. Its basic symbolism in Hinduism is it is a world pillar that separates Heaven and Earth. Meru has been present since the beginning of creation, many other sacred mountains surround it mainly four mountains which establish an orientation to the magic of the compass points and the divinities that preside over them. In Hindu cosmology there are successive periods in which the cosmos is articulated in four, three and seven divisions respectively. it is represented in the Puranas that the world was divided into four continents and the later Puranas mentioned that there were seven concentric ring- shaped continents. All these cosmographical dispositions make Mount Meru the centre of the horizontal plane and make it a point of reference for everything around it. But its symbolism is not only limited till here Meru is a vertical shaft which links macrocosm and microcosm, God and Men, time and timelessness. In accordance to the Hindu Puranas there are seven number of 'Lokas' or Planes which are at different

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heights of the sacred mountains and different deities reside at different levels and at the top of it lies **'**Swarga' or Heaven- the city of the Vedic God 'Indra'. Similarly, it also states that the levels of the mountains inside the earth correspond to multiple levels of hell which is a reference to the foothills of the mountains that initiates from the Earth but the whole of the summit is not limited to the surface of the Earth and goes beyond .Thus, Mount Meru is consecrated as the full vegetal energy of the Hindu religion and represents the Tree of Life in the religion, it is the manifestation of the Central axis theory of the Hindu Cosmos.

MOUNT MERU AND ANGKOR WAT TEMPLE COMPARISON

The culture of late medieval period of Cambodia (802 A.D.-1431 A.D.) discovered their expression of uniqueness through construction of marvellous sculpture and architecture. The people of Cambodia had an inherent love for the mystic and religious philosophy and this resulted in them building a series of magnificent temples for the deities they worshipped and had carved artistic images and also engraved beautiful bas-reliefs to decorate them. Thus, these temples glorified Gods and Kings.Pre-Khmer or Indo-Khmer art inspirations belonging to the 5th-6th century A.D. bore the closest affiliations to the Indian art styles. The Khmer period revealed an indebtedness to the inspiration from art styles of India which was more obvious in the surviving buildings of those era. Various excavations have found traces of Indian settlements in Siam and Cambodia where the works discovered were closely related to the types of sculptures created during the Gupta Dynasty that one could easily mistake them for being of Indian origin. Native chiefs of the era were attracted to the Indian culture due to the fact that it was characterized by having a specific way of life laid down by philosophical and religiousdoctrine. There can be two major possibility of the adoption of Indian religious way of life. The first being either Indians imposed their form of political and religious organisation on a native society of Cambodia, which taking inspiration from it created a political organisation of Indian pattern. The second being either an Indian origin became the ruler of a native society of Cambodia or a native chief may have summoned upon the help of a Brahmanical priest to set up a monarchy of Indian type.

The establishment of Khmer autonomy began in the late 8th century A.D and early 9th century A.D. 'King Indra Varman' was the progenitor of the Khmer art. he is believed to have been studied the monistic Vedanta philosophy of The great 'Shankaracharya' from a brahmin and was married to 'Indra Devi' who claimed her descent from India. She was the daughter of an Indian Brahman named 'Agastya.' This resulted in creation of sculptures and architecture styles that were heavily influenced by Hindu religious philosophy.During the Khmer period most of the important and typical elevations were in the form of the summit of stepped pyramid. This form of the architectural constructions mainly temples which also served as royal sanctuaries had been stimulated from the cult of the Temple Mountain built after the imagined shape of either'Mount Kailasa'or 'Mount Meru'.This was an importation of an old Indian concept of 'Pratibimba', making of either sacred mountains or unseen celestial regions in the form of architectural constructions.Angkor Wat Temple is one of the largest religious complexes in the world which of all the Khmer monuments has been best preserved. It has a legend associated with it that it was built by Indra-Lord of Heaven. It is a logical culmination of the temple mountain whose evolution has followed through preceding centuries. It was constructed by King Suryavarman II and was originally a Vaishnava shrine which was dedicated to lord Vishnu and the temple was constructed facing towards west. It occupied the centre of the capital and served as the burial sanctuary of the king that was considered at an equal stature with Lord Vishnu. Considering the symbolic aspect of the main entrance of the temple facing towards the west direction in Hinduism the idols of the gods that are worshipped are placed in the West direction. Also considering the funerary aspect of facing of the temple towards the West is the symbolic theme of it being the direction of the dead. It is also acquainted with the traditions of the ancient Angkor and present-day Cambodia of building the tomb. Thus, thistemple is a classic example of both the temple mountain and the funerary temple. It probably contains the ashes of the dead king. The design of Angkor Wat is focussed on three rising concentric galleries at the heart of the

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temple and a vast amount of space circling the galleries. Around it is a rectangular moat, which is a water filled border that isolates the grounds of the monument. The central sanctuary is 138 metres high which stands on a square terrace 33m high and 225 metres square. At the corners rise four towers connected by galleries and communicating with central shrine by covered passages and around this is a wall of galleries with towers at its four corners. Beyond this is an encloser measuring 850 by 1000 metres and surrounded by a wall of laterite and sand-stone. The whole was originally surrounded by a moat of 200 metres wide enclosing a total area of nearly a square mile. The sun rises in the east and sets in the west, thus on the basis of the Sun's movements the Earth's two major geophysical axes are based and the Khmer architects aligned their temples to accord with these axes. Numerous ancient Hindu texts state that the temple architecture must be in harmony with the universe. At the Angkor Wat the floor of the central sanctuary was raised 23 metre above the ground level, the tower symbolising union of King and the Divine. The moat around Angkor Wat is 200 m wide but extremely shallow and forms a sacred perimeter of water around the temple which separates the temple from the secular world. The laterite and sand-stone wall has been cut into large single entrances on the East, North and South and by a total of five entrances on the West. The moat that has a bridge which is used for the access to the temple is symbolic to the bridge of life, as mentioned in Hindu texts which is a separation between life and death and the realm of humans and celestial beings. The architectural focus of Angkor Wat is the central tower which isconnected to the gallery around it by roofed and pillared corridors on the East, North and South. It is rectangular in shape, the second and third terraced being setback to the east on the opposite side to the main entrance, thus lengthening the architectural perspectives along which the eyes travel to the cluster of terminal towers. Each terrace is surrounded by a gallery interrupted at intervals by pavilions, corner towers, decorated doorway, stairways and axial pavilions. The stairways leading from this courtyard to the second terrace are covered. Each platform is higher than the one below it so that the terraces avoid the appearance of being huddled one on top of the other. With Angkor Wat the temple mountain reaches its apex, the concentric galleries on each terrace, vaulted stairways and corridors and galleries of bas-reliefs. All depict the whole of Khmer art and its stylistic inspiration from the Mount Meru which is the centre of the Universe and the constant element of the Hindu cosmos.

CONCLUSION

Angkor Wat temple is an insightful accumulation of the religious philosophy of Hinduism the co-relation of the temple construction with Mount Meru speaks about the evolution of the architecture of the period on the basis of religious psychology. We can see the construction of the central tower which has several stages and eachsuccessive stage results in the increase in height which is similar to the concept of Mount Meru and the consecutive planes with the residing of different deities.**(Image C)** The concept of Horizontal and Vertical axis that was followed in the temple which is the moat that surrounded the temple with a bridge on it connecting it to the city horizontally whereas the central tower that vertically connected the temple to the planets and sky above, which mimics the mythical reference of Mount Meru a central axis around which the Cosmos itself revolves.

Sectional Perspective of Angkor Wat

Image C)

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Design of Built Forms of Wind Responsive Skyscrapers through Dynamic Interactions

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Abstract: Population density is constantly increasing world-wide and India being projected as one of the world's most populous countries brings out the major issue of shortage of land for future generations. Therefore, there is a need for us to go for more verticality in structures for providing necessary spaces in limited land areas. Skyscrapers are now an indispensable resource and with it comes its design. The design of a building or a built form always governs a few parameters, both for aesthetics and the structure. For a skyscraper, the function of Wind, is a crucial factor to be considered as we are moving up in the atmosphere with greater wind pressures. Wind characteristics change with every region and every season, according to the topography, physiology, geography etc. Every built form acts or reacts to these characteristics in its own unique fashion. A built form is the result of the plan, the façade and the openings on the façade. A sphere will react to the wind like no cube will, a cube will act in a manner a pyramid never will. Every solid mass (building) either acts as a barrier, or facilitates the air movement in the required direction as per the form. Wind has been the most important aspect that needs attention while making new age structures of mega million projects reaching sky. The paper discusses various ways how wind and Architecture can together accommodate through proper design approach. It provides statistical data on wind characteristics at varying heights for different shapes and forms of buildings in Mumbai region and also discusses what design approaches, used in skyscrapers across the world, can be similar or dissimilar to those in Indian context. Computational fluid dynamics shows wind flow behavior for different geometrical configuration to draw attributes of the best form or shape.

Key words – Wind, Wind effect, Geometrical form, shape, flow, Skyscraper

INTRODUCTION

The Wind is air in motion relative to the surface of the earth. It varies with time and space. Due to unpredictable nature of wind, it is necessary to design the structure by considering the critical effect of the wind on the it. The motion of wind is always governed by the state of its surrounding conditions. The wind forces depend upon terrain and topography of location well as the nature of the wind, size, and shape of the structure and dynamic properties of the structure. As the wind encounters a structure, it exerts positive pressure on the windward face.

Every physical conformation of a building will react to wind flow lines in distinctive manners. Some surfaces, planes or points would help deviate the flow lines or would converge them. Deviation in wind flow away from the building surface will always cater to reducing the velocity and therein the pressure on the building, which any design should aim at. Hence, fluid mechanics play an important part. It would be safe to say that a building standing tall in the atmosphere will experience the same kind of wind motion like that of a bird flying high in the sky. Just how an aerofoil shape was invented to cut through the wind passage for aeroplanes, taking influence from a bird. There can be a number of shapes and forms of buildings which work against wind.

The two very basic approaches of designing can be a static approach or a dynamic approach. Dynamic approach counters the static approach, assuming the buildings to be exceptionally tall, slender or vibration prone. These are methods generally used when the width to height ratio is 1:5 or above. The dynamic interaction between motion of the building and gusting of the wind increases effective wind loading. (Nirmal, 2017)

The paper will focus on the current designs for skyscrapers and effect of wind dynamics on them which are observed by placing 3D building models in simulation software having real-time wind conditions of Mumbai.

LITERATURE REVIEW

With the perfect and over the conventional correlation approach between Architecture and Engineering, has resulted in creating the landmark in the world. It is very important to understand phenomena of wind over the building form to counteract the wind pressure on the structure. Further, the design of tall buildings is not limited to wind sensitive design but rather using wind to the advantage of building.

The wind behavior can be classified into various phenomena. "Cross-wind" actions usually govern in design of very tall buildings; especially interference effects magnify these effects. Interference from buildings located in close proximity to the proposed building can cause large increases in cross-wind responses. The designer should not only consider the existing conditions but make allowance for future changes in the surrounding area during the design life of the structure. There are several different phenomena giving rise to dynamic response of structures in wind. These include buffeting, vortex shedding, galloping and flutter. Slender structures are likely to be sensitive to dynamic response in line with the wind direction as a consequence of turbulence buffeting. Transverse or cross-wind response is more likely to arise from vortex

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shedding or galloping but may also result from excitation by turbulence buffeting. Flutter is a coupled motion, often being a combination of bending and torsion, and can result in instability. For building structures flutter and galloping are generally not an issue. (J. & B., 2007)

The wind response is largely determined by building shapes. Buildings with rounded forms, rather than rectangular forms with flat surfaces, offer less wind resistance (Figure 1). Tall buildings that are short in horizontal dimensions are more critical for overturn and possibly for the total horizontal deflection at their tops (Figure 2). Open-sided buildings or buildings with forms that cup the wind tend to catch the wind, resulting in more wind force than that assumed for the general design pressures.(Figure 3)

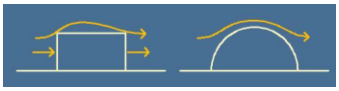

Figure 1 Wind action on built forms

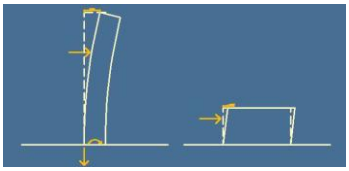

Figure 2 Wind action on different height of buildings

Figure 3 Wind action on semi-open built forms

Source: International Research Journal of Engineering and Technology (IRJET)

The plan form of a building affects the airflow around and through it. It could either aid or hinder the natural flow of wind. Physical obstacles in the path of airflow create pressure differences. This causes a new airflow pattern. Air tends to flow from high pressure areas. Knowing the direction of air movement, the plan form can be determined also as to create high pressure and low pressure areas. Building openings connecting the high pressure areas to low pressure areas would cause effective natural ventilation. (Nirmal, 2017)

Figure 4 Wind Action on various building plan forms

Source: International Research Journal of Engineering and Technology (IRJET)

Aerodynamic shaping at the concept stage of the building could significantly reduce the wind loads. The wind can be "disturbed" by changing the building shape along the height such as tapering or twisting thus reducing the synchronization and correlation of fluctuating excitations. (P.Mendis)

Some modifications on cross-sectional shape such as slotted, chamfered rounded corners, and corner cuts on a rectangular building can have significant effects on both along wind and across wind responses of the building to wind (KWOK, 1995) as in Taipei 101. Corner modifications in Taipei 101 provide 25% reduction in base moment when compared to the original square section (IRWIN, 2006) Chamfers of the order of 10% of the building width, makes 40% reduction in the along wind response, and 30% reduction in the across wind response when compared to the rectangular cross sectional shape without corner cuts. Excessive rounding of corners of the cross section, approaching a circular shape in the cross section, and cylindrical form in the building, significantly improve the response against wind. In the study of Davenport (1971), peak deflection of the model in circular cross-section was about half of the one with square cross section where the building models were representative of roughly 70 storey structures. Addition of openings completely through the building, particularly near the top, is another very useful way of improving the aerodynamic response of that structure against wind by reducing the effect of vortex shedding forces which cause across wind motion. (GÜNEL, 2007)

METHODOLOGY

TYPE OF RESEARCH: Qualitative and Quantitative Research

- To perform virtual wind tunnel tests through simulation on form of buildings for studying its behaviour towards wind flow.
- To study Live and Book Case Studies to understand problems, Mistakes and Solutions.
- To have a comparative analysis between different skyscrapers in Mumbai region and draw conclusions for optimum design solutions.

HYPOTHESIS: The form for the building will taper from its lowest floor to its highest floor for all built forms.

CASE STUDIES

Book Case study 1 : Burj Khalifa, Dubai

Architects: Skidmore, Owings and Merrill (S.O.M.)

Facility: Mixed use, basically Residential.

Features: 521 m, desert rose shaped plan.

Size: 37,00,000 m2

LOCATION:

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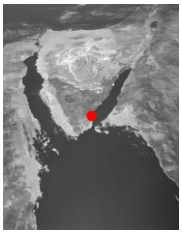
Coordinates: 25°11′49.7″N 55°16′26.8″E



Source: http://faculty.arch.tamu.edu/media/cms_page_media/4433/burjdubai.pdf

TERRAIN: COASTAL

PREVAILING WIND DIRECTION: The building has essentially 6 wind directions. 3 of these are when the wind directly blows into a wing. The other 3 directions are when the wind blows in between two wings. These wind directions were borne in mind when orienting the tower to the most strong wind directions for Dubai: north west, south and east. (Figure 5)

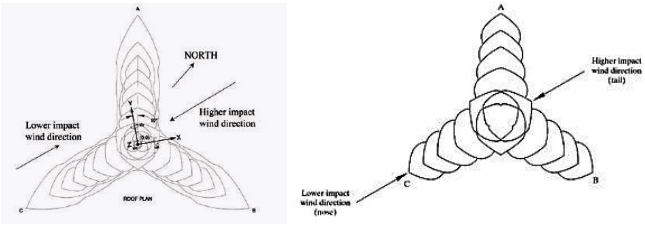


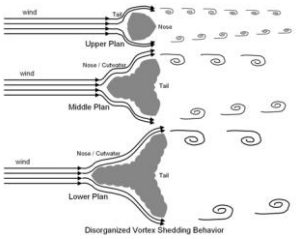
Figure 5 Wind direction in plan

Source:http://faculty.arch.tamu.edu/media/cms_page_media/4433/burjdubai.pdf

TOWER FORM: The floor plan of the Tower consists of a tri-axial, Y-shaped plan, formed by having three separate wings connected to a central core. As the Tower rises in height, one wing at each tier "sets back" in a spiraling pattern, further emphasizing its height. The result is 24 different primary floor plates (plus some less major variations), creating a stepping geometry that presents multiple building widths over the height of the building, providing an environment that "confuses the wind"—the wind vortices never get organized, because at each new tier the wind encounters a different building shape. Starting from a slender top, the building spreads out as the gravity and wind forces accumulate. As a result, even though the global forces are large, the forces in the individual members are not.

Several revisions to the building were made. Some were related to the geometry of the Tower: the size and shape of the wings were the setbacks changed throughout the process, as were their locations: the original massing had the setbacks occurring in a spiralling counter-clockwise pattern, which was revised to be in a clockwise direction. Taken together, these measures had a significant impact in encouraging disorganized vortex shedding over the height of the Tower. Another revision was related to the orientation of the building.

The Tower has six important wind directions, all parallel to the major axes of the wings—three directions where wind is blowing into the "nose" of each wing, and three directions where wind is blowing into the "tail" of each wing at the center of the building (Figure 6). The orientation of the Tower was then selected to better accommodate the most frequent strong wind directions for Dubai: northwest, south, and east.



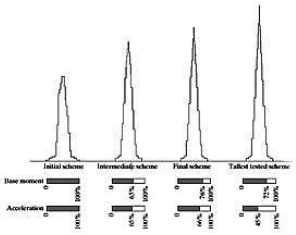


Figure 6 Tower Wind Behavior **Figure 7 Improved wind behavior**

Source: http://www.civil.ist.utl.pt/~cristina/EBAP/FolhasEdifAltos/burj-dubai/160.pdf

Book Case study 2 : Taipei 101, Taiwan

Architects: C Y Lee & Partners

Facility: Commercial Office tower

Features: 508 m, Square Plan with Static form

Size: 3,57,719 m2

LOCATION: Taiwan

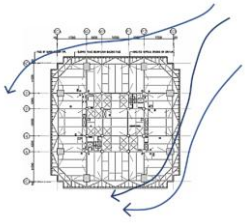
Coordinates: 25°2′1″N 121°33′54″E

Here a typhoon with 100 year return period brings winds of 43.3 m/sec (97 mph) averaged over 10 minutes at a height of 10 m (33 ft). This is similar to a three-second gust of 67 m/sec (150 mph).

Source: google earth

TERRAIN: COASTAL

PREVAILING WIND DIRECTION: North East to South West



Source: http://ctbuh.org/papers

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TOWER FORM: The W-shaped corners minimises the wind load on the structure. Building Vertical Shaping: The repeating modules were inspired by the joints of indigenous bamboo and the tiers of pagodas; each module has a narrower base and a wider top as if a flower opening to the sky. Each module has eight floors, and eight modules form the majority of the tower's height. In the Chinese spoken in Taiwan, 'eight' is a homonym with 'wealth,' making it a very appropriate feature for a financial center. A ninth module that tops the main shaft and supports an architectural spire has a smaller footprint but matching wall slopes. Below the repetitive flared modules, a 25 story base shaped as a truncated pyramid provides improved overturning resistance and lateral stiffness (Figure 8).

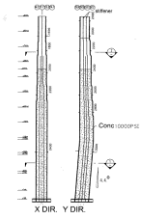


Figure 8 Source: http://ctbuh.org/papers

Plan Shaping for Wind: The challenge was a high wind environment. Tall, slender chimneys and skyscrapers experience alternating crosswind forces due to vortex shedding: wind passing the object separates from side faces in alternating whirlpools. When vortex formation set by wind speed and building dimensions coincides with building period, large forces can result. It can excite a skyscraper with crosswind forces much greater than those normally used for design. During a wind tunnel visit by C.Y. and the authors, RWDI demonstrated that a square tower with sharp corners creates large crosswind excitation. Rounded and chamfered (45o) corners reduced lateral response, but a 'saw tooth' or 'double notch' corner with 2.5 m (8.2 ft) notches achieved a dramatic reduction. See Figure 9. Architect Lee understood the significance of this shape and incorporated it into the upper module corners from that point on. See Figure 10.

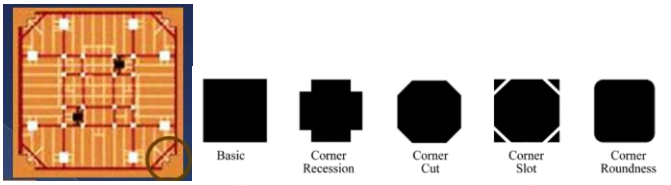


Figure 9 Corner Modification Source: The Role Of Aerodynamic Modifications In The Form Of Tall Buildings Against Wind Excitation (H. Emre Ilgin And M. Halis Günel)

a) b)

Figure 10 a) The Taipei 101 profile shows a truncated pyramidal base topped by eight, 8-story flaring building modules, a narrower equipment/observation deck module and a steel-spined spire. b) A close-up of the tower corner clearly shows the 'sawtooth' treatment above Floor 25 for wind vortex reduction. Source: http://ctbuh.org/papers

Book Case study 3 : The Gherkin, London

Architects: Foster and Partners

Facility: Commercial Skyscraper

Features: 180 m, Circular Plan with Bullet shaped elevation

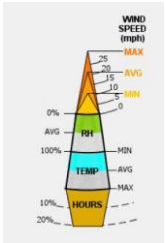
Size: 47,950 m2

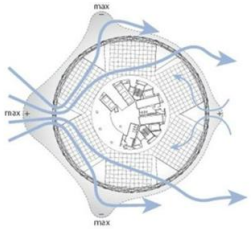
LOCATION:

Coordinates: 51°30′52″N 00°04′49″W

TERRAIN: Plain rough terrain

PREVAILING WIND DIRECTION:





Source: Foster + Partners

TOWER FORM: The overall cylindrical shape allows for the wind to move around the building. It breaks the hierarchy of solid rectangular boxes in the vicinity. Offers minimal resistance to wind, improving the environment for people on the ground and reducing the load on the building. The slim base reduces the reflections and increases daylight penetration. The bullet shaped building responds to specific demands of small site area. The design provides column free floor space, light, views, and incorporates many sustainable building design features. Atria between the radiating fingers of each floor link together vertically to form a series of informal break out spaces. These loads are all absorbed through the glass façade and eventually transferred to the diagrid. The pressurized air from the wind passes into the building through a natural ventilation system, which is incorporated through a double skin. There are open shafts built in between each floor that act as ventilation for the building and they require no energy for use. The shafts pull warm air out of the building during the summer and use

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passive heat from the sun to bring heat into the building during the winter. These open shafts also allow available sunlight to penetrate deep into the building to cut down on light costs. It has been said that 30 St. Mary Axe uses only half of the energy that a similarly-sized tower would use.

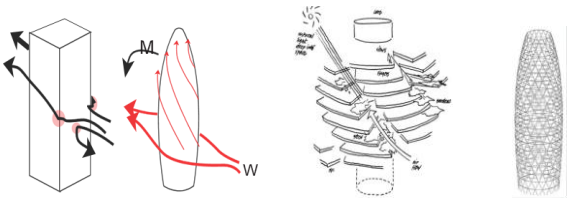


Figure 11 Wind interaction with form Source: Foster + Partners

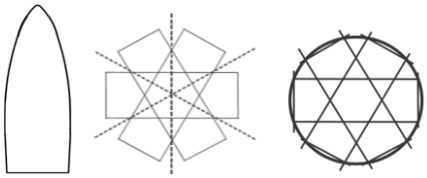


Figure 12 Massing, symmetry and geometry Source: Foster + Partners

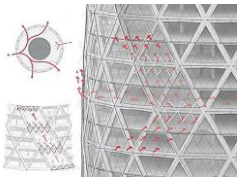


Figure 13 Wind flow lines trail the spiralling grooves around the aerofoil geometry Source: Foster + Partners

ANALYSIS OF CASE STUDIES

From the above three case studies it is for said that the design of a geometrical form requisite wind dynamics. A flow line will always be associated with the major or minor modifications in the shape, may be in the plan form or in the section form. Understanding the parameters like Location. Terrain, Prevailing wind conditions and the Tower form (in plan and in section) are necessary to gain a few ideas while planning or designing a skyscraper. Different locations have different effect of winds on the built form.

DATA COLLECTION AND ANALYSIS

In case of the Indian sub-continent, considering the Mumbai region, which has an ever increasing potential for construction of skyscrapers, the following analysis has been done. The wind-rose diagram of Mumbai given below shows the wind direction to be from South-West to North-East.

Figure 14 Wind Rose Diagram of Mumbai

Basic Wind Speed of Mumbai = 39m/s

In table 1 given below, the graphs showing the relationship between the wind pressure and height have been calculated by the formula,

Vz = Vb x K1 x K2 x K3 x K4

Where,

Vz = Design wind speed at height z

Vb = Basic wind speed (Mumbai)

K1 = Probability Factor (risk coefficient)

K2 = Terrain Roughness and Height Factor

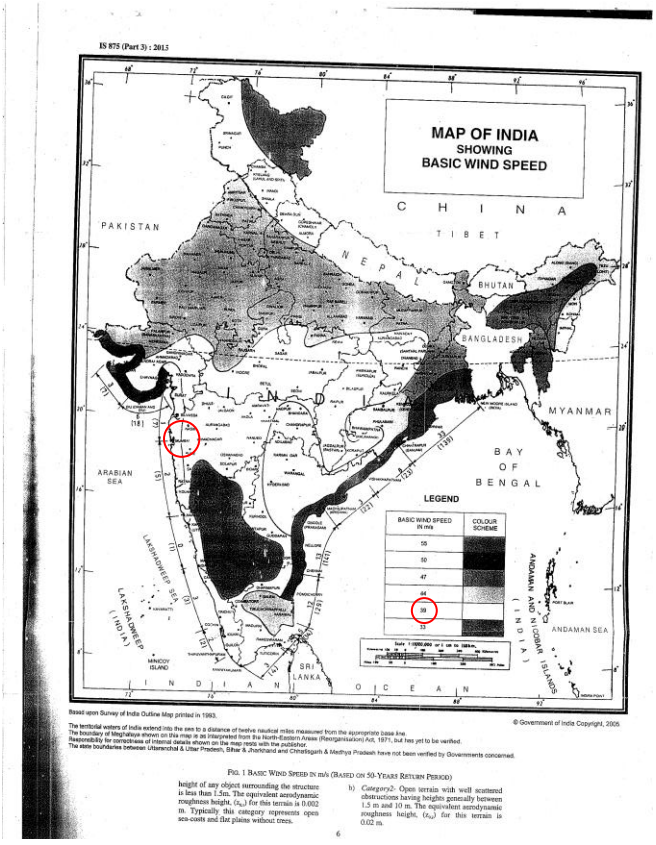
K3 = Topography factor

K4 = Importance factor for the cyclonic region

Wind Pressure

Pz = 0.6 Vz^2

IMPLEMENTATION OF STANDARDS (NBC/DC)



Source: Design Loads (Other than Earthquake) for buildings and structures- code of practice

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6.3 Design Wind Speed (V_z)

The basic wind speed (V_b) for any site shall be obtained from Fig. 1 and shall be modified to include the following effects to get design wind speed, V_z at any height z, for the chosen structure:

a) Risk level,
b) Terrain roughness and height of structure,
c) Local topography, and
d) Importance factor for the cyclonic region.

It can be mathematically expressed as follows:

$$V_z = V_b k_1 k_2 k_3 k_4$$

where

V_z = design wind speed at height z, in m/s;
k_1 = probability factor (risk coefficient) (*see* 6.3.1);
k_2 = terrain roughness and height factor (*see* 6.3.2);
k_3 = topography factor (*see* 6.3.3); and
k_4 = importance factor for the cyclonic region (*see* 6.3.4).

This is the criterion for measurement of regional basic wind speeds and represents airfields, open park lands and undeveloped sparsely built-up outskirts of towns and suburbs. Open land adjacent to sea coast may also be classified as Category 2 due to roughness of large sea waves at high winds.

c) *Category 3* — Terrain with numerous closely spaced obstructions having the size of buildings/structures up to 10 m in height with or without a few isolated tall structures. The equivalent aerodynamic roughness height, ($z_{0.3}$) for this terrain is 0.2 m.

This category represents well wooded areas, and shrubs, towns and industrial areas full or partially developed.

It is likely that the, next higher category than this will not exist in most design situations

Table 1 Risk Coefficients for Different Classes of Structures in Different Wind Speed Zones
(*Clause* 6.3.1)

SI No.	Class of Structure	Mean Probable Design Life of Structure in Years	k_1 Factor for Basic Wind Speed m/s					
			33	39	44	47	50	55
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	All general buildings and structures	50	1.0	1.0	1.0	1.0	1.0	1.0
ii)	Temporary sheds, structures such as those used during construction operations (for example, formwork and false work), structures during construction stages and boundary walls	5	0.82	0.76	0.73	0.71	0.70	0.67
iii)	Buildings and structures presenting a low degree of hazard to life and property in the event of failure, such as isolated towers in wooded areas, farm buildings other than residential buildings	25	0.94	0.92	0.91	0.90	0.90	0.89
iv)	Important buildings and structures such as hospitals communication buildings/towers, power plant structures	100	1.05	1.06	1.07	1.07	1.08	1.08

Source: Design Loads (Other than Earthquake) for buildings and structures- code of practice

6.3.3 *Topography (k_3 Factor)*

The basic wind speed V_b given in Fig. 1 takes into account the general level of site above sea level. This does not allow for local topographic features such as hills, valleys, cliffs, escarpments, or ridges which can significantly affect wind speed in their vicinity. The effect of topography is to accelerate wind near the summits of hills or crests of cliffs, escarpments or ridges and decelerate the wind in valleys or near the foot of cliffs, steep escarpments, or ridges.

6.3.3.1 The effect of topography shall be significant at a site when the upwind slope (θ) is more than about 3°, and below that, the value of k_3 may be taken to be equal to 1.0. The value of k_3 is confined in the range of 1.0 to 1.36 for slopes more than 3°. A method of evaluating the value of k_3 for values more than 1.0 is given in Annex C. It may be noted that the value of k_3 varies with height above ground level, at a maximum near the ground, and reducing to 1.0 at higher levels.

Table 2 gives multiplying factors (k_2) by which the basic wind speed given in Fig. 1 shall be multiplied to obtain the wind speed at different heights, in each terrain category.

Table 2 Factors to Obtain Design Wind Speed Variation with Height in Different Terrains
(*Clause* 6.3.2.2)

SI No.	Height z	Terrain and Height Multiplier (k_2)			
	m	Terrain Category 1	Terrain Category 2	Terrain Category 3	Terrain Category 4
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	1.05	1.00	0.91	0.80
ii)	15	1.09	1.05	0.97	0.80
iii)	20	1.12	1.07	1.01	0.80
iv)	30	1.15	1.12	1.06	0.97
v)	50	1.20	1.17	1.12	1.10
vi)	100	1.26	1.24	1.20	1.20
vii)	150	1.30	1.28	1.24	1.24
viii)	200	1.32	1.30	1.27	1.27
ix)	250	1.34	1.32	1.29	1.28
x)	300	1.35	1.34	1.31	1.30
xi)	350	1.35	1.35	1.32	1.31
xii)	400	1.35	1.35	1.34	1.32
xiii)	450	1.35	1.35	1.35	1.33
xiv)	500	1.35	1.35	1.35	1.34

NOTE — For intermediate values of height z in a given terrain category, use linear interpolation.

6.3.2.3 *Terrain categories in relation to the direction of wind*

The terrain category used in the design of a structure may vary depending on the direction of wind under consideration. Where sufficient meteorological information is available, the basic wind speed may be varied for specific wind direction.

6.3.2.4 *Changes in terrain categories*

The velocity profile for a given terrain category does not develop to full height immediately with the commencement of that terrain category but develop

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Source: Design Loads (Other than Earthquake) for buildings and structures- code of practice

The Wind flow lines for the five buildings have been derived from the observations through virtual wind tunnel test by simulation.

3.2.1 Live Case study 1

IMPERIAL TOWERS

Architects: Hafeez Contractor

Facility: Residential Skyscraper

Floor count: 2 x 60

3.2.2 Live Case study 2

PALAIS ROYALE

Architects: Talati Panthaky Associates

Facility: Residential Skyscraper

Floor Count: 88 floors

3.2.3 Live Case study 3

NAMASTE TOWER

Architects: WS Atkins Plc

Facility: Mixed-Use Skyscraper

Floor Count: 63 floors

3.2.4 Live Case study 4

PLANET GODREJ

COMPARATIVE ANALYSIS OF CASE STUDIES

Table 1 Comparative analysis studying various parameters for design

Architects: DP Architects

Facility: Residential Skyscraper

Floor Count: 51 floors

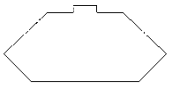
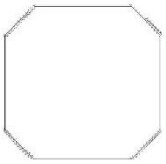
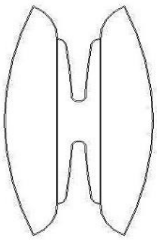
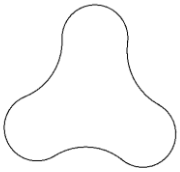
3.2.5 Live Case study 5

WORLD ONE

Architects: Pei Cobb Freed & Partners

Facility: Residential Skyscraper

Floor Count: 117 floors

PARAMET-ERS	IMPERIAL TOWERS	PALAIS ROYALE	NAMASTE TOWER	PLANET GODREJ	WORLD ONE
Geometric Form in Plan	 A squeezed hexagonal shaped plan.	 An octagonal shaped plan with 4 diagonal sides shorter than the rest 4. Also has a balanced geometry.	 An organic form, consisting of two concave surfaces at a short distance acting like capillary.	A slight curve which is concave in nature but is an open form.	 An organic form, developing from a basic triangle, spreads in 3 different directions acute to each other.

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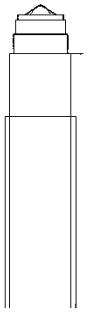
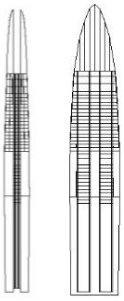
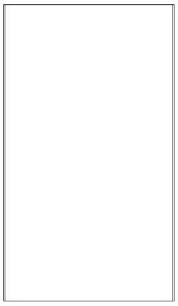
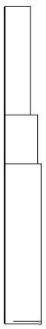
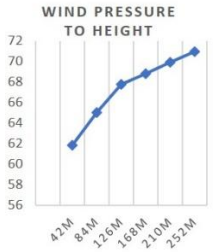
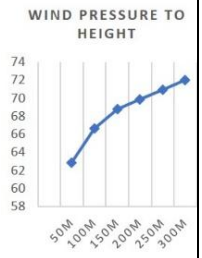
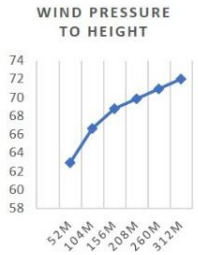
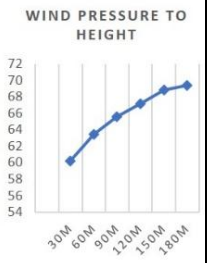
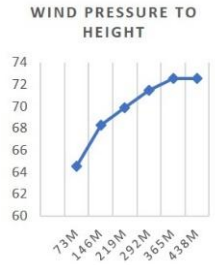
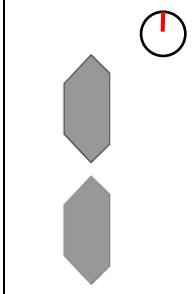
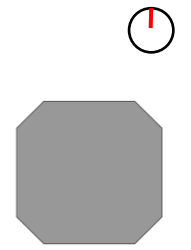
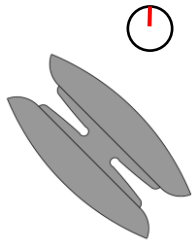
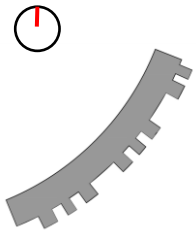
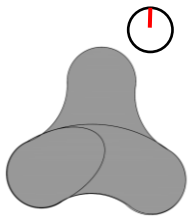
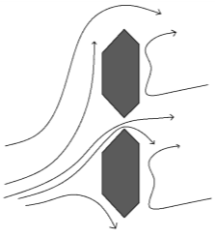
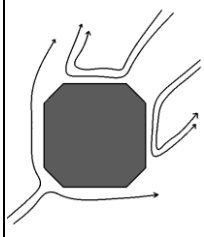
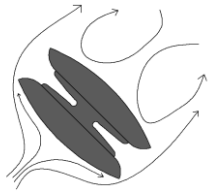
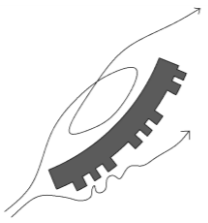
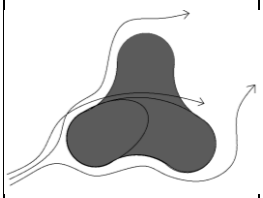
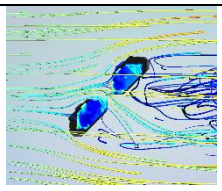
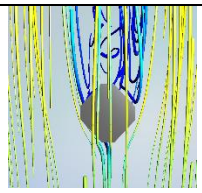
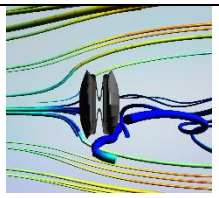
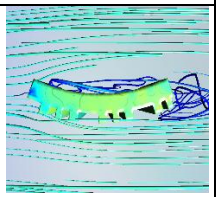
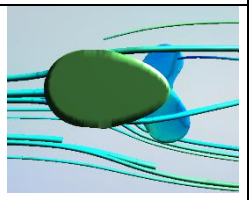
Geometric Form in Section					
	Observed setbacks in section. Reducing nature as we move upwards in height.	A regular rectangular shape in section with no setbacks or tapering towards top. Is slender in section.	An aerofoil shape. Width of a floor first increases slightly then descreases gradually towards the top.	Rectangular in section.	Rectangular section in a plane having setbacks.
Total height	254 M (833 ft.)	320M (965 ft.)	316 M (1037 ft.)	181 M (594 ft.)	442 M (1450 ft.)
Wind pressure at various heights					
Orientation					
Effect of Wind Dynamics					
Simulation Plan					

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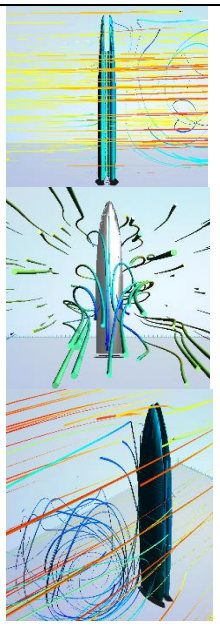
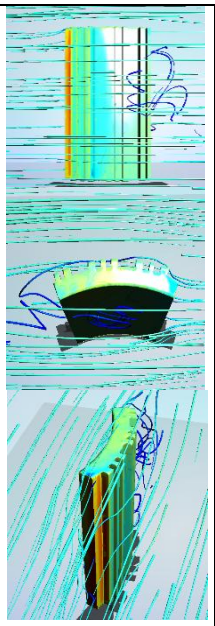
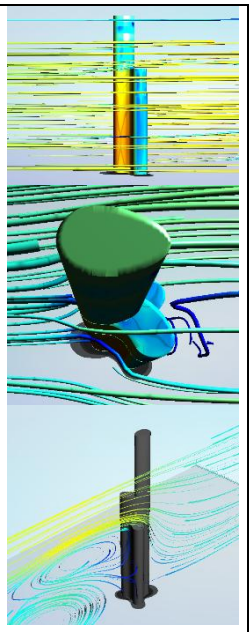
Elevation View					

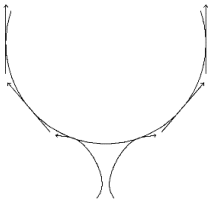


Figure 15 Tangential Flow Lines

CONCLUSION

With these examples already in place it is believed that Architecture is not limited to designing spaces but go hand in hand with different fields of engineering. The 'tapering' effect is utilized by creating smaller surface areas at higher levels and reducing the upper level plans, and thus mitigating the wind load. The more sculptured a building's top, the better it can minimize the along wind and across wind responses. While reducing the plan areas at the upper level by 'varying the shape' of the building along its height, minimizes the wind forces by causing the wind to behave differently, preventing it from becoming organized, as in case of the Burj Dubai Tower. Aerodynamically favorable forms are preferred. Some modifications on cross-sectional shape such as slotted, chamfered rounded corners, and corner cuts on a rectangular building, can have significant effects on both along wind and across wind responses of the building to wind, as in Taipei 101.

A curved shape of the building in plan, when the approaching wind direction is towards the concave side of the building, will give a thrust which is tangent to the surface and hence comes in less contact with it allowing the flow lines to deviate. Material of the façade also plays an important role in such cases.

Through the graphs in the table given above it is inferred that the height to wind pressure relationship forms a parabolic curve i.e. as the height of the building increases the wind pressure increases but with a decreasing rate. It is known that, Pressure = Force/Area which implies, pressure is inversely proportional to area. Therefore, it can be said that along with the decrease in plan area of a building for greater heights, a reduction in the height of each floor as when moving upwards gradually, the overall surface area in contact with the wind pressure will decrease hence, reducing wind loads.

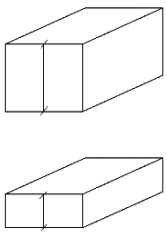


Figure 16 Height reductions

Every building mass under the influence of wind shows high wind pressure surface at the leeward side and a low wind pressure surface at the windward side in the simulation. Reduction in the area or nulling it out at the leeward surface, can cut down on the higher wind loads.

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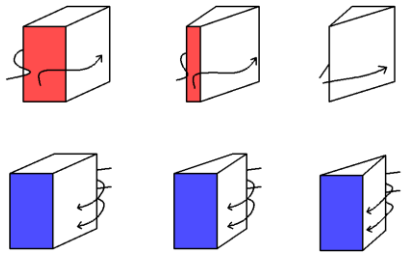

Figure 17 Reduction in negative wind pressure

A hexagonal shaped plan has the least workability towards wind dynamics which can be observed through the case of Palais Royale. Also, in case of Imperial Towers two buildings placed at a short distance from one another create a narrow passage for the wind to pass in between them, thereby increasing the velocity of the wind at critical junctions.

In case of Planet Godrej, a loop formation is observed at the inner side of the concave surface. We know, as the acceleration of a particle increases, the radius in which it moves increases hence, for smaller acceleration, radius needs to be small. Minimalization of the radius can be achieved by increasing the concavity of the form. The grooves or offsets are positive assets of wind resistance. They trap the wind flow and deviate them in the required direction. A triangle and a curve respond to wind optimally. The geometric form of the World One tower is significant which combines both.

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude from the bottom of my heart to my guide Prof. Shreyas Paranjape for his valuable guidance, inspiration and encouragement. His keen and indefatigable indulgence in this work helped me to reach an irreproachable destination.

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Role of Courtyard as a Model for Micro Climate Modifier in Hot and Dry Climate

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Abstract : Factors like global warming, pollution and consumption of fossil energy have encouraged the need of sustainable development. Increasing rate of global warming, led to the increase in demand for passive cooling techniques. Courtyard is the one of the most significant feature used in buildings for passive cooling. Courtyard being originated from hot and dry region plays a very important role in maintaining the thermal comfort and microclimate of the building. It is an open space surrounded by cluster of rooms. This paper attempts to explain literature study of the role of courtyard in maintaining the micro climate of a structure in hot and dry region. The main objective of the research is to understand the effects of courtyard geometry on the changing nature of the micro climate of a building in hot and dry region. Further can also be established guidelines for efficient courtyard design in different types of buildings.

*Keywords:***Courtyard, micro climate, orientation, geometry, passive cooling technique, thermal comfort, hot and dry region.**

1. INTRODUCTION

Due to the increase in debates on climate change and sustainability in different regions, sustainable and green building constructions have been on the rise. Building design forms must not ignore atmosphere contemplations. An elective way to deal with the manner in which the buildings are designed is expected to enhance the environmental performance of buildings and limit their expense of running it, which could incorporate power and water utilization.

Courtyard is a universal design element which has been tried for several times of years all around the world.The use of courtyard as an integrated means of architecture in different building around the world has been dated back to centuries ago.Courtyardis a building element that is originated from the hot and dry region. It is basically an enclosed area surrounded by a building or walls and opens to the sky [fig.01].

Figure 01: Basic courtyard sketch

Courtyards are common architectural patterns throughout many periods of history and in many regions. They are referred as a micro climate modifier, which may improve thermal comfort conditions in the enclosed as well as the attached built volume. It is an architectural design element commonly applied in tropical buildings for its social, environmental and therapeutic potentials.It is influenced by social, economic, cultural and environmental conditions.Most households have employed the courtyard for different purposes and activities. The courtyard serves as a means to provide natural light, cool air, privacy as well as security to the surrounding spaces within the building.The courtyard system comes in different shapes and sizes depend on the size of the building and the region. It could be square shape, I-shape, rectangular shape, circular shape or amorphous etc. Courtyards as the open spaces of houses play the most critical and effective role in absorbing solar energy, so controlling sunshade -due to thermal comfort necessity- is really important in architectural system of buildings.Proportions, placement directions, materials and courtyard form play the major role indetermining the solar energy amount on various surfaces of courtyard and providing visual and thermal comfort for residents.The courtyard building has been recognized as the representative building of the hot dry regions and a valuable answer to harsh climate. Solar radiation, as one of the most influential parameters of the hot and dry climate, can have an influence on the design.

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1.1 HOT AND DRY CLIMATE

Hot and dry climates are typically found between 15° and 35° north and south of the equator. In these locations, stable descending air and high pressure aloft create hot, arid, conditions with intense sunshine. Hot and dry climates are generally hot, sunny and dry year-round. Maximum daytime summer temperature goes as high as 45 degree centigrade and relative humidity as low up to 20 %.In this region, the wind is usually local. Whirlwinds, especially in the afternoons are associated with sand and dust. Sand and dust is another reason for employing courtyard building form in such areas; because it protects the courtyard building from whirlwinds.

2. METHODOLOGY

The conduct of the research paper is employed on the basis of two methodologies:

1) Unobtrusive: It includes library study on the concept of sustainable architecture, hot and dry climate and courtyards as passive cooling techniques, type of courtyard.

2) Literature case study: Three different buildings of hot and dry climate zones of world are selected for the case study. This study is carried out to identify the effects of orientation, proportion and geometry in each case. Selection process of cases was based on the following criteria:

a) Climate selection: The study was carried out for hot and dry climate zoneswhere there is largely unbroken sunshine for the whole year due to the stable descending air and high pressure aloft.

b) City selection: Two cities namely Rajasthan (India) and Negev (Israel) are selected from the hot desert climate regions. These regions witnesses strong whirlwinds with sand and dust.

Finally, all descriptive study both literature and library are integrated to propose a physical-environmental design model for courtyards, as a passive cooling strategy for future sustainable buildings in hot and dry climate. The model will be beneficial in the designing of different type of building in the similar climatic condition.

3. LITERATURE REVIEW

The literature study reviews the basic functions of courtyard and the sources of heat gain into the building.

3.1 SOURCES OF HEAT GAIN

Major heat input is subjected to the occupant's metabolic activity and from the use of artificial lighting and other appliances resulting in internal heat gain. The heat gain is also depends on building type. Solar radiation is another major source of heat gain. The incidence of solar radiation [fig.03] on external surface varies with time, location and site condition; however, its effect indoors strongly depends on the building design, orientation and the way spaces are used in the building. The courtyard geometry is related to the solar path and since the sun is the main source of heat and the solar radiation, being dependent on the altitude and latitude it is important to study. The basis of climate responsive design is to make use of such energies to maintain the thermal comfort inside the building, when the outdoor temperature is out of comfort level.

3.2 COURTYARD FUNCTIONS

Courtyard is the traditional pattern in hot and dry zones, where most of the openings face a well dimensioned interior open courtyard. This type not only allows protection against the sun but also privacy and protection against dusty winds and sandstorms.Literature study on courtyard in hot and dry climate suggests the various types of evaluation which proves that the orientation [fig.02] and the proportion are the two important factors for the change in the micro climate, as the orientation and proportion are directly or indirectly related to the heat gain and solar radiation of the building.A courtyard does not have a fixed plan. Usually they are rectangular or square, it can also be circular or curvilinear. In addition, the design form of courtyard can be fully enclosed (four sided), semienclosed (three sided) or in some cases even two sided.The design form of the courtyard plays a vital role as microclimate modifier to the environment.

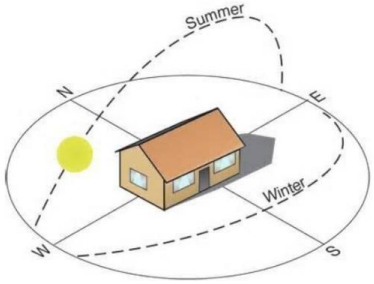

Figure 02: Orientation of the building according to sun path.

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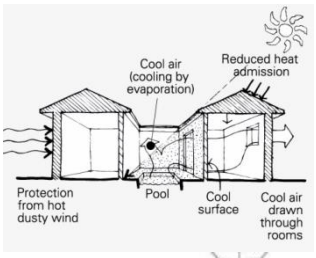
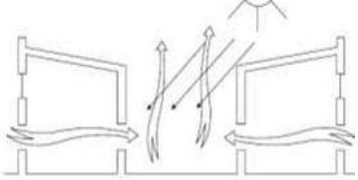


Figure 03: Working of Courtyard.



4. CASESTUDY

4.1 COURTYARD HOUSE BY AR. SANJAY PURI, RAJASTHAN, INDIA.

The design of the courtyard house is in correspondence to the hot and dry climate of the Rajasthan where strong dust winds and sandstorms are common. There are series of courtyard [fig.05] in the house but two of them are main courtyard [fig.04]. The two courts are linked by open corridors.

Figure 04: Site plan with one of the recessed space shading that area.

Sanjay Puri has said **"The layout of the Courtyard House is similar to the traditional "bhunga" houses of the Rajasthan villages where each room is an entity by itself."**All the functional spaces are radiating from the courtyard. The breaks are recessed which create shadow effect and cool down the living spaces in summers. The courtyards are oriented towards the north south direction so as to reduce the solar radiations on the elongated surfaces [fig.04]. These two main courtyards are completely enclosed on all four sides but the other small courtyards are semi enclosed, orienting towards the north direction and are highly recessed. These recessed spaces make houses much cooler inside than the outdoor environment [fig.06].

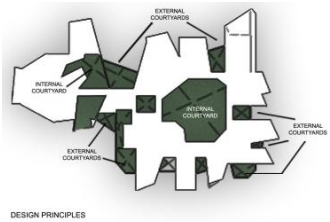


Figure 05: Placement ofcourtyards in the building

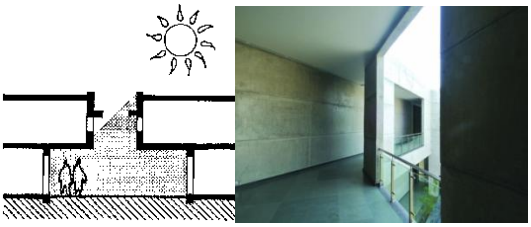


Figure 06: Effect of recessed corridors connecting different courtyards.

4.2 THE SEDE BOQER CAMPUS, NEGEV, ISRAEL.

This study took place at the Sede Boqer Campus, situated on the highlands (30.8^{o}N latitude, 500m altitude) the environmental conditions of the area includes frequent dust and sand storms, intense solar radiation and a very hot and dry wind blowing from neighboring deserts, usually carrying large quantities of dust, which result in the conditions above or below the comfort zone. Prevailing wind directions range from north to northwest.

Two courtyards that are chosen for the study are the part of complex of dormitories of the campus. They are intended to provide a comfortable open space for the occupants. The courtyards measure 5.5m x 21m in plan and are enclosed on three sides by continuous connected building whose height alternates between 2.6m to 3.1m. The open sides of the two courtyards are oriented towards different directions: one faces due south while the other faces west [fig.07].

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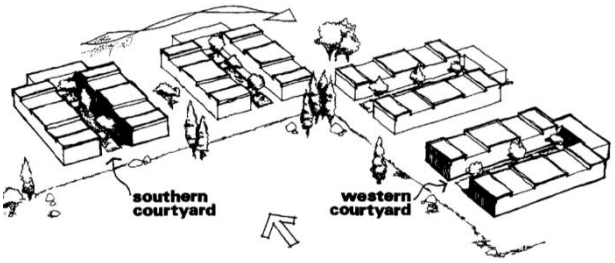

Figure 07: Lavout of the courtvards

The temperature in the courtyards is monitor during the hot periods of the season. The data summarized below are based on the measurement periods. In the afternoon hours the temperature recorded in the west facing courtyard is higher by 2-4^{o} C than the south facing courtyard. The variation in the thermal behavior observed in the two courtyards may be clearly related to the effects of geometry: the difference in orientation creates a certain lack of symmetry in relation to both solar exposure of the courtyards during the day and wind exposure throughout day and night.This greater contribution of direct solar radiation appears to be a significant factor in the accelerated heating of the west courtyard.The lack of shading [fig.08] is in itself a significant factor in determining thermal comfort, due to the increased exposure of inhabitants to direct sun. During the afternoon time strong winds were observed from the west-northwest. These winds caused accelerated exhaust of the hot air which was enclave in the western courtyard, but did not affect the southern one. Thus the attenuation of wind flow in the narrow direction of the courtyard is clearlyobserved.

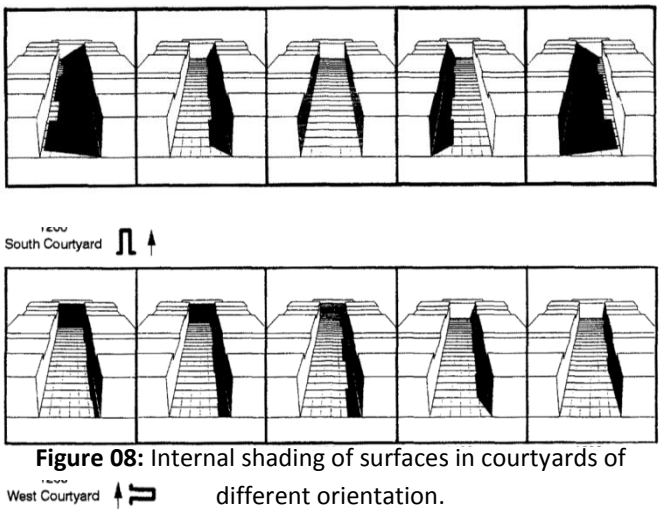

Figure 08: Internal shading of surfaces in courtyards of different orientation.

5. ANALYSIS

The case studies carried out in different areas of the world with different types of building tells that the in both the cases the microclimate is affected by the orientation of the courtyards. In the courtyard house of the Rajasthan the geometry of the courtyards are unusual than the other forms like square or rectangle which are so designed that the connecting passages between the courtyards are recessed which allows the creation of shadow inside the building resulting in the decrease in the temperature. On the other hand in the case of Sede Boqer campus the geometry of the two semi-enclosed spaces influence their thermal behavior to a decisive extent. The difference in the indoor and outdoor temperature of the building is observed to be very less. The creation of microclimatic conditions poorer than those outside the attached courtyard may prove to be of negative influence on the thermal behavior of the enclosing built volume. From the above case studies it is observed that the type of the courtyard is also an important factor along with the orientation and geometry of the courtyard.

5.1 MICROCLIMATE MODIFIER

Above case studies help in knowing the role of courtyards as micro climate modifier. Courtyards are useful in maintaining the thermal comfort inside the building only when the building is designed keeping in mind the orientation, type and geometry of the courtyard. It reduces the temperature by 3-4^{o}C inside the building in summer. In this way it helps in maintaining the microclimate of the building.

6. CONCLUSION

This paper describes a research effort that contributes towards understanding the characters of courtyard designs. The amount of solar rays received on the courtyard building surfaces has a great influence on the produced heat in courtyard buildings.Courtyard in buildings have almost the same design criteria in all the climatic zones but the appropriate form, dimensions and proportions are dependent on the climatic characteristics of each zone. Air movement and day lighting performances in the courtyard buildings are dependent on its design variants such as; form, size, area, orientation, shading devices, vegetation etc. All these factors contribute to the courtyard's role in maintaining the microclimate of the building.

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Understanding Change and Continuity in House Form: A Case of Sirohi

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Abstract: The interplay of culture–climate and architecture has been a theme most widely accepted and researched by scholars time and again. Rajasthan, for its rich architectural heritage owing to its culture and tradition, in a particularly hot and dry climate has been most appropriate to examine this relationship. However, despite having rich architectural heritage Sirohi has remained quite unknown hence this paper tries to fill this gap by the study of houseform at Sirohi. The Study aims to comprehend the influence of cultural aspects, layers of change and continuity,on the architecture of this town.The Scope of the paper has been limited to three houses of a community.

Keywords: Architecture of hot and dry climate, settlements of Sirohi, change and continuity, house, culture, organization.

INTRODUCTION

The built form in traditional architecture is a product of culture, social beliefs, time, material and climate contributing to a sense of rootedness. The traditional architecture reflects this very concept across all scales i.e. - house, cluster, and city. A city at any time period is in a stage where something happens continuously. It can be seen as a manifestation of these layers at any period of time. Thus in the continual process of time, the city can be understood by examining the factors which lead to continuity and change.Traditional houses, those which are specific to a region and culture, and built with local ingenuity, criticallyprovide a sense of belonging and cultural identity. The house is a microcosm that satisfies not only our biological but also our "social and spiritual needs" (Jackson1952).

Hot and arid climate, along with the cultural patterns of Rajasthan has generated a particular kind of builtform in this region. The buildings are introverted and the courtyard is the most central space of the house and holds the surrounding spaces it is like a nucleus towardswhich all other things gravitate; its strength lies in its capacity to provide protection against climate.Though the larger *Havelis* have more ground area the scale of the courtyard is magnificently maintained. Rajasthan has remained famous for its rich architectural heritage reflecting its culture and tradition in, particularly hot and dry climates. Various cities of Rajasthan like Jaipur, Jodhpur, Jaisalmer, Udaipur, etc. have been studied. Sirohi despite having very traditional architecture it has not got due attention by the scholars.

House form and lifestyle of settlements in Rajasthan and India are undergoing a transition from traditional to modern. In recent timesSirohi has started expanding its old territory with new approaches. Also in the old part of town, many of the houses started to demolish to reconstruct. The present article focuses on the observed changes in architecture, typology of house-form and lifestyle, with a case of Sirohi. It brings together the multiple layers which are interlinked and part of community life; these layers can be identified as cultural beliefs, privacy, and status of women. These social systems are far more important than any physical restraint and have the greatest differentiating effect on the form of vernacular housing (Rapoport 1969). Thus Sirohi is the most pertinent case to study its traditional house form and identify the factors of continuity and change from the earliest to the present context.

AIM

The research aims to examine the factors of the formation of a house from the earliest point to the present, identify the continuing and changing factors with understanding the influence of change.

OBJECTIVES

- To document the traditional architecture of Sirohi.
- To analyse the organization of houses and understand the traditional pattern of house form in relation to habitants.
- To identify the tangible and intangible factors that sustain, modify and change house form.

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METHODOLOGY

The research has relied on primary and secondary sources for data collection and understanding of the different phenomenon. The initial research consists of library research from books, articles, thesis for understanding the aspect of culture and to know the history of Sirohi, Rajasthan. As a means to collect the data of the city, many historians, scholars and writers in the area were interviewed. The second stage is of documenting the chosen case studies which include measure draw, photo documentation, and informal interviews. The third stage includes the analysis of case studies to identify the factors in the formation of house form, examine the continuing, changing factors and influence of change.

CRITERIA FOR SELECTION OF CASE STUDIES

Sirohi town grown over 500 years has a much wider range of house forms, selection of case studies is based on-

- The age of house form to be from oldest to the newest.
- The location of house form in the settlement to be from closest to the palace to the gate of the town.
- House form to be from different communities to understand the organization and relation of community to house form and being of the same typological type.

SIROHI – History and It's Organisation

Sirohi, situated under Sirnava range was established in 1405 AD by Deora dynastythatbelonged to the Chauhan Rajputs. Name Sirohi comes from being situated under the Sirnava range. Thetown was located at the centre of the hill but due to the water stream coming from hill, the location of the town changed to the western edge of the hill in 1425 AD by Maharaja Sesmal which is the present town of Sirohi. Town shares boundary with Marwad in north and west, Palanpur in south and Mewad in East.The palace of town is situated on the topmost part on thenorthern part of thehill which is visible from a far distance. The oldest part of the Palace was built by Maharaja Akharaj. The present palace is the addition in the oldest part which was made in different time periods by successors of the Royal family. Close to the palace is a cluster of Jain temples known as Derasari which was made in 1577AD.

Town has two gates one at the north edge of town and others in the south. There are two primary roads, one starting from south gate to north gate and other bisects this from centre which connects to palace known as Palace road. These two primary roads are branched by secondary roads which further goes to tertiary. On the primary road from North gate till the Palace road is the main market which accommodates all the occupation of different communities residing in the town.The settlement is a mix of many indigenous communities that have evolved over a period of time. House form and its settlement pattern of each community have similarities and distinctions which can be seen clearly. At all the stages of growing social and cultural factors have been the primary forces of influence Castes residing in the town are Brahmin, Rajput, Jain, Mahajan, Charan, Mali, Darji, Sonar, Luhar, Suthar, Kumbhar, Nai, Dhobi, Gosai, Rabari and many more. All individual secondary and tertiary streets are of these different castes.

TRADITIONAL ARCHITECTURE OF SIROHI

The traditional architecture of any place is reflected in its physical and cultural aspects, the factors of Sirohi in the formation of house form are as follows.

- Culture–Sirohi being a mix of many indigenous communities all of them follow the same pattern of belief on a larger scale with the addition of religious belief at each community level.Men are responsible for earning while women are associated with household activities. Each family being in 3 parts parent, children, and grandchildren interaction within the family with each other is much free and normal except the wife of the son, who can't talk to father of son directly and also interaction is very little. Females of the house usually use to cover their faces by sari when there is any male elder to them or any guest in the house. All the community holds a great belief and respect for God and Grain.
- Climate – Sirohi lies at 308m above sea level. The climate here is considered to be a steppe climate. Steppe is a dry, grassy plain. Regions have distinct seasonal temperature changes, with cold winters and warm summer.
- Material – The locally available materials in Sirohi are Stone, Wood and Achakal bricks which are locally made.

ORGANIZATION OF THE HOUSE

Spatial distribution at First Floor Level

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Spatial distribution at Ground Floor Level

0	Phela_ entrance
1	Por_ living room
A	Washroom
2	Haar_ chokdi- washing area, staircase, passage
B	Rasoighar_ kitchen
3	Aori for women_ room
4	MandirAori , Patar
C	AnajAori_ storeroom for grains
5	Chowk_ terrace
6	Aori_ bedroom
D	Kateri_ balcony

The traditional houses are essentially two storied – ground and first floor. The ground is organized with functional spaces divided into 4 parts and above has flexible, multipurpose activity spaces. All the houses have one entrance from the street and are linear in form.Staring with a sequence of the house from the ground.

Phela – The entrance of the house is the connection between house and street. It has raised a platform and staircase to enter the house. The raised platform is used by habitants and the outsiders for interaction with other houses nearby

Por – The first room in the house also called as bethak room is used by men of the house. Elder man of the house uses this space to sleep at night. Guests who come to a home, men are accommodated primarily in this space.

Har – The second part of the house after por is a transition space between men and women spaces of the house. Har word comes from local term heri which means street. This space has thethe service areas like kitchen, washing area, Paniara- drinking water, staircase. The space also has a cut in the slab it generally acts as a courtyard but the size of opening being small it seems to be a cut in the slab.

Rasoighar – Kitchen which is in the second part in the har is a small space with niches in the wall for storage. It has a small cut in the slab which allows smoke to pass out.

Aori for women – The third part of the house is a room that is used by women primarily. It has also had a cut in slab smaller than the one in Har. As it is being deep in the linear house this cut is made for light. This is the maximum used space on the ground floor.

Mandir and AnajAori – The fourth and last part of the house is for the need and belief of the house and holds a much important place. This space has a Temple and storage for grains. The space is also called patar for having a big box like container that stores a major amount of things that are used on the functions and occasions in the house. The room has no light or any opening for ventilation. As it has the most valuable things in the house it is placed in the deepest partand kept dark.

Washroom – This is placed in the por. All the streets have nala which are drains so washrooms are kept in the fast part which directly connects tothis drain.

Chowk – This is located on the above floor which spreads on the second and third parts of the house. It is the biggest part of the house. It doesn't have any specific function to it but is flexible enough to have any function or activity happen. It is also the most private place in the house visually and physically. Space also connects to lower floor by having two cuts on the floor of Har and Aori. This is the core space of the house.

Aori– Above floor have two Aori which are bedroom on both ends of the chowk. Aori towards the street side has kateri which is balcony which connects visually to the street.

The traditional house form of Sirohi is a pure formation by its cultural factors. The ground floor is more of functional spaces with the segregation of men and women area which is also because of visual street connection to show their culture of the house. The above floor is different from below as it again merges the segregation of men and women. The floor primarily allows the flexible and free interaction of family despite showing their culture. The ground floor is therepresentation of the cultural tradition of settlement whereas above floor is the representation of the family-culture which is identical to them. Traditional culture is visible to all whereas family culture is private and core to the family itself.

CASE STUDY

Tracing the Evolution of Houseform

Three case studies are documented to examine the evolution is house form and identify the continued tradition and changes in it.

House is organized in the same traditional sequence. The ground floor is divided into 4 parts with male area first with transition second third of the female room and fourth as mandir and storage. The first floor has chowk in the centre which is accessed by a staircase. Two rooms are attached on both sides of the chowk. House is compact and short in a linear direction compare to others. Chowk is divided into 2 parts. At present one room is attached above the chowk as per requirement. Except for painting of the house, there are no major changes seen in it.

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House 1: Located at Kothari pol (1910)

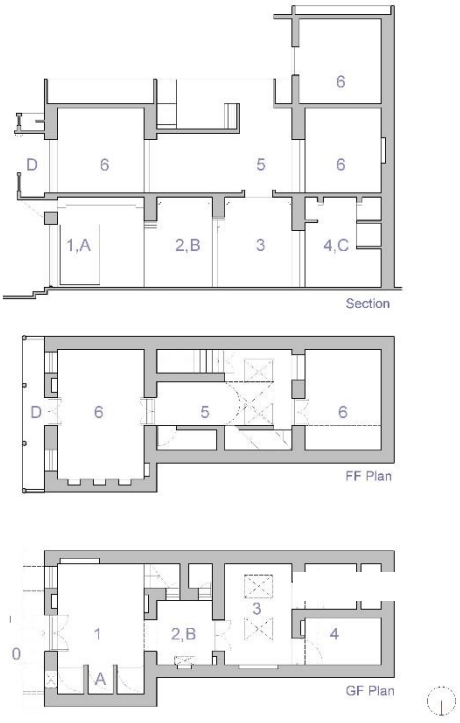

Fig. 1.1

Fig. 1.2

Fig. 1.3

House 2: Located at ChotiBrahmpuri (1975)

Fig. 2.1

House is organized in the same traditional sequence tracing from house 1. The ground floor is divided into 4 parts with male area first with transition second third of the female room and fourth as mandir and storage. The first floor has chowk in thecentre which is accessed by a staircase. Two rooms are attached on both sides of chowk. House is longest in the linear direction compare to others.Chowk is the longest part ofthe house having semi-open space. House is not used by the original owner of the house, is rented to a 'chipa; (tailor) family. House is used in the same cultural tradition by family. House used by tailor family women aori which is third part of the house is accommodated by sewing machine. Women being at homework on machine from 10 am to 6 pm. Men of the house have a shop in the market, who comes back home around 7 pm. The usage of rooms

Fig. 1.2

Fig. 1.3

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according to its cultural way is seen clearly when all the members of house are there. There is no change in the house.

House 2: Located at ChotiBrahmpuri (1975)

Fig. 2.2

Fig. 3.1

House organization is the same according to the tradition in the division of parts on the ground floor, but the functionality of each space has changed.Ground floor divided into 4 parts, 1st has staircase and washrooms and place to remove shoes, 2nd in the living room of the house, 3rd and 4th being majorly same divided with partitions of rooms have a kitchen, storage, mandir, and room. First floor is again divided into 4 parts as in ground floor 1st being same as below as service area having washroom, washing area and drying space for clothes, 2nd is again a type of living room as below attached with a room, 3rd is made with an idea of chowk but is covered with slab and is much similar to room and 4th part is divided into two parts. There are two more rooms made on the third floor. The ground floor is primarily used, the first floor is used by children'

House 3: Located at Sengali Market (2016)

Cultural Changes and House form

The traditional culture of house formation has continued in the same sequence from house1 to house2 where the ground floor is organized with sequential functional spaces and with segregation of men and women and above floor having chowk as a core multipurpose space. Thinking of the family in the settlement was very simple and similar to having an interactive simple life in being with the cultural pattern of the society. To its solution, each house had chowk which was very simple, plain but capable of catering multiple opportunities in it and served to any member of the house. Tracing the sequence from house2 to house3 there are visible changes and continuity in the thinking of society. The ground floor has remained the same in the division of 4 partsbut only in the terms of organization. Part1 instead of being por which was the main area of male and for guests, here it became an empty space with staircase, washroom, and space to remove shoes. There is a new element of the water tank which is added in this part which changed the function of space. Thus here thinking of the services changed the space organization. Part2 here became the living room from har which was the transitional space in the house. Part3 and Part4 being majorly one with some internal walls have a kitchen, store, temple room, and a room. Thus the ground floor being culturally functional spaces and segregation with transition has become too simple division and workable space. The first floor in the house1 and 2 are entered from har on the ground floor and opened in chowk whereas here it is accessed frompart1 of the house which is service area and open again to a service area. There is kateri towards the street side but seems to be an extension of the floor as the façade of kateri changed to the railing. House 1 and 2 having chowk as a core space has been missing in house3. There are nos. of rooms made on the floor which are made with the thought of the future expansion which are of no use in present condition.

Thus, there are visible changes and continuity in thinking and resulting in the organization in traditional architecture of Sirohi. In the present time of huge density, the thinking of making house form is major of its future expansion. Resulting in its house form consists sequence of plain and empty rooms which are made functional by using

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it. The core place in the house which was chowk has lost resulting in this.

CONCLUSIONS

In a modern context where architects hold the prime role in shaping the house form, it is pertinent to look back at this traditional architecture to understand the role of core space and organization and reflect back on it.

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Effects of Urban Green Spaces on Physical Health

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ABSTRACT : Urban green spaces are an essential part of urban planning, and have a positive impact on physical health, mental health as well as helps improve one's social interaction. Not only at an individual level, but also has benefits on a societal level. Studies show that it is beneficial in terms of economy, ecology and also the people living in the locality are happier as compared to the others. This paper talks about the importance of Urban Green Spaces in order to promote a healthy lifestyle. Research tools such as field survey in order to study the spatial organization of the built and landscape elements in a park are used. Activity mapping for understanding the user interface. Interviews and questionnaire to study the impact of activities in parks on health enhancement. The expected outcome from this study would be to formulate some ground rules which could be used for the planning and the spatial organization in a park. Urban green spaces, here, refer to the public parks or public gardens, in residential areas only.

Keywords: urban green parks, spatial arrangement, physical health enhancement

INTRODUCTION-

India is a developing country, taking big steps towards urbanization. Urbanization or urban planning comprises of different parts. There is planning of commercial zones, residential zones, industrial zones, landscape, open spaces, etc. and working out the connection between these spaces. Urban green spaces are an essential part of urban planning. Urban green spaces as well as other open spaces in urban planning are as important as doing the smallest detail in a building. Looking at the growing urban cities, the proportion of green spaces compared to the built mass is very less, which is not an ideal case. Especially in today's lifestyle, where people are not much concerned about their health, it is very important to design these green spaces such that they would motivate people towards having a better and a healthy lifestyle. Urban green spaces have a positive impact on physical health, mental health as well as helps improve one's social interaction. Along with these, it has other benefits like a safer locality, fresh and clean air, etc. There has been a lot of research done on urban greens paces and its benefits. Studies show that the use of urban green spaces on a regular basis has a positive effect in order to overcome diseases such as obesity, cardiovascular diseases, diabetes and premature loss of life. Effective use of these spaces also helps maintain the metabolism of our body. Not only physical, but also mental health problems such as depression, can be overcome, as suggested by the studies. The aim of this research is to study the importance of Urban Green Spaces, that is public parks and public gardens in order to promote a healthy lifestyle. The studies will be done using various research tools such as field survey and interviews in order to study the spatial organization of the built and landscape elements in a park. Activity mapping for understanding the user interface and their response towards the parks. The impact of activities in parks, on health enhancement would be studied through interviews, questionnaires and surveys. The expected outcome from this study would be to formulate some ground rules which could be used for the planning and the spatial organization in a park. The open spaces in different zones like residential zone, industrial zone, etc. have different functions, but their impact on human minds are very powerful. Here we will be talking about the urban green spaces in residential areas. Urban green spaces, here, refer to the public parks or public gardens in residential zones only.

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AIM- To study the importance of public urban parks and gardens in order to promote a healthy lifestyle.

OBJECTIVES- 1. To study the spatial organization of the built and landscape elements in a park.2. To understand the user interface and their response towards parks.3. To study the impact of activity in parks, on health enhancement.

MATERIAL AND METHODOLOGY-

Research question- How can the urban green spaces be designed in a locality to encourage people to spend time on physical activities on a daily basis and also promote a healthy lifestyle?

The research is done using various research tools like field surveys, interviews and questionnaires and activity mapping. A qualitative research is done in order to understand the human response towards these spaces. Also, there are case studies done where two public parks in Pune – 1. Dr. Shyamprasad Mukherjee Udyaan, Erandwane and 2. Shahid Major Pradeep Tathawade Udyaan, Karve Nagar have been studied. Both the case studies have been done keeping in mind the three main objectives, which are-Objective 1 - To study the spatial organization of the built and landscape elements in a park.Physical mapping – Field survey and interviews with park management. Objective 2 - To understand the user interface and their response towards the parks.Activity mapping – Observations and interviewsObjective 3 – To study the impact of activity in parks on health enhancement. Interviews, questionnaire, survey on space and activity, health enhancement. In order to analyse the urban green spaces, the following points need to be studied-What are the various aspects that can be used to help improve physical health. - How are the green spaces utilized by different age groups, genders?- What different spaces (e.g.- seating, space for activities like yoga/floor exercises) can be provided based on the different activities that take place in a green space? Methods of data collection-1. Secondary data collection through referring books and existing research. 2. Primary data collection- Unstructured interviews,Non-participatory observation, Mailed/ Collective questionnaireScope- The study will be done for public green spaces, open for all, rather than gated communities as that would give a broader scope of the study.The age group selected for the study is 18 years and above. Limitations-The research is limited to studying only the physical health benefits.These areas selected will only be public spaces in residential zones

LITERATURE REVIEW-

(A.C.K. Lee, 2010)-The health benefits of urban green spaces: a review of the evidence

This paper talks about the physical as well as non-physical health benefits of having urban green spaces. Though the results are not very affirmative, there have been studies conducted on various aspects related to the urban green spaces. It states that there is a weak evidence for links between physical health, mental health and well-being, and urban green space. Environmental factors such as the quality and accessibility of green space affects its use for physical activity. User determinants, such as age, gender, ethnicity and the perception of safety, are also important. The paper concludes that most of the study findings show that urban green spaces are health beneficial. However, establishing a casual relationship is difficult and simplistic urban interventions may therefore fail to address the underlying determinants of urban health.

(Michelle C. Kondo, 2018)-Urban Green Space and Its Impact on Human Health

This paper talks about green spaces with an urban context. What is the impact of urban green spaces on its locality or as a society? Apart from health benefits, it also talks about the threats of having urban spaces in a locality. The evidence shows that there is a consistent negative association between urban green space exposure and mortality, heart rate and violence, and positive association with mood, attention and physical activity. It states that the results were mixed, and that there is no specific association between urban green spaces and general health, weight status, depression and stress. The study was too low to conclude upon factors like birth outcomes, blood pressure, heart rate variability, cancer, diabetes, etc. Thus, it concludes by saying that there needs to be more studies done to make generalizations and meta-analyses, of these and other health outcomes possible.

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(Andrew Chee Keng Lee, 2015)- Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning.

The paper starts with talking about the already done research about the relation between urban green space and health. It states that there is a need to understand the mechanisms by which the benefits accure. It talks about focusing on the reality, rather than considering a casual relation between the user and the space. The various determinants of the use of green spaces are discussed. It talks about the mechanisms of functionality and the implications for research and practice. The paper also talks about the potential threats and the possible solutions.

(Takano, 2002)- Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces.

This paper talks about the use of urban green spaces by the older age group. The relation between the longevity of senior citizens in megacities or densely populated areas and walkable urban green spaces. By walkable green spaces they mean, the spaces that are functional or can be accessed by humans for use. The green areas in a residential area should be emphasized and developed for further more use. The study is done not considering various factors like gender, age, race or socioeconomic factor. For senior citizens, the ease of access to the green space is also an important factor.

(Jolanda Maas, 2006 July)- Green space, urbanity, and health: how strong is the relation?

The relation between green spaces, urbanity and health is that health is dependable on green spaces which are a part in urban cities. With the growing urbanization it is equally important to have a good health, for which green spaces are necessary. Green spaces have a direct impact on human minds, health and living. Green spaces are considered to be more than just a luxury while urban planning, which is not an ideal case. Every one, despite age, gender, caste, socio-economic status should be able to access the green spaces. There is a difference in the use of green space in urban and rural areas. In urban areas however, people make more benefits of the space.

CASE STUDIES –

1. Dr. Shyamprasad Mukherjee Udyaan

Figure 1. Dr. Shyamprasad Mukherjee Udyaan Entrance Gate

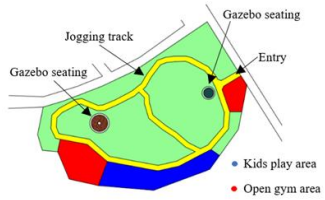

Figure 2. Schematic plan for Case Study 1

While selecting the case study, the locality of the park was observed. Being a completely residential area with some commercial shops like general stores, groceries, the majority of the people coming to the park were the local residents in the area. A sample size of 50 was selected of which 25 were males and 25 females. The division of 25 was further done on the basis of age groups-

18-25 years – 3 samples each

25-45 years – 4 samples each

46-65 years – 4 samples each

66 years and above – 4 samples each.

This was done in order to avoid biased views and results on the subject. Observations were made during parts of the day – one in the morning between 6am-8am and in the evening between 5pm-7pm.After interacting with the people visiting the park, here are some of the good points that they told about the park. 1. The park is located in a prime area and also has good access, along with parking right in front of the park. 2. There are no hawkers who sit outside the park or cause nuisance in the area. 3. The park is very well maintained on a regular basis, along with the workout instruments and the kids play area.

The results show that 80% people, out of the total surveyed, visit the park on a daily basis, 7% visit twice or thrice a week and 13% visit only

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occasionally. Out of those, 33% people approach the park by vehicle, while 43% live at a distance of 5-10 minutes walking distance from the park and 23% live at a distance of 10-20 mins walking distance from the park. 64% of the people make use of the workout instruments provided in the park. 54% people visit the park in the morning, while 70% people visit the park in the evening. The overlap of 16% shows the people visiting the park at both times.The bar diagrams below show the response to the questionnaire in percentage. The data was collected as per different age groups but for analysing the data the average of all 25 male or all 25 females is considered.

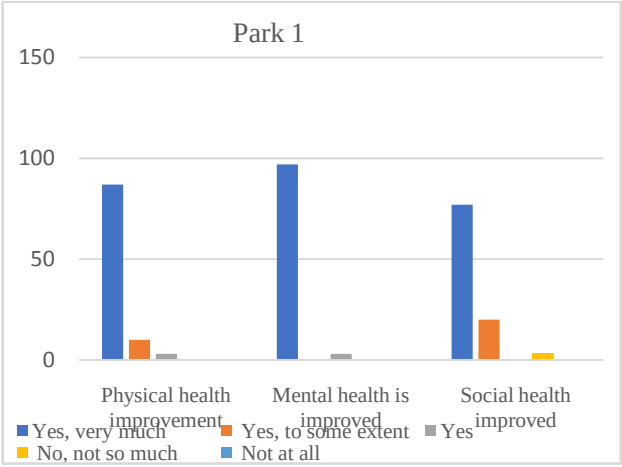

Figure 3. Bar chart showing different results for health betterment for Park 1 in percentage

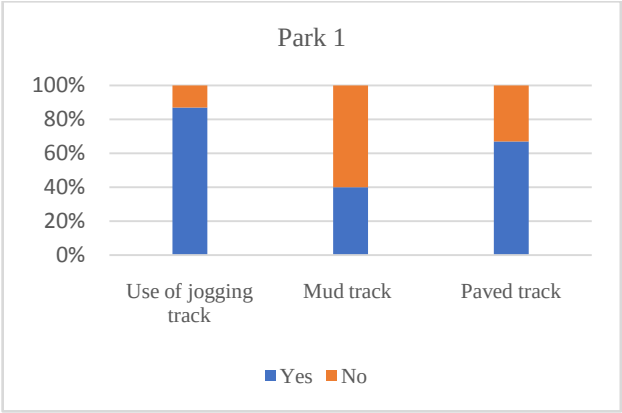

Figure 4. Bar chart showing Jogging track related data results for Park 1 in percentage

2. Shahid Major Pradeep Tathawade Udyaan –

Figure 5. Shahid Major Pradeep Tathawade Udyaan

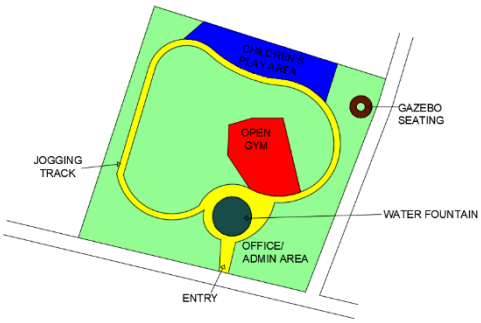

Figure 6. Schematic plan for Case Study 2

This park also is located in a residential, with some commercial shops and restaurants in the surroundings. The park is majorly accessed by the local residents in the area and also by some of the people living on Sinhgad road, which is around 5mins away from the park. The samples collected for this case study are 50 as well. Out of the 50, 25 are males and 25 are females. The division of 25 were further done on the basis of age groups –

18-25 years – 3 samples each

25-45 years – 4 samples each

46-65 years – 4 samples each

66 years and above – 4 samples each.

The footfall here as compared to the other case study is less, since the park in terms of area is smaller than Park 1. The length of the jogging track differs accordingly. Also, the number of workout instruments provided in the park are less as compared to park 1.

The results show that 80% people, out of the total surveyed, visit the park on a daily basis, 7% visit twice or thrice a week and 13% visit only occasionally. Out of those, 20% people approach the park by vehicle, while 43% live at a distance of 5-10

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minutes walking distance from the park and 37% live at a distance of 10-20 mins walking distance from the park. 43% of the people make use of the workout instruments provided in the park. 83% people visit the park in the morning, while 47% people visit the park in the evening. The overlap of 36% shows the people visiting the park at both times.

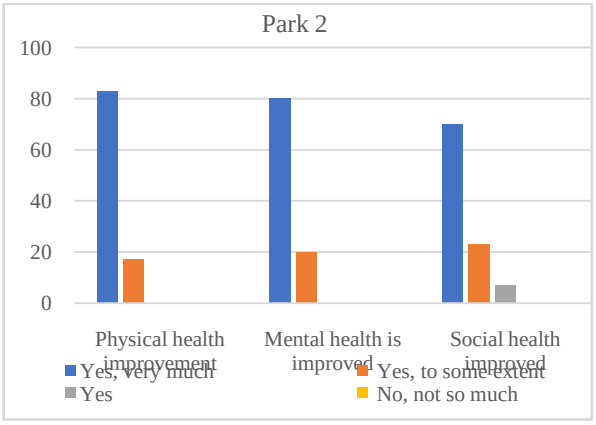

Figure 7. Bar chart showing different results for health betterment for Park 2 in percentage

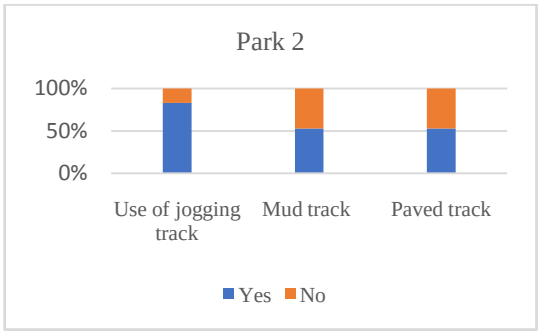

Figure 8. Bar chart showing Jogging track related data results for Park 2 in percentage

The study of both the case studies in done in the exact same method. There are some points which are common for both the parks, where as in some cases either of the two are better. But park 1 being constructed later than the park 2, has a greater number of facilities for the users. The results are more positive for case study 1 than case study 2.

RESULTS AND TABLES -

The table below shows a comparative analysis for both the case studies –

Table 1. Table showing the comparative analysis for different factors affecting physical health

POINT	CASE STUDY 1	CASE STUDY 2
Daily use of park	80	80
Improvement of physical health	87	83
Use of open gym in the park	67	43
Use of the jogging track in park	87	80
Covered / Open to sky track	0 / 100	0 / 100
Mud track / paved track	40 / 67	53 / 53
Helps improve mental health	97	80
Helps improve social interaction	77	70
Benches / Gazebo	87/40	83/33
Effect of water body	60	47
Effect of soft background music	63	40

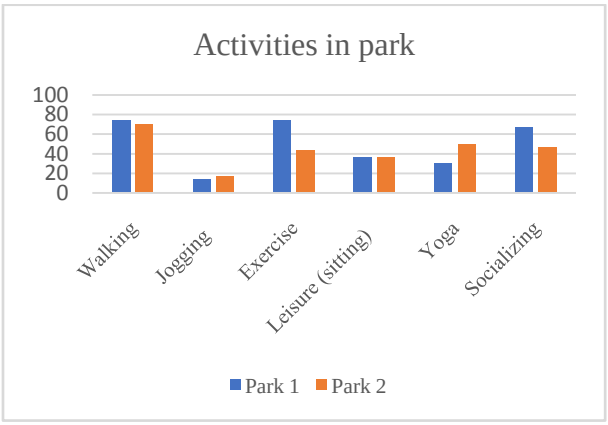

Figure 9. Bar chart showing comparison between the percentage of activities carried out in the two case studies

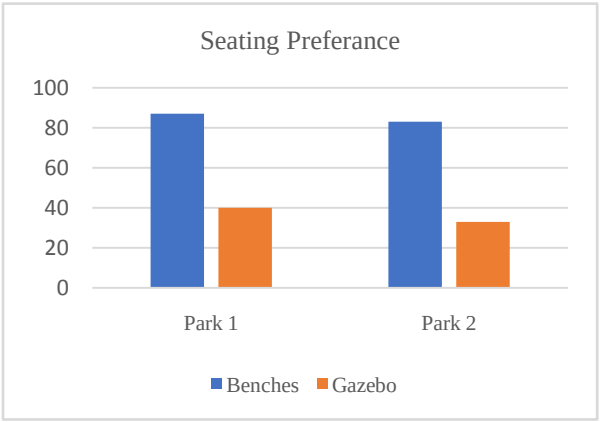

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Figure 10. Bar chart showing comparative figures for seating preference in percentage

CONCLUSION-

As the above bar diagram shows the comparative analysis of the average percentage of the various activities carried out in both the parks. In both the cases, people most commonly use the park for walking, exercising and socializing. These three factors play a major role in the well-being of a human, both in terms of physical as well as mental health. Based on the interviews and analysis done, the effects of urban green spaces on physical health can be analysed as-

- The park should be designed considering the universal design guidelines.
- The provision of workout instruments in parks is very advantageous. People make use of these instruments willingly if they are maintained on a regular basis.
- The jogging and the walking track are used by almost everyone. Some people prefer a normal Mud track while some prefer a paved track. This difference is majorly affected by the gender and the age factor. But while planning, it is always advisable to provide both types of tracks.
- The track should preferably be straight, with not too many curves and turns. It should be evenly levelled.
- While taking the interviews, some people suggested to have a semi open or shaded jogging track, for especially during the rainy season. Hence, if possible, the track can be so designed that a part of the track is covered, maybe by a semi-arch, or giving pergolas throughout.
- Open to sky seating is preferred by people than closed/ covered seating. Thus, benches provided in the park can be of materials like wood or plastic rather than concrete benches. The height of the benches should not be too low (below 450mm, as observed).
- If Gazebos are to be built, they should not be very small. They can be rectangular or circular in shape. The gazebo observed in the Case study 1 was sufficient enough for the footfall of that park. It has the radius of around 3M along with 16 benches with a capacity of 3. The space left in the middle was sufficient to cater indoor yoga practice sessions. Hence this size can be considered as a reference.
- The presence of water body has a positive effect on the mind.
- Music is the best soothing therapy; hence soft background music is always a good option.
- Overall, the park should be well lit, there should be no dark corners or shadow areas left.
- The trees to be planted in the garden can be flowering trees, as it gives a better impact and is a visual pleasure for our minds.

Thus, by the general observations, it is clear that urban green spaces are beneficial for our physical health, and not only physical health but also mental health, social life, ecology and economy.

ACKNOWLEDGEMENTS –

I would hereby like to thank all the faculty members, Dr. Banani Banerjee, Dr. Priyamvada Chitale, Ar. Anita Kavathekar and Ar. Ashwini Shitole, who have guided me so well. I am grateful for the knowledge that they have shared with me throughout the process.

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v. Urban green space, public health, and environmental justice: the challenge of making cities ‘just green enough’ [5]

vi. Urban residential environments and senior citizens’ longevity in megacity areas: the importance of walkable green spaces [6]

vii. Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning [7]

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Application of Semantics and Semiotics in Understanding Design Philosophy of Ar. Charles Correa Within Context of Indian Architecture

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ABSTRACT : In order to communicate, a formal or otherwiselinguistic system is adapted. The language can be understood only when the sender and receivershare a common system of symbols and signs. Similarly,Architectural languagehas semantics and semiotics that have the ability to convey meaning through spaces visually.Architect Charles Correa's ideology was shaped due to Socio-Cultural-Economic context as well as the climate of Indian sub-continentforming an Architectural vocabulary which was very specific to Indian context.This research paper attempts to explore and understand the mediums used by Architect Charles Correa to convey meaning in Indian Architecture through Visual Analysis.

Keywords
Architectural Language, Semantics, Semiotics, Form and Character, Communication in Architecture, Symbols and Signs, Indian Architecture, Works of Architect Charles Correa.

Introduction

Communication is a social activity through which the information can be transferred by the sender and interpreted by the receiver after decoding. According to George Miller the science of communication contains a set of signs and symbols that have meaning embedded in them which are perceived by someone who has the ability to decipher, understand and interpret those signs and symbols.(George, 1951)

A Language is a structured system of communication which involves spoken, written / verbal and non-verbal. These languages also include the signs, symbols and scripts which makes communication feasible. Signs and symbols are not only studied in a language but rather it has its place rooted in rituals culture, image and art.(Tavsan, 2018) This can be classified in two broad divisions: Verbal communication and Non-verbal communication.

Communication ability of some signs and symbols can be perceived much stronger than the others due to the logical conditioning of mind which is known as perception. Thus, the communication function is subjected to human interpretation which results into implicit meanings.(Gawlikowska, 2013)

Architecture is a visual form, falling into non-verbal category of communication that can be understood as language with grammar and vocabulary as Architectural Language. For understanding the architectural language and the semantic and semiotic model consisting of symbols and signs shall be used. These signs and symbols themselves might not have a meaning individually but together with context are able to generate expressions.

Indian Architecture and Ar. Charles Correa-Over 150 years of architecture in India remained under the British influence. After the independence it was necessary for Indian fraternity to cast an impression over the world by projecting culture, heritage, modernity, vividity in its design so as to emboss the existence of great nation. Therefore, after the independence, Indian architecture immediately parted from European classical styles and rushed into modernism. This modern architectural period proved to help the scenario. Charles Correa, B.V. Doshi, Raj Rewal were the one to develop the technology, design to make something which contributed towards building the great Indian society. (Foundation, 2016)

Ar. Charles Correa used to think about the climate conditions, comfort levels and with the support of escalating and improvising technology Correa formed his most iconic structure in the heart of Mumbai 'Kanchenjunga Apartments'. This apartment building with duplex, internal staircase, courtyards, was a lavish structure satisfying the increasing population and without compromising requirements. Ar. Charles Correa also did not just think in terms of Physical or Social Context, rather his works depict the Context of Time which they were a part of. Hence Correa says, "*Architects should think of the various attempts made in the history, critically analyze the facts and elements and then should improvise on them as needed*." (Correa, 2000)

Ar. Charles Correa's aim was to develop an architectural style specific to India's climate which became a milestone, benchmark and also his signature.

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Research Background And Methodology

Semantics and Semiotics -The expressions of communication in Architecture which are semantic and semiotic message systemshave the ability to convey meaning through space and is limited to human perception and understanding.These two elements govern how one communicates and perceives architecture. Semiotics and Semantics is parallel to the study of meaning-making or interpretation of signs. This includes study of signs, analogy, metaphor, symbolism and signification.
Formal Discursive Communicative methods of architecture are described as semantic which results in development of Form. Drawn shapes play a critical role not only in representing a design concept but also in allowing the designer to reinterpret them to develop new ideas.(Schwarzfischer, 2011)

Non-Formal Non-Discursive Communication is described as semiotic, the phenomena of grammar and limitations of spatial communication is referred as character. The non-discursive communication of architecture is more linked with real world situations and experiences. It uses context to communicate to arouse emotional response, it is therefore a medium used to transmit easy-to-decode messages through architectural forms.(Gawlikowska, 2013; Khan, 1984)

The space has the ability to communicate through Form, Space, Order, Character and Atmosphere but ability to recognize the code by its receiver.(Penn, 2003)

Communication -According to the existing theories in literature of Communication through Semiotics can be majorly classified into three main types:

Syntax - A sign is anything that communicates a meaning, that is not the sign itself, to the interpreter. All the languages rely on the process of semiosis that have the ability to relate the signs and their meanings. Signs can communicate through any of the senses, visual, auditory, tactile, or taste. (Leach, 2005)

Semantics - A swiss thinker Ferdinand de Saussure introduced these terms as the relationship between signs and what their actual meanings are conveyed. The signifier is the image which acts as a reference for something whereas the signified is what the message conveyed is about.(Saussure, 1959),(Juodinyte-Kuznetsova, 2011).

Pragmatics - Then French semiotician Roland Barthesin his theory “Semantics for Beginners” says, Denotation is the primary or literal meaning of a word which when separated from the from the feeling it evokes (Explicit meanings), On the other hand Connotation are the ideas or the feelings which are associated with the denotations (Implicit meanings). (Barthes, 1999)

This paper tries to deal with all the three aspects of semiosis i.e.- syntax, semantic and pragmatic parts of architecture.

To understand the basic theory of the languages-communication, Semantics-semiotics, Literature papers reviewed, established significance as well as a need in the Indian Context. The primary case examples chosen for visit were Bharat Bhavan - Bhopal, IUCAA – Pune which provided a better understanding in terms of Visual Observation and Analysis.The established precedents in the Semantics and Semiotics language model provide the base for the further derivations made.(Ramzy, 2013)Structured Interviews were also conducted with the architects who have worked with Ar. Charles Correa to analyze the design ideology, philosophy and methodology. Content Analysis of writings by Charles Correa along with transcribed Articles - *“Transfer and transformations”, “Blessings of the sky”* along with the Movies- “Volume Zero” and “Into the Unknown”.

Analysis, Results and Tables

The Visual Analysis was conducted for the following structures to Identify and document the visual components responsible for Form and Character generation.

Bharat Bhavan, Bhopal

Under the leadership of Jawaharlal Nehru (India’s first prime minister), India saw the formation of various new architectural buildings with cultural institutions. A new draft stating the need for cultural revival and sustaining India’s intangible and tangible heritage was formed. The intent was to give a platform for practitioners of this traditional art form and educate others about these in an accessible urban area.(Correa, 2000)

This is how the vision of ‘India House’ or ‘Bharat Bhavan’ was born, envisioned to be built in each of the 21 states (in 1970). It was imagined to be a cultural center that spoke this vision through a series of galleries and exhibition/performance spaces(Foundation, 2016)

The first commission of this vision went to Architect Charles Correa where he was endowed with the responsibility to design the first-ever Bharat Bhavan, in Bhopal (Madhya Pradesh).

Bharat bhavan consists of series of sunken courtyards and terraces which are facing towards the lake and thus the whole building morphology is embedded into the terrain. When one enters through main entrance, the only element seen is the skyline of Bhopal across the main lake which

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emphasizes the fact that there is no need for this kind of structure to stand out Architecturally.Rather it can even be equally convincing with subtle and subdued form suitable for such activities. As steps brings down into the series of interconnected sunken courts one finds himself surrounded by the various activities. The materials which are used for the project tend to be the local stone (Red Sandstone and Dholpur Stone) that is used as a cladding on the regular Reinforced Concrete works which itself was way ahead of time. The various wood works seen are a result of Local Craftsmanship and the Local wood available. The Reinforced concrete lintels are a replication of traditional Indian wood works used I the formation of lintels and sill. (Frampton, 1996),(Correa, 2000).

Figure 1: Images of Bharat Bhavan through various courts, Steps and terraces, Construction Details.

TABLE 1 –BHARAT BHAVAN

SNo.	Signifier	Signified	Connotation/ Denotation	Meaning
Activities				
1	Focus on Cultural Facilities and Tribal Arts Center as well as Museums.	Cultural Significance	Denotation	Importance given to Culture tradition and the Arts and Crafts inscribed into the very land.
2	Entry to Courtyard	No formal Reception, Corridors.	Connotation	Total Independence in Activities and Arts.
Form and Geometry				
1	Access from the top and stepping down into the courtyards.	Easily approachable to common man.	Connotation	As one proceeds through the sunken courtyards various connections in a casual arrangement states a gesture of welcoming.
2	No Built Spaces seen from the Entrance.	Backdrop is the Skyline of Bhopal	Denotation	The idea is not highlighting the building itself rather to emphasize on the context and the culture which it has.
3	Grid	Uniformity	Connotation	Repetition of module and structural stability.
4	Courtyards	Planned Informal but introvert spaces	Connotation	Search of identity within oneself.
5	Conical Dome	Heavenly light	Connotation	Seeking guidance from the super power.
6	Absence of windows	Casual Movement and interconnectivity	Connotation Denotation	The same way with which all arts are connected
Materials				
1	Local Red Sand Stone and Dholpur Stone.	Connection with the context.	Connotation	Local material gives an identity which follows context and connects with the people.
2	Reinforced Cement Concrete	Innovation in Construction Technology	Connotation	During the 1980's the construction technology had just started development in R.C.C.
Construction Technology				
1	Ledge and battened doors	Simplicity	Denotation	Local Craftsmanship and Traditions
2	Ferrocement Conical Dome	Innovation in Form	Denotation	Highlighting the upcoming technology on the basis of current culture and traditions.
3	RCC band at Lintel level	No Cladding, exposed structural.	Connotation	Reminder of traditional wooden architectural construction.

IUCAA, Pune

In 1988 with the Prof. Govind Swarup and Dr. Jayant Narlikar a committee was formed which proposed State of the art Astronomy and Astrophysics laboratory within the Savitri-bai Phule Pune University Campus. **The Inter-University Centre for Astronomy and Astrophysics (**IUCAA) consists of an Educational Area with Research Library and other Equipment and apparatus labs. The Devyani Court consists of stepped sit out spaces depicting the boundaries of universe which are expanding infinitely with the focus in the center containing two binary stars (black holes merging into one). The Roche Court consists of idols of 4 great scientists Aryabhata, Albert Einstein, Issac Newton, Galileo Galilei which depicts the presence of their knowledge through the ages and has passed on for further research. The Seirpinski court connects the residential areas with the main courtyards which is the graphical representation of the Fractal patterns. The Primary philosophy behind the Courtyards was to bring in the vast universe and to provide space for the building to breathe. The Design initiated with drafting the initial

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content of the courtyards or so called "the zero spaces" with a purpose and then providing the built massing which caters to the purpose on a more fundamental level.(Frampton, 1996)(Correa, 2000)

Figure 2:Images of Various Elements of IUCAA, Pune

TABLE 2 - IUCAA

SNo.	Signifier	Signified	Connotation/ Denotation	Meaning
Activities				
1	Functioning Research Facility for India Under SPPU	Significance given to Astronomy and Astrophysics.	Denotation	Importance given to making a search for the unknown, gesture to accept challenges and finding the truth.
2	Entry to the structure	Patterns on the wall pointing towards sky.	Connotation	The pattern represents steps which eventually form an arrow which points and leads towards sky.
Form and Geometry				
1	Access from the top and stepping down into the courtyards.	Easily approachable to common man.	Connotation	As one proceeds through the sunken courtyards various connections in a casual arrangement states a gesture of welcoming.
2	Built wall on the Entrance.	Hierarchy in Material	Denotation	The whole idea convinces to point out the sky which is mysterious in various ways.
3	Grid	Uniformity	Connotation	Repetition of module and structural stability.
4	Courtyards	Enclosure in four walls and exposure to infinite sky.	Connotation	Identifying the ground and what we are but still curious to experience the "beyond".
5	Relationship of Built steps with unbuilt and intangible nature.	Blackholes and the Event Horizon resulting into Binary star configuration.	Connotation	Man trying to explore and discover new theories about perception.
6	Patterns in flooring insmaller courtyard (Residential Area).	Fractal Geometric Pattern (Seirpinski Triangle)	Connotation Denotation	Architectural response given to scientific theory which suggests infinite nature and space.
7	Postures of Scientist Aryabhata, Isaac Newton, Albert Einstein, Galileo Galilei.	Signifying the contribution given by them in the field of astrophysics.	Denotation	The current research and discovery which are being done are being taken forward by the scientists.
Materials				
1	Basalt Stone, Kadapa Stone, Polished black Granite.	Connection with the context.	Connotation	Local materials are used in various walls to denote typical Signs and Elements. Ashlar Masonry is used to form the base the claddings are done by Kadapa stone and the Sky is denoted by Black Granite.

Conclusion

Architectural works beyond their Utilitarian purpose contains cultural emotional and social expressions which an architect tries to articulate through their works. Through this paper it is evidently seen how these architectural vocabulary and languages that can be seen through their works which is the foundation for expression of ideology and philosophy.

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Satellite cities – An Inclusive Approach for a Sustainable City

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Abstract: India's rapid urbanization has given rise to densely packed metropolitan area which face problems like - long hours of intercity travel, urban sprawl, pollution and wastage of productive time resulting in increased levels of stress. This research is focused on development of sustainable Satellite Cities as a futuristic solution catering to sustainable development and growth of existing urban centres in India. Pune, Ahmedabad, and their satellite towns are researched on the parameters like transit, environmental impact, land use policy, inclusiveness and quality of life to develop a matrix which will serve as a guide for visionary satellite towns.

Keywords: *Satellite cities, Sustainable cities, Inclusive cities, Indian cities*

INTRODUCTION

India is undergoing rapid urbanization and growth which has resulted in a dense and congested urban fabric. This speedy and uncontrolled growth has given rise to numerous problems which create bottlenecks in the growth of the city. There are three ways in which a city grows - (i) Horizontal development – Causes longer travel times and traffic chaos (ii) Vertical development - Causes surge in land prices and stresses the infrastructure and (iii) Development of Satellite Cities – Establishment of a new city in close proximity of a parent city which has an independent governing body. In the past several decades, satellite cities have played a major role in decongesting metropolitan areas. There are growing appeals for development of these new satellite towns which are away from the urban chaos but within close proximity of the parent city.

Vertical Growth Horizontal Growth
Developing Satellite Cities

Image showing different ways in which a city grows. Image source – author.

HISTORY

Conceptualized by Sir Ebenezer Howard, garden cities were self-sufficient, concentric clusters which had open spaces, green belts, parks and radial boulevards. Once the garden city reached the optimum population, another city would be developed nearby. Sir Ebenezer Howard thought of several of these concentric clusters as satellites for bigger urban centres. The first garden city created was created in 1905, Letchworth as the satellite to London. Letchworth promised its residents a clear distinction between factories and homes, quiet neighbourhoods and a lot of open spaces, all of which London fell short of. In short, Letchworth promised a better quality of life. Low taxes for factories, lower prices of land to build homes and lower rents attracted a lot of investment into Letchworth. These magnets resulted in influx of population which shot up the land prices and the city could not remain affordable for the worker class and became the abode of the wealthy people, defying its economic and social visions.

GLOBAL SCENARIO OF SATELLITE CITIES

Satellite cities accommodate the population influx which comes into the into the parent city by providing housing and basic amenities. It provides the parent city with labour and work force. These new towns promise a better quality of life for all. Since satellite cities came up only in the beginning of the 20th Century, its only now, that we can observe its effects in terms of environmental, social and economic impacts. Satellite cities have come up all around the world surrounding megacities creating large metropolitan regions. Today, satellite cities are easily envisioned but most of them fail at solving the problems, rather add to them or create new ones. Satellite cities are supposed to be independent centres in terms of providing jobs and homes. Due to the imbalance, the intra city travel between the satellite city and the parent city has given rise to long hours of travel, increased fuel consumption and pollution.

CURRENT SCENARIO OF SATELLITE CITIES IN INDIA

India is not far behind the world when it comes to establishing new satellite cities. Big cities like Delhi, Mumbai, Chennai, Bangalore, Pune and Ahmedabad have

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multiple satellite cities to cater to the urban pull these cities have. Satellite cities pop up with new magnets but fail to balance out the strengths with opportunities. The metropolitan areas are expanding horizontally and are eating up open spaces in and around the city at an astounding rate. As prescribed by the World Health Organization, every person living in the city should have access to 9 square meters of open spaces within 800 meters from the residence. Most Indian cities fail to achieve the bare minimum and cities are giving away the open spaces meant for recreation to develop concrete jungles.

CASE OF PUNE

Pimpri Chinchwad, North-east of Pune, was set up as an industrial town and a satellite to Pune city. After setting up Pimpri Chinchwad, people from Pune started traveling to Pimpri Chinchwad on a daily basis for their jobs. Being away from Pune but within close proximity, the new land attracted investment and boosted economic growth in the area. This increased job opportunities in the area which were lacking in Pune. There was no formal Public transport which existed.

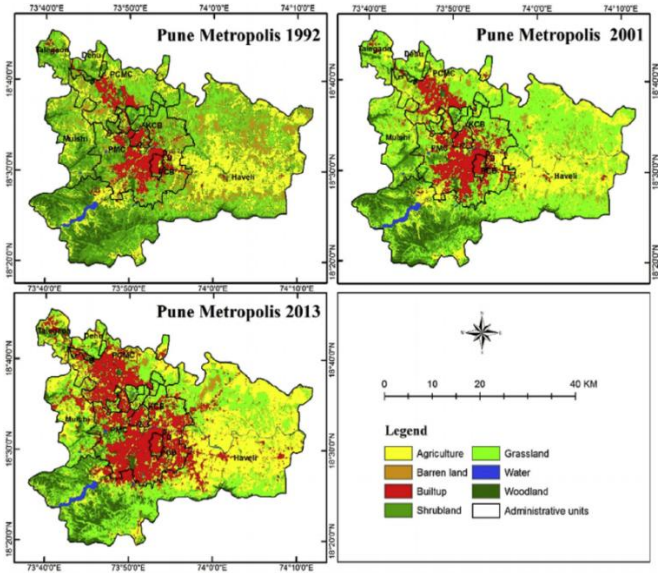

Image showing growth and sprawl of Pune, Hinjewadi and Pimpri-Chinchwad City. Image Source (Kantakumar, 2016)

Hinjewadi, North-west of Pune, was set up as an IT Park which housed multinational IT Companies. Lakhs of people travel daily from Pune to Hinjewadi for work. After understanding the need for housing in the vicinity, gated communities and high end apartments popped up in Hinjewadi, catering to IT professionals. There was no housing that was developed which would include low income groups or economical weaker sections who act as workforce and household help. Hence, many of the apartments remain unsold due to lack of maids and household help.

With the rapid urbanization, the open space left per capita is just 1.4 square meters as against 9 square meters as prescribed by the World Health Organization.

CASE OF AHMEDABAD

Gandhinagar, North-east of Ahmedabad, was set up as the new administrative capital for the state of Gujarat 30 km from the former capital city of Ahmedabad. Gandhinagar houses the administrative buildings in the city centre surrounded by housing blocks in the periphery. One of the policies that Gandhinagar adopted was to house only the government legislative and administrative buildings in Gandhinagar. Realising the mistake, Gandhinagar is now coming up with the new development plan which includes residential zones and industrial zoned on the periphery of the government blocks.

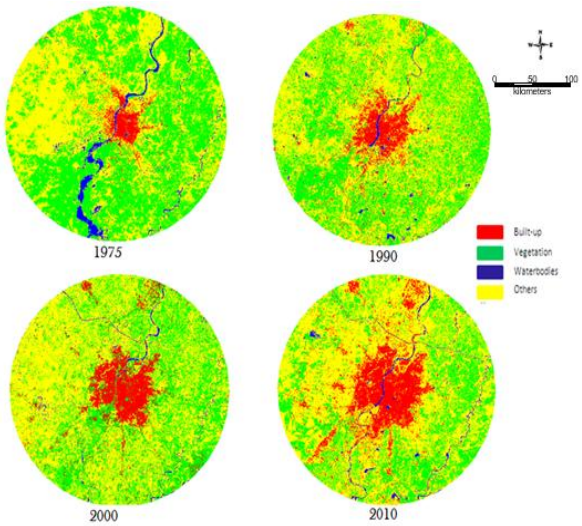

Image showing growth and sprawl of Ahmedabad, Gandhinagar and Sanand City. Image Source
http://wgbis.ces.iisc.ernet.in/energy/water/paper/Monitoring-Spatial-Patterns/results-discussion.html

Sanand, South-east of Ahmedabad, set up a TATA nano plant which boosted local economy and gave a sudden boost to urbanization process. This led to a huge influx of people into the town, which increased the demand for housing hence, increasing the land value. Both the activities led to Intra city travel to and from Ahmedabad.

With the rapid urbanization, the open space left per capita in Ahmedabad is just 0.37 square meters as

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against 9 square meters as prescribed by the World Health Organization.

ANALYSIS
CASE OF PUNE

Lack of public transport led to an increase in private vehicle ownership and increased vehicular movement between Pune, Pimpri-Chinchwad and Hinjewadi. City records show that as of 2016-17, Pune has 2.3 million two-wheelers and seven-hundred thousand four-wheelers. A worrying fact: Pune, with 1,260 vehicles per km, ranks second in terms of vehicle density among Indian cities. This has resulted in extreme levels of pollution and traffic jams.

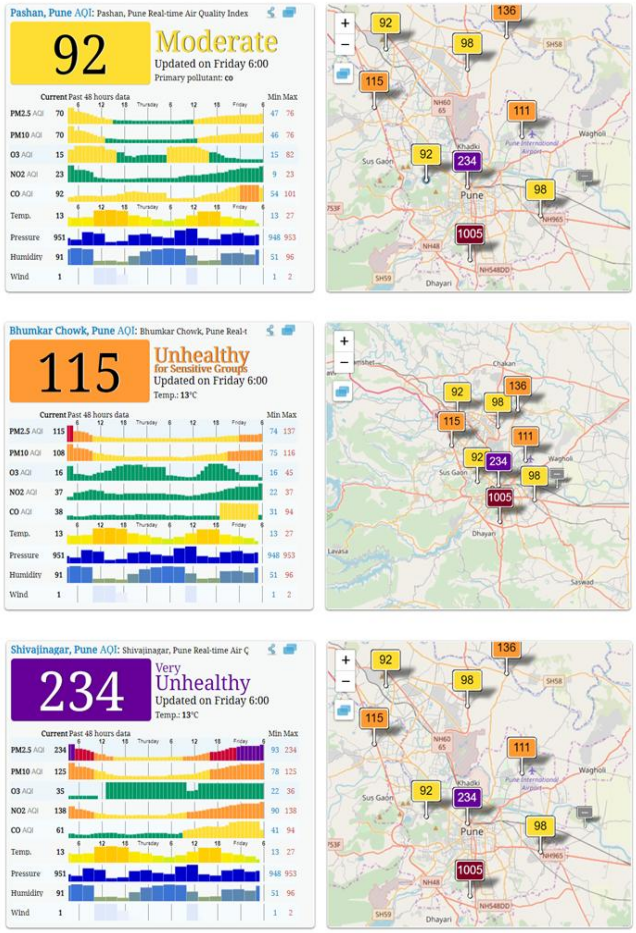

Image showing deteriorated air quality in Pune city. Image Source https://aqicn.org/city/pune/

Hence, city administrators realised that pre-emptive measures for urban mobility is the need of the hour. In the case of Pimpri-Chinchwad, Pune's twin city, due to the lack of effective intra and inter-city public transport systems, there was a steep rise in private vehicle ownership. Which, if not rectified, would have stalled the immense progress it made. In a combined effort, Pune Municipal Corporation, Pimpri-Chinchwad Municipal Corporation, and Pune Mahanagar Parivahan Mahamandal Limited turned their focus on the bus rapid transit (BRT) system. The rapid transit network, which was duly reviewed by the India Programme, was called the Rainbow BRT. It effectively utilised Pune's bus fleet and network, while also improving Pimpri-Chinchwad's connectivity to its twin city. (ITDP - https://www.itdp.in/)

Lack of open space per capita led to the degradation in quality of life forcing children to stay indoors and rely on electronic devices which take a toll om their mental and physical health. This has also created unsafe neighbourhoods to walk in for senior citizen.

CASE OF AHMEDABAD

Due to its land use policy for administrative and legislative buildings only, Gandhinagar city experienced lack of activity and increased crime in evening after the office hours. Gandhinagar District in Gujarat stands 89th in all crime records in 2013. 126th in no of murders, 122nd in no of rapes, 108th in no of robberies, 186th in no of thefts, 43rd in no of dacoities, 156th in no of kidnappings, 212th in no of riots. Gandhinagar has highest crime rate of 498.15 compared to National crime rate 218.67 in 2013. (NeighbourhoodInfo)

Even after developing one of the best BRT Systems, Janmarg, Ahmedabad dose not cater to the last mile connectivity in fringe areas, resulting in rise in the number of private two wheeler ownership in the outskirts of the city. According to transport department, 2.9 lakh vehicles got registered in Ahmedabad in 2017, in which 2.09 lakh were two wheelers and 57,661 were four wheelers. The figures are in stark contrast when the number of two wheeler registrations were only 1663 in the year 1999. (Times of India, Jan 22, 2018)

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PROBLEM	CAUSE	SOLUTION
Rise in private vehicle ownership	Bad/ nonexistent public transport infrastructure	Good public transport with last mile connectivity
Rise in level of pollution	Rise in inter – city travel with private vehicles	Good jobs-home ratio in a city
Increased Stress levels	Long hours of travel	Walkable neighbourhoods
Increase in crime rates	Deserted neighbourhoods	Mixed use land policy with eyes on street concept
Negative impacts on mental and physical health	Lack of open spaces for all	Strong policies in land use pattern with protected green and open spaces.
Lack of opportunities for LIG and EWS	Gated community development	Equal opportunity for all sections of society and creation of new job opportunities

Table 1 . Analysis of problems faced by satellite cities and Parent cities.
Source - author

CONCLUSION

Peoples' safety, transport, good jobs-home ratio, social equity, mixed land use policy and plenty of open spaces should be the baseline criteria to establish any new satellite city. These base criteria can help planners and developers to extend urban areas in a successful, sensitive and sustainable manner.

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Leisure Spaces in Highrise Residential Complex : Status of Swimming Pool

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Abstract :Todays scenario of happy and comfortable living standards leads to attractive residential projects by developers with multiple activities like, health and entertainment activities, in India. While these innovative inclusions in terms of amenities are mostly relegated to luxury residential projects, one feature that is commonly included in most residential projects is a swimming pool.This research paper aims to address the existing swimming pool spaces and their condition with respect to its maintainance provided in a residential projects in Pune, city. However, there has been much debate about the necessity of a swimming pool, it's maintenance and its utility to its residents.Specifically It's soughts to find out the condition mapping of existing swimming pool in the high rise residential complex.May be under or over utilise and lead to more or less usage after sometime. Applying the methodology of studying literature related to swimming pool, direct observations, site visits of the residential complex, people experience, management and other authority.

Keywords : Maintenance, Ambience, Privacy, pool, Quality, Status

1.Introduction:

Swimming pools, at least man-made watering holes for bathing and swimming, go back at least as far as 2600 B.C.E. The first elaborate construction are probably The Great Baths of Mohenjodaro, an ancient and elaborate bathing site in Pakistan made from bricks and covered in plaster, with terraced decks that wouldn't look out of place in a modern pool landscape. Mohenjodaro probably wasn't used for general lap swimming, however. Scholars believe it was used in religious ceremonies (Bellis, Mary. "The History of Swimming Pools." ThoughtCo, Jan. 29, 2020, thoughtco.com/history-of-swimming-pools-1991658.)

1.1 History and background

More man-made pools surfaced throughout the ancient world. In Rome and Greece, swimming was part of the education of elementary age boys and the Romans built the first swimming pools (separate from bathing pools).

Figure 1 swimming pool in2600 B.C..E

Figure 2 Swimming Pool First century BC in Rome.

The first heated swimming pool was built by Gaius Maecenas of Rome in the first century BC. Gaius Maecenas was a rich Roman lord and considered one of the first patrons of arts—he supported the famous poets Horace, Virgil, and Propertius,making it possible for them to live and write without fear of poverty.

1.2 Evolution:

However, swimming pools did not become popular until the middle of the 19th century. By 1837, six indoor pools with diving boards were built in London, England. After the modern Olympic Games began in 1896 and swimming races were among the original events, the popularity of swimming pools began to spread

According to the book Contested Waters: A Social History of Swimming in America, the Cabot Street Bath in Boston was the first swimming pool in the U.S. It opened in 1868 and served a neighborhood where most of the homes did not have baths.

In the 20th century, a number of leaps in science and technology took swimming pools to a new level. Among the developments, chlorination and filtration systems that delivered clean water into the pool. Prior to these developments, the only way to clean a pool was to remove and replace all the water.

This paper aims at finding out the status of swimming pool as a Leisure space inhighrise residential complex:

2. Objective to study**:**

i. Various technical and legal aspects related to Swimming pool

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ii. Recent conditions of swimming pooland immediate around spaces.
iii. Factors affecting the smooth working of pool
iv. User'sperception age and gender wise study of activities.
v. To study Original planning aspects and their execution.
vi. Schedule of maintenance

3.Scope: Though there are many factors influencing the nonusage process of swimming pool my analysis is limited only to the elements.

4.Limitations**:**This research is limited to record the users percep[tion of swimming pool use which is constructed on groundand used by apartments users having 11to 20 floors in Pune city only.

5.Literature review :

The research interest of this work is the status of swimming pool in highrise residential complex. In this section, we present the studies whose subject, objectof study, and methodology are close to our currentresearch related to in-between space, social interaction,spatial configuration, and space syntax.Social use of residents.

Mike Wheat Technical Director Norcros Adhesives, UK says that, The choice of construction methods and the specification of materials associated with the build up of tiled finishes to swimming pools and ancillary areas is wide and varied, however, the goals to be achieved for a successful facility are;

i. Safety in use
ii. Durability of performance of finishes
iii. Technical performance of a specialist facility
iv. Aesthetic performance

It can be argued that the tile grout can either playa part or can influence all four of these factors. To achieve the required standard of appearance it is essential to ensure that the quality of the workmanship and associated materials match those required standards.

Nothing detracts more from the appearance of the tiling finish than poor setting out, bad alignment, tile lipping etc. Quality installation begins with ensuring that the surface preparation and condition of the background are as recommended. The use of the correct tools, especially notched trowels, when applying the adhesive will influence the surface trueness of the tiling and the selection of the most appropriate adhesive to suit the combination of substrate, tile and service conditions is important. Equally, the adoption of the correct fixing method, especially on floors, will often playa part in the final appearance of the grouted joints. Voids in the bedding beneath tiles lead to the grout slumping in the joints, which, in turn, creates a reservoir for dirt accumulation, a situation made worse by a badly tooled, uneven grout surface. Further aspects of attaining a good standard of workmanship include setting out, cutting, alignment of joints and trueness of the finished plane of tiling. They(Mike Wheat Technical Director Norcros Adhesives, UK) have all seen how shoddy grouting and poor quality joint finishes can spoil the appearance of even the most attractive of tiles. It is recalled that many years ago, Derek Johnson, the then Chairman of H&R Johnson Tiles, was always complaining that poor grouts and grouting ruined his beautifully crafted tiles - and he was usually right.(Mike Wheat Technical Director Norcros Adhesives, UK)

Col RakeshPassi (retd), secretary, The Poona Club say that the Swimming pools using borewell water still operationalWhile the Pune Municipal Corporation (PMC) has issued notices asking all the swimming pools to halt operations, much to the delight of swimmers many professionally-run pools across the city and the pools at private clubs are still operational as they use borewell water for the purpose.The pool managers say they are not violating any civic order as they are not using water from PMC supply. "At our pool , we have two borewells that supply water to the pool. We have a good filter system and hence do not even require to dry and refill pool water. However, if we are required to close down the pool, we might seize the opportunity for a comprehensive maintenance. As of now, we have not taken any decision in that regard," said Col RakeshPassi (retd), secretary, The Poona Club.

At Tilak Tank in Deccan Gymkhana, an employee said that the pool services have not been affected as they use borewell water for the purpose.(Col RakeshPassi (retd), secretary, The Poona Club)

MeherIrani, swimming pool operations manager, Poona ParsiGymkhana, said that it's a myth that swimming pools require a lot of water. "Many pools today have good filter system. The same water is filtered and circulated. The only water required is for shower and there too we use borewell water. So even if the the civic body cuts off water supply completely, it wont affect us in the least," said Irani.

Kavita Sharma, director, Swimming and Life Saving Training Centres, The Rashtriya Life Saving Society (India), said of the 400 swimming pools in the city, only 50-60 are professionally operated with their own filter and chlorination plants.

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"The rest are private/society pools which refill water frequently. It is these pools that waste more water," she said.

In a letter to the municipal commissioner, Sharma has pointed out that if the pools are closed, the operators will not be able to cover the cost of electricity and maintenance. She has pegged the loss at estimated Rs 50-60lakh.

"The operators will not be able to pay salaries to lifeguards and coaches. Who will be responsible for this?" she asked, adding, the pools should be penalised only if they are using water from the PMC supply.

6.Material and Methodology:

Various legal and technical aspect of swimming pool: Pools pose a risk of drowning, which may be significant for swimmers who are inexperienced, suffer from seizures, or are susceptible to a heart or respiratory condition. Lifeguards are employed at most pools to execute water rescues and administer first aid as needed in order to reduce this risk.

Diving in shallow areas of a pool may also lead to significant head and neck injuries; diving, especially head-first diving, should be done in the deepest point of the pool, minimally 2.4 m (7 ft 10 in), but desirably 3.7 m (12 ft), deeper if the distance between the water and the board is great.

Pools also present a risk of death due to drowning, particularly in young children. In regions where residential pools are common, drowning is a major cause of childhood death. As a precaution, many jurisdictions require that residential pools be enclosed with fencing to restrict unauthorized access. Many products exist, such as removable baby fences. The evidence for floating alarms and window/door alarms to reduce the risk of drowning is poor.[34] Some pools are equipped with computer-aided drownin prevention or other forms of electronic safety and security systems.

The by laws of swimming pool offer a formal structure to the construction, management, maintenance and safety of swimming pools. These byelaws offer information covering the following:

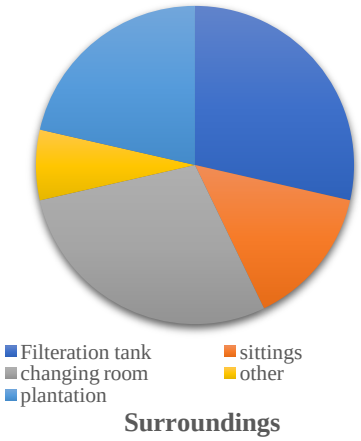
i. Applying for permission to construct and operate a swimming pool
ii. Swimming pool inspections by the authorities
iii. Modification of existing swimming pools, structuring the swimming pool, fittings and accessories
iv. Water treatment system
v. Personnel including pool manager, lifeguards
vi. Safety features and rescue equipment
vii. Water quality
viii. Operation and maintenance
ix. Operational timings
x. Regulations for swimming pool users

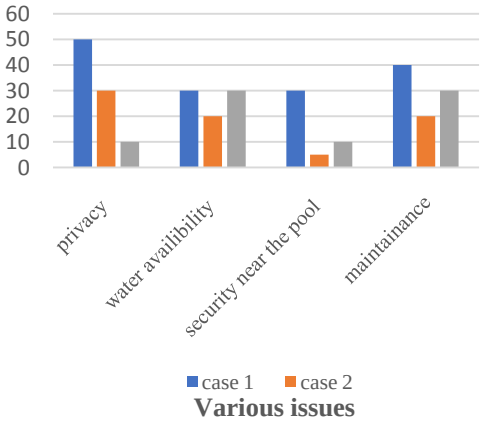
What about existing swimming pools?

For existing swimming pools, owners must carry out modifications mandated in these byelaws within a period of two months from the date on which they are effective. They can begin using the swimming pool only after the authorities inspect and approve it. (Technical aspects and maintaince of swimming pools.)

7: Result and Table :

i. Case 1 : Ujwal Paradise, Dhayri, Pune
ii. Case 2 : Suncity , Anandnagar, Pune
iii. Case 3 : Rohan Kritika , Navshamaruti , Pune.





8.Conclusions:

The status and use of swimming pool is dependent upon various factors like maintainance, water availaibility,

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privacy , policies of athourity. Highest priority was given to privacy for use purpose for all age groups and genders. Other subsiquitny issues redarding smooth working of pool is the responsibility of athourity and responsible use by users. The smooth functioning maintance issues were negible where one time maintaince was paid. Public awareness about decipline and responsible use has to be taken care of.

9.Acknowledgments

The author would like to acknowledge Dr.RajendraKoli, Ar.ShilpaIngawale, Mr. TusharHanmgar, Miss KartikiKelkar, MrSaranglathe and Miss MuktaiGaikwadfor their contribution to this work.

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Nature of modern life around transit hub in India

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Abstract: This paper discusses the current condition of areas around transit hub (railway station, bus stand and metro station) in India and design principles to solve the problems identified. The current conditions means the study of psychology of people around/ using the hub, the development of commerce, the lifestyle of people residing, the street patterns and circulation of different modes of transport systems. The problems were identified by different means of communication like surveys, interviewing local people, architects and urban designers. The design principle which are developed with reference to case studies of cities like Mumbai, Ahmedabad , Paris and by basic architectural design standards and should be used as guidelines for better development of the country.

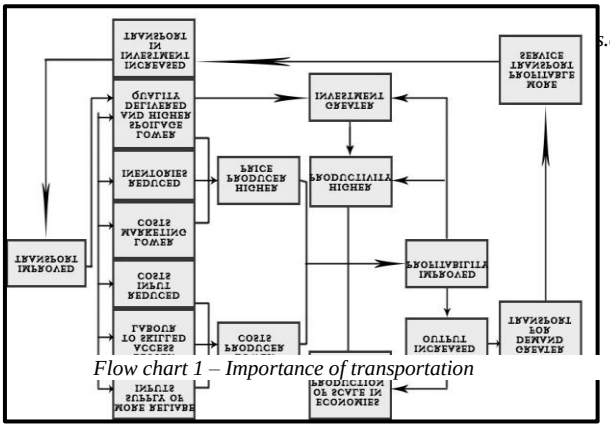
Keywords: **Transit hub, Nature, Modern life.**

I. Introduction

Transportation is driving force behind overall development. To support a wide variety of activities ranging from commuting, tourism, supplying energy needs, to distributing partsand final goods, societies (Citizens)have become dependent on their transport system. Developing transport systems which is related to dimensions such as nodes, locations, networks and interactions has been a continuous challenge to satisfy mobility needs, to support economic development. All spatial flows, with the exception of pedestrian trips and personal vehiculars, involve movements between terminals. Also the facilities in and around the terminal/hub makes the area a destination itself and can provide a ripple effect that encourages investment in area, generates new revenue streams, boosts wider prosperity and improve quality of life around transit hubs.

Transportation: "Movement of individuals, information and merchandise from one place to another with help of some mode is called transportation." They are mainly dependent on the commercial activity from which operational attributes such as transportation costs, capacity, efficiency and speed are derived.Transportation is an economic activity different from the others, it trades space with time and thus money. The fundamental purpose of transportation is geographic in nature, because it provides movements between different locations.

Importance of transportation:



Flow chart 1 – Importance of transportation

The above flow chart (1) explains the importance and output of improved transportation facilities. Economic benefits: Better production in both agriculture a industrial sectors, reduction in cost of production, reduction in scarcity, growth in foreign trade, specialization of labour and mobilization of resources, promotion of tourism.Social Benefits: More Employment Opportunities, Education Expansion, Social and Cultural Spirit, Higher Standard of Living, Relationship between Villages and Cities.

Modes of transport:

The means by which people and freight achieve mobility are transport modes. They fall three basic types– land (road, rail and pipelines), water (shipping) and air (table 1)Any facility where passengers and freight are assembled or dispersed is called a terminal. Terminals are points of interchange involving the same mode of transport or a point of interchange between different modes of transportation. Sometimes large transport terminals become the locational hub to their location since they become only points of transit between different segments of the transport system or the status of gateway in that area.

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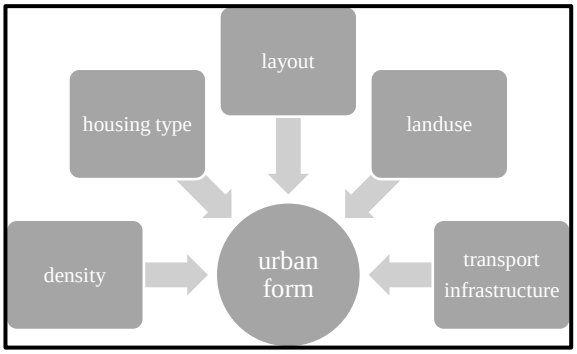
II. Literature

Transportation and urban form: Urban form is the study of human immigration and process of their creation and revolution. Due to the country's adoption of a mixed economy, which gave rise to the development of the private sector and acceleration to urbanization.

Role of transportation in urbanization: Transportation points develop or destroy the cities. Well-organised, cheap and economical transport facilities are of the first importance in the economic and social life of our cities and towns. Transportation system shapes metropolitan form and the form of metropolis shapes the transportation system. Thus, transportation, both intercity and intra city, is of prime concern of both urban and transport planners.

Elements of urbanization:



Flow chart 2 Elements of urbanization

Density: It gives the measure of number of people living in an area. By knowing the density we can figure out the culture of the area. Housing type: Buildings are the most pronounced elements of urban design - they shape and articulate space by forming the street walls of the city. The characteristics of housing in urban settlements can have an important bearing on everyday living: it hasbeen noted that residents living in low– density dwellings with large gardens will have distinct experience of urban environment fromhigh—rise apartment dwellers.

Layout: Layout describes the configuration of elements of streets, public spaces, blocks and buildings. Layout is important influencer. Public spaces make high quality of life in the city possible. Example the grand avenue "the Champs– Elysees in Paris to small intimate pedestrian streets.

Transport infrastructure: Transport systems connect the parts of cities and help shape them, and enable movement throughout the city. The quality and character of cities is defined by these various modes of transport, and that makes the cities either friendly or hostile to pedestrians.

Land use:The term land use is used to describe the different functions of the environment. Within the urban context, the dominant land use tends to be residential but a functional urban area requires industrial, retails, offices, infrastructure and other uses.

Road ways	Railways	Airways	Waterways
India encompasses of the second largest road network in the worldroad network of over 5,603,293 kilometres (3,481,725 mi) as in 2016.	Indian Railways has the largest rail network in Asia and also is the world's second largest rail network. Indian Railways transports almost 2.5 crore passengers daily	Major Indian airports provide both domestic and international flights. The Indian airport transportation network of effectively fulfils the needs of massive tourists and visitors who are arriving in the country from distant locations.	India forms one of the biggest peninsulas in the world with a coastline of more than 7,500 km. India has 13 major sea ports and about 200 non-major sea ports and intermediate ports
Cars, taxi ,van , bus, motorcycle, bicycle, rickshaw, carts	Local, suburban, monorail, metro, trams.	Passengers ,cargo	Ferry, cruise, cargo

Transportation problems: Road congestion**:** As populations increase, the average travel distances and intensity are expected to increase because of direct correlation between them.

Air pollution:The intensity of air pollution in Indian cities is judged based on CPCB's (Central Pollution Control Board) air quality classification.

Deteriorating traffic rules:Deteriorating road safety affecting transport infrastructure development. People driving habits/ manners leading to more accidents and problems like ongestions, these also includes the government transport drivers.

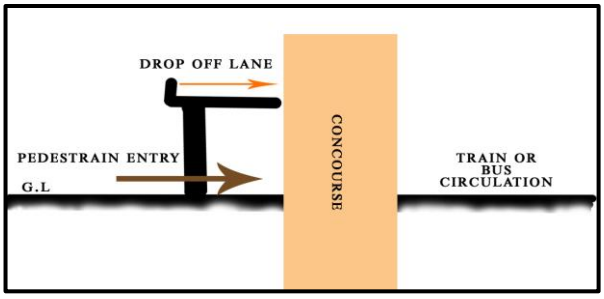


Image 1

Parking problems: The space required for a family of four (range from 85-250 sq. ft. depending on income level) is less

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than a car (typical spot = 280 sq. ft.). The shortage of parking spaces both on and off the streets in Indian cities increases the time spent searching for a parking spot and induces traffic congestion.

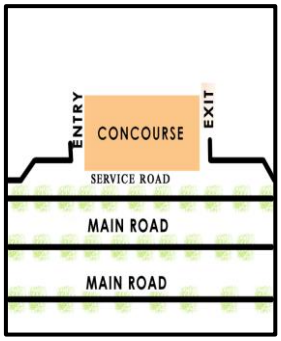

Image 2

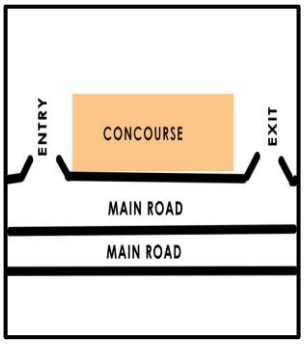

Image 3

Survey and interview results: In the survey and interviews of people of age group ranging from 18-47 years, either being a student or businessman or career hustlers having roughly income below 25,000 / 50,000 to 1lakh rupees. It is noted that most of people use public transports (trains, buses) on daily bases, these mode of transport varies according to different states. People are satisfied by current transit hub (bus stand /train station) structure, but they have problems like traffic congestion, hygiene, bad pedestrian walkways around the transit hub. Regarding the safety of people at night and daytime, many commented that it is being improved in past few years. Most of people suggestion were about the hawkers occupying space on the walkways, not giving a clear pedestrian walk and creating more confusion and about parking problems.

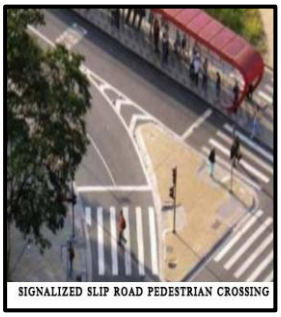

Image 4

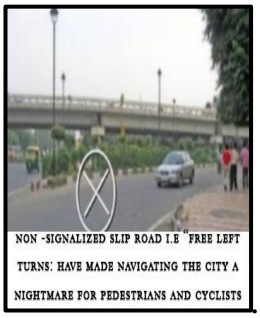

Image 5

III. Results and design principles

After interviewing various people, getting results from the survey conducted, case studies, simple observations and by applying architectural standards following are the design principles:

Image 6

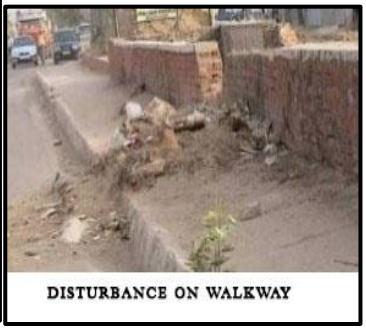

Image 7

Levels: It was observed that all the circulations (vehicular/pedestrians) everything happens on horizontal level creating more confusion and hustle for the users (Image 1). The solution for problem could be making things happen ondifferent levels (Image 2).

Entries / exits: The entries /exits of the transit hub (railways, bus stands) spills out straight on the main roads and disturbs the flow of the traffic (Image 3). The flow of traffic would be less disturbed if an entries and exits of the vehicles would be from a service lane or a by lane. (Image 4)

Image 8

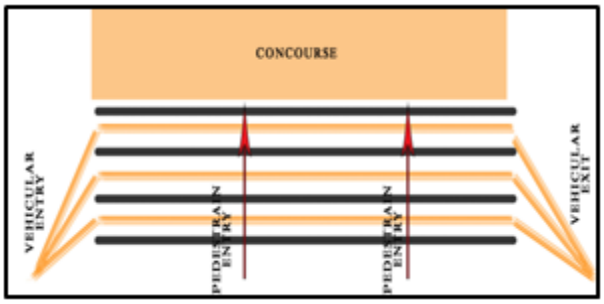

Image 9

Kerbs & slip roads: Decreasing turning radius of the slip roads increase safety of pedestrians, by shortening crossing

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distance, decreasing vehicle turning speed and makes drivers look out for pedestrians while taking turn. Slip roads in many cities are meant for the "signal free "movement of traffic and to spare the left turning traffic having to wait at traffic lights to take turn. This design feature has made crossing for pedestrians, cyclist and physically challenged people difficult to cross the road. The solution to this problem would be a signalized slip road or introduce a slightly raised crossings.

Footpaths: Footpaths should be considered as a transportation system which is connected and continuous just like roads and railways. Consistency of design elements, colour and texture help provide visual continuity and clam traffic even at crossing

Hawker's zones & frontage zones: Attractive windows and hawkers in shopping districts or entries leading upto a building create stoppages for pedestrians or users of the building. This disturbs the speed of pedestrian's traffic at the entrances of transit hub/ station. These hawkers take up about 0.5 to 1 meter additional space which must be provided in order to provide conflict free movements. In the survey, most of people answered saying these hawkers create disturbance and spoil the whole setup of the transit hub (Image 9). Actually, a design solution to this could be that, the hawkers could be placed and planned accordingly (Image 10).

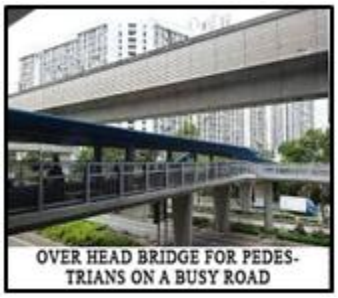

Image 10

Image 11

* Street busy, vibrant and safe .
* A variety of retail options and cheap food.
* Mixed-use and encourage walk trips in a city planned predominantly based on private vehicles.
* Generate self-employment for large number of people

Foot over bridge and traffic calming:

Foot over bridges are one of the alternative for roads where crossing distance cannot be lessen. They are to be provided only under circumstances (Image 12). Some other options for crossing could be undergroundcrossings or at grade crossings or traffic calming. Traffic calming is management of traffic through combinations of various devices and techniques, through this management technique the safety of pedestrians, residents etc is more, and it reduces vehicular speed and enhances the quality of life. The streets can be kerb less and paved with different materials to give impression of low speed or only pedestrian zones (Image 11). They can also be paved to create friction and lower the speed of vehicle. Boulevards or trees can be planted creating a physical barrier for vehicles in pedestrians dominated areas.

Image 12

Image 13

Image 14

Image 15

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Street tree planting: A transit hub becomes a heating island with all the vehicular moments and the area around has very less tree to compensate for the heat released. It is observed how badly trees and footpath are constructed (Image 13). The image 14 shows a proper way of planting trees. Following are the reasons, how planting trees is beneficial: Provides shade to pedestrians and cyclists. Reduces local ambient heat through shading the surfaces and making cool, comfortable for users to use.Absorbs pollutants and improve local air. Helps create a sense of enclosure and place making on streets for street furniture. Flowering or deciduous trees create a change seasonal urban experiences. It is observed that utility easements are placed on the footpath at side of a tree .Pedestrians corridor and utility easements must be placed separately from tree planting zones. Ideally utility should be placed in ducts or duct banks. Tree granting finished at the same level as pavement allows people to walk over them while still allowing water, air nutrients to access the roots.

Public toilets and dustbins: It is observed people use unwatched boundary walls of public spaces as public toilets and dustbins. Solution to this problem is provide

Image 15

Image 16

toilets and dustbins every 500-800 meters (5-8 minutes' walk) from each other and other destinations. Public toilets should be environmental friendly SulabhShauchalayas because: They don't smell .They consume less water and easy to clean .They can be used for techniques like biogas production etc. for generation of electricity. They provide employment.

Street lights: It is observed that the height of the street lamps is so much that it does not serves the purpose. The main intent of street light is: Safety of road users. Increase security and keep street active after dark. Provide visual night time environment .Reduce night accidents. Before placing the lights light engineer has to be consultant and necessary calculation has to be done.

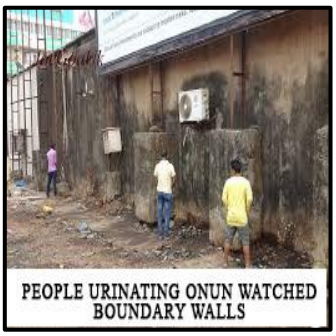

Image 17

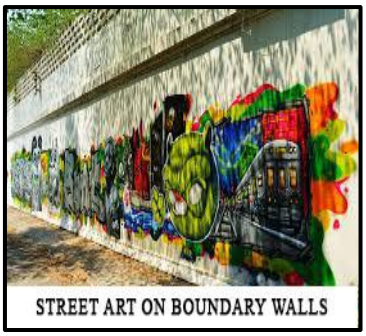

Image 18

Image 19

Boundary art: It is observed that there is no feeling of belonging, pavements are not maintained and boundary walls are abandon, therefore things like these happen.

Street furniture & signage: seating is an essential piece of street furniture which provides pedestrians and public transport users a place to rest or pause in the middle of their fast busy life.. In India many places have lack of these places the pictures taken in Mumbai shows the condition and need of such furniture. Also, to promote more public transports there

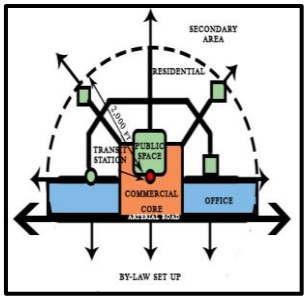

Image 20

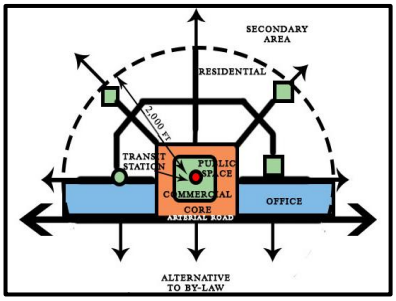

Image 21

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should be adequate maps showing the routes and boards showing timings of buses at the road side stops. Banners to be placed properly because they add a sense of place and identity to unique neighbourhood or a destinations.

Buffer zone: It is observed according to rules (image 20) transit hub are always in centre and are heating islands in that area, but an alternative (image 21)where transit hubhas a buffer of trees around it so the pollution is lessen , sound pollution is lessen and it creates an urban space which plays with physic of the people .

Conclusion

The current condition of transit hub (railway station /bus stand) and area around it in India is bad. This majorly affects the health of people phycology of people and countries infrastructure. By changing some small regular approach, it can make a big difference in improvement of the infrastructure and life of people around transit hub.

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Building Forms- An Inspiration Through Nature

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Abstract: Nature has been an inspiration and influence of many design theories. Nature-inspired designs by architects and designers have a long tradition. It is important to study nature to decipher the holistic relationship between human, buildings and nature. Following nature's trail by understanding the patterns, strategies & principles is necessary to create man-made system, structures and forms for better functioning and efficiency. Nature-inspired designs or Biomimicry have several levels. These levels include visual, abstracted, conceptual or computational designs. The main objective of this research is to understand the levels of Biomimicry. The understanding is achieved by case-study method of different levels and typologies. This is an observational type of research, where the methodology used follows qualitative analysis of selected case studies. The case studies are based on, Simulation that is the visual level of mimicking that involves literal translation or abstraction of building forms from nature. In this research paper, Lotus temple, Delhi and Guggenheim Museum, New York are studied in detail for understanding of simulation. Further cases depend on Interpretation that is the conceptual level of mimicking involving the understanding of the principles of nature i.e. geometry, structure and its functioning. The outcome of this study enhances the level of understanding of biomimicry. This could further be used to propose certain parameters for future designing of nature-inspiredbuildings

Key words – Biomimicry, Forms, Nature

INTRODUCTION

In the present age, where the world is undergoing drastic changes with the increase in population and usage of natural resources there is a dire need of a direction that leads to restorative and regenerative human systems that further leads to a sustainable world. A way forward could be by imitating to design improved and innovative solutions for architectural building form. To better understand the levels of biomimicry, it is necessary to understand various possibilities or approaches within biomimicry. The basic two strategies are top-down and bottom-up approaches, the former states the process of design looking at biology whereas the latter refers to biology influencing designs. Under these two approaches fall other categories like Simulation, interpretation, Integration, Replication and. Emulation relationship between buildings and nature. This research aims to study the aspects of nature and their inspirations

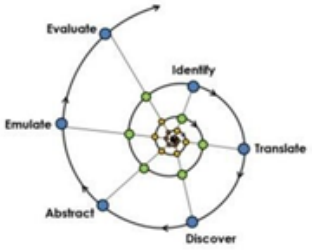

Figure – 1 Biomimicry Design Spiral (source- *Biomimicry- an analysis on contemporary biomimetic approach by SakthivelRamaswamy*

1.1 Simulation

nature to solve these complex human problems. Research on nature-inspired designs by architects and designers has a long tradition. Even before designers, indigenous cultures have mimicked nature in the process of coexisting with nature. The earliest examples being caves and leaves or trees to escape harsh natural conditions. The Greeks have been inspired by the organisms having balanced and harmonious proportions. Architects like Le Corbusier, Frank Lloyd Wright, Antoni Gaudi etc. have always used nature as a prominent source of inspiration. "Yurta" an invention in 2000 B.C. to Gaudi's master pieces in 21st century the growth has been quite revolutionary.

Biomimicry means designs inspired from nature by understanding its form, principles, function and processes. The nature-inspired designs can be classified into three major levels that are visual, conceptual and computational. It is important to study these levels to obtain or establish aholistic. This involves mimicking or copying the appearance of forms from nature to design buildings and structural forms. The form, the skin, the movement and other visual attributes becomes the source of inspiration with the designer borrowing one or more of these attributes to the design. Simulation that is the visual level of mimicking involves literally translated or abstracted building forms from nature. Most buildings out of this approach are given biomorphic character by enlarging the scale of the inspired naturalform

1.2 Interpretation

This involves understanding of the principles and functions of nature and interpretation of the same in buildings.

1.3 Integration

This approach tries to integrate the tectonics derives from

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forms in nature along with system or functions to make structures work in harmony with the surroundings.

1.4 Replication

This can also be termed as elementary biomimicry in which nature is mimicked as a cohesive whole not by a particular form, function or process. This level tries to attain the integrated functionality that is observed in nature like plants and organisms.

1.5 Emulation

This level is also termed as advanced biomimicry, which is based on modelling natural processes to the degree of self-rectification.

This research furthers talks about Simulation, Interpretation and Integration in detail. The question in this research is to understand how far these ideologies are reflected in our built environment and what the future possibilities of the same will be applicable to achieve a sustainable ecosystem.

LITERATURE REVIEW & METHODOLOGY

The literature on Bio-mimicry has fluid boundaries. A lot of research papers have been published on the same, further its possibilities depends on the topic of discussion or inquiry. In 1997, Benyus described biomimicry as being from the Greek "bios", which means life, and "mimesis", which means imitation. According to Benyus(2007) designers are mimicking the nature-inspired level as what the organisms have learned to do. Zari (2015) claimed a design that is inspired from nature may imitate the characteristics of an organism, that may be inspired by the three levels that is behaviour or the ecosystem of the organism and its surroundings. Guild (2007) "Three levels of biomimicry that may be applied to a design problem are typically given as Form, Process and ecosystem.". Pawlyn (2011) in her research paper states the first level of biomimicry is the mimicking of natural form. This type of imitating is to copy an organism for its morphological attributes like its visual shape, components, materials or how it looks. The first level is to replicate an organism's design. The second level is to imitate the natural processes. This level is to copy a biological entity's emergence or actions and processes within its environment. The third level is the imitating of the natural ecosystems. The last level is a more complicated set of processes than the first twolevels.

METHODOLOGY

This would be an observational type of research, where the methodology used would follow qualitative analysis of selected case studies. The Primary source would be book case studies & Secondary sources would be research papers andreviews.

The case studies are selected under two categories:

1) Simulation- Lotus Temple, New Delhi

2)Integration- 30 St. Mary axe (The Gherkin), London

The Parameters that would be studied in the case studies are Form, Function and Process. The outcome of this study will help to decipher a basic design theory, it will also enhance designers understanding and help them to determine which aspect of "Bio" to "Mimic" (Nurul, 2017)The field closely follows the paradigm of visual and conceptual inspirations from nature to obtain creative detail, mechanisms or shapes and structures in the Designs.

CASE STUDIES

1. Simulation

Direct mimicking or feigning the appearance of forms from nature is known as simulation. This approach helps in deriving forms, figures and metaphors by various designers and architects. Further using technology for representation of these mimicked forms from nature is used to express the designs. This level involves built forms which are literally translated or abstracted from nature**.**

1.1. Literaltranslation

In this approach nature's form and appearance are copied or mimicked literally, where in the scale would vary from the original form that is being mimicked.

1.1.1. Lotus-Temple, NewDelhi

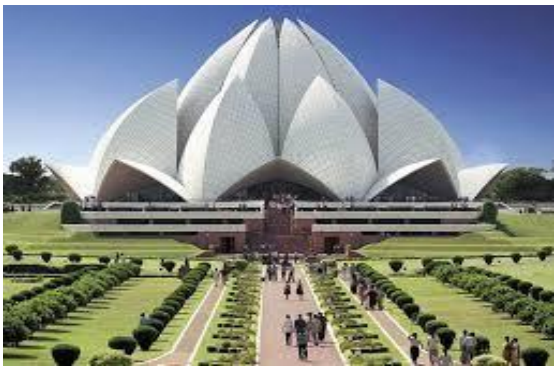

Figure – 2 Front Elevation- Lotustemple
(source- google image)

The structure is inspired by the lotus flower and is arguably one of the most visible instances of biomimicry in contemporary architecture. Lotus Temple follows the same process of mimicking nature, it is inspired from the Lotus flower. Conceptually Lotus flower symbolizes purity and holiness in the tradition. The temple gives the impression of a half-open lotus flower, afloat, surrounded by its leave. All elements are in multiple of 9 as it is said to symbolise comprehensiveness, oneness and unity

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1.1.1.1 FORM:

The Lotus temple is organized as a nine-sided circular structure that is comprised of twenty-seven "leaves" (marble- clad free-standing concrete slabs), organized in groups of three on each of the temple's ninesides.

1.1.1.2 FUNCTION:

The aforementioned "leaves" are integral to the organization of the space and are classified into three categories: entrance leaves, outer leaves, and inner leaves. The entrance leaves (nine in total), demarcate the entrance on each of the nine sides of the complex. The outer leaves serve as the roof to the ancillary spaces, complemented by the inners leaves which form the main worship space. These inner leaves approach, but do not meet at the tip of the worship space and are capped with a dramatic glass and steelskylight.

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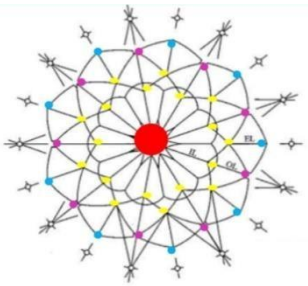

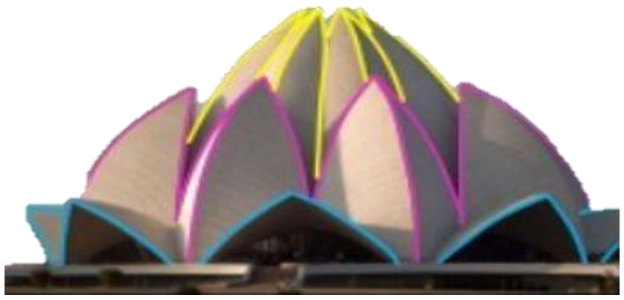

Figure – 3-Plan of Lotus Temple, 4- Elevation showing different uses of inspiration
(source- arch-daily)

2. Integration

This level involves design approaches that deals with integrating the tectonics that is mimicking the principles of nature through geometrical or structural interpretation and systems derived from nature. This is done so as to achieve self-efficient structures that work in harmony with the nature. The main aim is to achieve sustainability, a structure with low-energy consumption that would work with nature's dynamic systems.

2.2. The Gherkin (30 St. MaryAxe)

Figure – 5 Front Façade of The gherkin, 6- Elevation (source- google image)

The structure is called so due to its form resemblance to a young cucumber used for pickling. It is the first environmentally progressive high-rise structure that uses passive energy savingsystems.

The form is mimicked from a sea sponge known as, commonly called as Venus Flower Basket. It is a cylindrical sponge made of natural glass (bio silica). It grows till 6in in length with a strong exoskeleton. The tufts of glass fibres are about the thickness of a human hair and grows at the base of the sponge. The sponge has multiple layers of glass held together by an organic glue making it extremely resistant to cracking and breaking. It is arranged in a lattice or open crisscrosspattern.

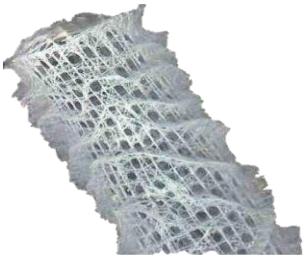

Figure – 7 Venus Flower Basket

(source- google image)

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The Gherkin mimics the shape and lattice structure of the sponge to do in air what the sponge does in water.

2.2.1 FORM:

As the Sea Sponge grows, it builds up a tracery of geometric regularity. These delicate frames are sufficient to support and protect the enclosed soft body of theorganism.

(ex. Fractals)

2.2.2. PROCESS:

The steel exoskeleton of 30 St. Mary Axe mimics the hexactinellid lattice of the Venus flower basket. It has a lattice-like, diagonally braced structure around the exterior that allows for an open floor plan without interior columns. The openness also provides a large amount of natural light penetration inside the structure.

2.2.3. FUNCTION:

The structure's air ventilation system is mimicked from the analogy of the sea sponge. The shape of the building defines the flow of wind just as the sponge helps water flow round it.

CASE STUDY	FORM	FUNCTION	PROCESS	ANALYSIS
1. Lotus Temple	Inspired through lotus flower	The leaves are divided into 3 parts separating different spaces		Simulation approach; only form is mimicked
2. The Gherkin	Inspired through Venus flower basket- Euplectella	Air ventilation system mimicked from the porous wholes of the sea sponge	Exoskeleton of the structured mimics the hexactinellid lattice of the sponge	Integrated approach where form, system and process is mimicked as that of the venus flower basket
ANALYSIS	Literal or abstraction of nature's form to achieve the structural form	By understanding the working process and system of nature and mimicking same so as to solve a problem	By understanding the morphogenesis in living organism to achieve working system of a building	Redefining the relationship between nature and buildings, to achieve and develop new sustainable technologies and structures.

Table 1- Analysis of case study

CONCLUSION

Nature inspired design approaches defined as simulation, interpretation, integration gives a way forward to achieve various built structures, achieving sustainability and efficiency. The analysis done on form, function and process gives an overview of contemporary techniques and technologies involved in the mimicking process.

Simulation approach copy the appearance and the form of natural forms to achieve a biomorphiccharacter.

Interpretation approach if done to achieve the underlying principle of nature and functioning of natural systems. Integration approach to biomimicry involves simulation as well as tectonic interpretation. Structures designed through integration achieve structural strength, functional efficiency and leads to a sustainable solution.

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude from the bottom of my heart to my guide Ar. Meghana Patel and Ar. Ketaki Gujar for their valuable guidance, inspiration and encouragement. Their support helped me to reach an irreproachable destination.

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Approaches of Adaptive Reuse of Heritage Structures

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Abstract: The cultural significance of India reflects in its heritage structures and architecture. Today they have started losing its essence as it is no more assigned a function, hence maintenance becomes an issue. Recently there is an increasing trend of reusing heritage structures in order to keep it lively whilst preserving the structure. Adding function to these structures is an effective way to retain the cultural significance of the structure. Adaptive Reuse enables such structures to continuously derive relevance from use and thus remain dynamically evolving. Apart from conserving the structure, its cultural significance should also sustain, which is seldom talked about in previous literature. This research focuses on different approaches of adaptive reuse and its effects. The research shall help in further studies regarding reuse of such culturally significant structures and the various approaches which can be followed.

Key words -Adaptive Reuse, Heritage, Cultural Significance, Hospitality Industry

INTRODUCTION

India is known for its diverse culture that reflects in its rich heritage. Most of our current architectural marvels have been designed long ago by our ancestors. Originally these were built to accommodate the rulers and their warriors and also a dignified shelter for the ruling family. The structures which were residences for the rulers and emperors; Forts and mansions, are today being preserved with no function to sustain. Since the grandeur and scales are not relevant to accommodate present living conditions, these significant structures should be assigned some function to keep them alive for the generations to come. Adaptive reuse has thus been practiced on heritage structures to conserve it and make them habitable and active. Yet simply assigning a function does not help in actually conserving its cultural significance – a sensitive approach towards reuse should be followed to ensure this. This study focuses on different approaches of reuse of forts and palaces to cater to the hospitality industry – Resorts and restaurants. The set parameters help in understanding how a particular space in the heritage structure is assigned different functions in different projects with the help of 3 case studies. The secondary focus of the study was about the use of materials for reuse and how it compliments with the original structure. Since hospitality industry requires various services which were not used in the olden days, a major concern in the study is about how the new services are added and treated with the traditional structure. New additions shall include toilets, hvac systems, kitchen services, lighting etc.

LITERATURE REVIEW & METHODOLOGY

"So much of our future lies in preserving our past" – Peter Westbrook. Thus reusing our historic structures in order to preserve its stories and culture becomes the most ideal method of preserving it, but while doing so we must be considerate enough to not suppress the significant character of the structure. As the time changes, the function changes and thus the requirements also change. Thus accommodating newer demands within the frame of an old structure becomes critical. So keeping this as a focus of the study , parameters were selected – reuse of structures into resorts and restaurants. The research was conducted with the help of case studies to understand the different approaches of reusing a heritage structure to serve the purpose of hospitality. The case studies selected are from 3 culturally different zones with certain significance- City Palace baradari (Jaipur) Chidambara Vilas(Chettinad), Jadhavgadh fort (Pune). These projects have a similarity – Palaces Reused to cater to hospitality industry, but the

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scales of the all 3 projects were different; for understanding different outcomes of similar functional change. Qualitative analysis of these cases has helped in understanding various approaches of reuse of heritage structures and the factors affecting it.

JADHAVGADH AS A CASE

The Jadhavgarh Fort was transformed into a heritage hotel, which would cater to leisure travelers and provide quality banquet services for large gatherings. The 30,637sqft. Fort was restored by Ar.Karan Grover in 2007. The fort resort has 57 rooms comprising of 3 suites, 38 rooms of various types, 12 royal tents and four Neem cottages spread across the fort's three wings.(Jadavgarh Fort, n.d.) The fort reflects the symbolic Maratha architecture which compliments the idea of a luxury resort. The sprawling lawns serves the perfect destination to host weddings, the pool side seatings and spa offers rejuvenation to the visitors , a one of a kind "aaimueum" exhibits exquisite artifacts and the rooms and tents offer a place to stay.The restoration is a mix of olden charm and modern-day luxury, but the exteriors have been treated to hold on to the Maratha charisma. Visitors are welcomed at the grand darbar (Fig. 1.1) which houses the information desk and reception (Fig. 1.2). Traditional Maratha seating's and the cool environment due to the stone structure creates a soothing effect upon entrance. Within the fort central courtyards act as gathering space for tourists and outdoor sitting for an inhouse restaurant. A pool and spa area (Fig 1.3) located on the first-floor terrace which is a calm silent zone with 2 huge neem trees retained during the restoration to create a cool micro climate. A restaurant named "chhajja" has indoor, outdoor and balcony seating options , where the balcony is the chhajja over the main darbar entrance (Fig. 1.4). Though the interior of the restaurants showcase a stark different look with bright yellow lighting , not so rustic furniture , tiled flooring building the ambience of a present day restaurant (Fig. 1.5).The same case follows in the rooms where the interiors(Fig 1.6) do not compliment the traditional Maratha exteriors creating diverse contrast from outdoors to indoors. The use of identical materials and finishes in the interiors would have helped in creating a holistic feel throughout the Fort.The new services could be easily identified on the characteristic Maratha backdrop- with ducts visible on a façade(Fig 1.7) to Hvac systems placed outside cottages(Fig 1.8) but toilet pipes were sensibly concealed by stone walls and creepers(Fig 1.8).The food was transported to the upper levels via trolley systems (Fig 1.10).Overall a gap was ascertained in creating a holistic appeal of a Maratha resort due to the presence of opposing "present day appeal" in specific spaces of the fort.

Figure 1.1 - The entrance Source- www.hotel.com.au

Figure 1.2 - The reception Source- Author

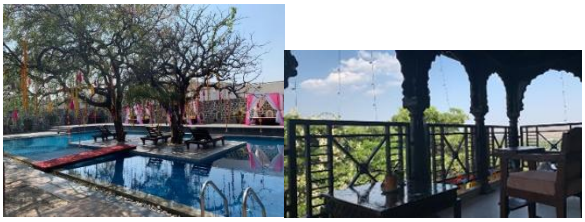

Figure 1.3 -Pool Source- Author

Figure 1.4 - Cafe Chhaja Source- Author

Figure 1.5-Chhaja Interior

Figure 1.6 – Rooms Source-(Fort Jadhavgadh, n.d.)

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Figure 1.8 -HVAC system
Source – Author

Figure 1.9 - Pipelines
Source – Author

Figure 1.7 -Service duct
Source – Author

Figure 1.10 - Services
Source – Author

BARADARI , CITY PALACE JAIPUR AND CHIDAMBARA VILAS AS A CASE

Baradari Restaurant -Situated at the avenue of City Palace Jaipur an amalgamation of historic revelations and contemporary additions is a fine dine restaurant which was created as an extension to the original palace café. The restaurant is a 14,000sqft. space divided into indoor and outdoor zones. The indoors have a royal yet modern touch with the traditional Jaipur Thikri work coordinated with marble and Tiled flooring (Fig 2.1). The furniture remains subtle and blends with the structure. Toilets have abundant marble and glossy finished surfaces which affects the holistic impression of the palace (Fig 2.2). The structure was given a new expression by stripping of layers of cement and paint and repairing the exposed rubble masonry with lime mortar. The courtyard was envisaged as a binding element between the city and the museum.(Adaptive Reuse – Baradari, City Palace Jaipur by Studio Lotus, n.d.)The handcrafted marble and brass pavilion with 12 columns magnify the historic character of the palace. Some adaptations in baradari were: the administrative block, now the bar with its rugged, distressed columns. Though the building boasts of rich stone work, an inconsistency is design is identified. All columns were not identical giving it an “Flawed look”.(Jaipur’s City Palace gets a newly renovated cafe, 2016)

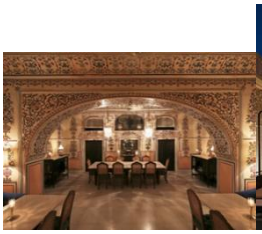

Figure 2.1 -Interior
Source – (Adaptive Reuse – Baradari, City Palace Jaipur by Studio Lotus, n.d.)

Figure 2.2 -New additions

Chidambara Vilas, Chettinad -A 110 year old palatial mansion once a residence of NattukottaiChettiars,was converted into a heritage hotel. The structure pursues a diverse style combining Indian and colonial architecture where the spatial hierarchy is conveyed through variation in décor ranging from highly adorned to simple and practical as one moves through the mansion. Local material and workmanship was used to carefully restore the mansion without disturbing its essence.(Ranee Vedamuthu1, 2014)Facade treatment of the extension (Fig 3.1) matcheswith the historic fabric by incorporating the traditional elements like parapets, stucco, columns, arches, and color scheme. Provision of attached toilets in guest bedrooms have been done carefully by providing a channel in the walls to accommodate the plumbing lines so as not to interfere in the overall appearance. Minute detailing like electrical accessories in the form of switches and switch board (Fig 3.2) have been replicated following the original details but with new material. Services like sewage treatment plant, water recycling and treatment plant and electrical room are planned in a discreet manner. Replacement of broken Aathangudi tiles on the roof and floor using Aathangudi tile masons to restore the existing pattern and color. Material restoration was done delicately by preparing local chettinadu plaster on site and applying wherever plaster had given way. The guest rooms and dining area has upheld the simple traditional appeal with the help of wood ,carvings and typical tiling patterns.(Fig 3.3) The extensions required to accommodate modern hotel requirements like guest rooms , toilets , hvac , lighting , water supply , drainage were done following the Chettinadu

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architectural style. A responsive approach is seen while adding these new spaces to maintain the historic fabric of the mansion.

Figure 3.1 -Exterior after reuse
Source -Research paper (Ranee Vedamuthu1, 2014)

Figure 3.2 -Minute detailing for reuse
Source -Research paper (Ranee Vedamuthu1, 2014)

Figure 3.3 – Rooms and dining
Source- (Chidambara Vilas, n.d.)

PARAMETERS	BARADARI,JAIPUR	JADHAVGADH,PUNE	CHETTINADU MANSION
Holistic Visual appeal	Blending modern material with traditional effortlessly.	A visible change between new and old structures.	Delicate material restoration to maintain the original character
Functions Accommodated	Fine dine Restaurant	Heritage resort and banquet	Heritage resort
Furniture , lighting and HVAC	• New simple furniture • Low energy electronically-controlled LED lighting systems • Energy efficient air-conditioning systems	• Restored old furniture and added new ones • Halogen lights used majorly • Hvac ducts visible on the rear facade	• Furniture with Chettinadu detailing. • Discreet planning of services
Overall Apeal			

Table 1.1 – Comparative Analysis

CONCLUSION

Adaptive Reuse of heritage structures into resorts has its own complexities regarding additional services and treating them such that it compliments the heritage character of the structures. This can be done is various methods depending on the major factors– The notion of the architect, availability of skilled craftsmen and traditional materials. No approach can be specifically termed as a Hence an holistic and sensitive approach ascertains beneficial results.

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude from the bottom of my heart to my mentor, ArNinadRewatkar for his valuable guidance, inspiration and encouragement. His support helped me to reach an irreproachable destination.

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To Experiment, Affordable Temporary Night Shelter For Homeless, Using Paper-Mache

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Abstract : Food, clothing, and shelter are basic human needs. However, many barely manage to fulfill the first two necessities and the third remains beyond their reach. Slums can provide an escape, yet individuals often cannot afford them. A large section of the population, therefore, lives and sleeps at public spaces, like pavements and streets, and is categorized as the homeless population. Hence, there is a need for temporary shelter which is affordable to the homeless people. In order to suffice the need for a temporary shelter, the research focuses on exploring the possibilities and drawing parallels using 'Paper Mache' as the only construction material.

Key-words- affordable, temporary-shelter, homeless, paper-mache, weather-resistant, eco-friendly.

Introduction

Every metropolitan city has both positive and negative sides. The positive being, it gives hope to the dreams of the people and exposure to various opportunities such as – a better living, reach out to all the facilities and more. The rapid growth of the city and its population, due to which the competition is getting tougher day by day, giving rise to the space crunch in the urban cities.

Many authorities, a group of environmentalists, and the government, together, are coming forward with various schemes and concepts to overcome the upcoming crisis in the future. In the current scenario, one part of the city is highly developed with all the necessary amenities, including leisure activities, while the other part of the city is filled with slums, unhygienic shelters and many without even a shelter.

The basic human needs are – food, clothing and shelter, however, many barely manage to fulfill the first two necessities, but the third remains beyond their reach. This is because people migrate from rural to urban, in need of a job and a better lifestyle, some of them manage to get what they want but the rest of the people end up working to earn at least for the survival, and then add up to the population of the homeless people.

A large section of the population, therefore, lives and sleeps at public spaces, like- footpaths, pavements, and streets, and is categorized as the homeless population. Homeless attempts to create shelters out of tin, cardboard, wood, and plastic, which becomes a temporary shelter without weather-resistant properties. Also, these types of shelters are difficult to handle, non-portable, and need lots of materials that make the product unaffordable. Slums can provide an escape, yet individuals often cannot afford them.

Thus, homelessness can be defined as a condition of people lacking housing, because they cannot afford or are unable to maintain a regular, safe, and adequate shelter. Hence, there is a need for temporary shelter which is affordable to the homeless people.

Temporary shelters are a service, for homeless people, which offers temporary residence to prevent one from exposed weather conditions and provides safety. Affordability depends upon the material chosen to build the shelter. While researching on the selection of the appropriate material for the experiment, the research came across the artifacts, sculptures and models made up of paper-mache which can be held in any shape possible along with the unbreakable strength after casting and resulting in the light-weight model.

These properties influenced the selection of the material, i.e. Paper-mache.

Hence, Paper-mache is being selected out of other materials (which cross the affordable limit) for the construction of the affordable temporary night shelter for homeless people.

In the latter experiment, the shelter modules made with the paper-mache were treated with waterproofing and fireproofing solutions to make the structure and prevent the individual from exposed weather conditions.

Literature-Review

A paper by Piyali Ghosh, Geetika Goel, Mohit Ojha, Homeless shelters in urban India: life sans dignity, 2002 [i] Talks about the cities in India that are already struggling to meet the rising demand for infrastructure development which are kept under increased pressure to accommodate continuous inflow of people from rural areas and from smaller towns and other cities.

A paper by Chandra Sabnani, The Use of an Unconventional Construction Material for Affordable Housing in India, 2017 [ii] Rapid growth in the urban area results in the creation of sections within the society with limited means, pushed into a life long struggle for survival. In such a scenario, even the basic needs are not possible to be met with.

A Paper by Dr. Julia Wardhaugh, Rural homelessness in India, 2012 [iii] Talks about Rural poverty and landlessness leads to rural-urban migration, which in turn increases the level of urban homelessness. Government responses may either be to improve rural infrastructure and thus attempt to prevent the causes of rural-urban migration, or to attempt to regulate the lives of the urban homeless population.

A paper by Gordon Solberg, Waste Paper produces Low Cost Housing, 2002 [iv] In this literature, low-cost housing by using paper with concrete has been discussed, which initiates the idea of structures made by using paper. It can be shaped in any form, is light-weighted after been cast and is cheap compared to the other materials used in the construction.

A paper by Hakan Arslan, Re-design, re-use and recycle of temporary houses, 2007[v]. Temporary houses made for homeless people should be reused, easy to cast and affordable.

A paper by Chandra Sabnani, The Use of an Unconventional Construction Material for Affordable Housing in India, 2017 [ii] The literature raised the possibilities of using unconventional materials to provide the urban poor population to overcome the affordability factor instead of using conventional materials.

In a paper by Antonio G. Valdecasas, Ana M. Correas, Carmen R. Guerrero, Jesús Juez, Understanding complex systems: lessons from Auzoux's and von Hagens's anatomical models, 2009 [vi] and Elizabet Nijhoff Asser, Lost fingers, scurfy skin and corroding veins – conservation of anatomical paper-mâché models by Dr. Auzoux, ICOM COMMITTEE FOR CONSERVATION, 2008 [vii] states that the models made up of paper-mache material has good strength, durability, easy to cast and inexpensive.

Materials and Methodology

Paper is the only material, which is easily available, reusable, lightweight and eco-friendly. Paper Mache is a mixture of paper with water and glue. Newspapers or any other old paper (avoid glossy and thick papers) are used in the making of the mixture. The main objective of the research is to study material behavior, examine the structural stability, testing against weather conditions and lastly comparing the cost of the module.

Procedure

(Note – The experiment is carried out manually and at a lower scale, i.e. 1:10, hence, the requirements of the amount of the materials are accordingly)
The following are the required materials for the execution of the experiment.

- 4-5 Newspapers,

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- 1/2kg Fevicol,
- 1Litre of Tap Water,
- Vessel/bucket, and
- Plastic formwork (according to the shape and size finalized)

Stage-1

- Take the newspapers, cut it into pieces, and keep them in a vessel/bucket filled with warm water.
- Let the paper soak and submerged into the water, for several hours or overnight.

Stage-2

- Once the pieces are soaked fully, mix it, blend it with the hands, and squeeze it through the fingers until it looks and feel similar to the oatmeal. If necessary add a bit more water and let it soak for a little longer.
- Drain (75-90)% of water while carrying out the paper mache from the bucket and keep it aside in a vessel for further mixing.
- Now add 1/4kg fevicol, which acts as a binding element, to the Paper mache and mix it well until it looks and feels similar to the dough.
- For this particular experiment, as plastic is smooth and can be easily removed, a plastic bowl is used as formwork. It can be used for n number of times as a formwork.
- Now, apply the mixture, immediately after mixing the fevicol with the paper mache, onto the formwork. This continues until it is up to the required thickness for the module.
- Keep it under the sun rays, until it dries too hard like a stone. It takes around 2 days of sunlight to dry up from the outer side. Now take the formwork off, and let it dry from the inside, under the sunlight, for 2 more days.
- The same procedure is repeated to have 2 modules in total for the experiment purpose.

fig. 1. Module before drying

Stage-3

The above procedure is carried out to create a base for further experimentation.

- Modules 1 and 2 are further treated with a polyurethane coat and white cement + URP coat, respectively.
- Module 1 is treated with a polyurethane coat, 3 times, from outside and inside of the module. While
- Module 2 is treated with the mixture of White cement + URP until it attains a thickness of 2mm. After applying the coat, leave the model for several hours/overnight to dry completely.

Test for Water-proofing

module 1 and module 2 were further kept under tap water for an hour to check for absorption.

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fig.2. Module 1 fig.3. Module 2

Test for Fire-proofing

module 1 and module 2 were further kept in the presence of fire flame via lighter to check if it catches the fire or not.

fig.4. Module 1 fig.5. Module 2

Cost of the module

The cost of the module (made up of paper-mache) is low as compared to the other materials used for making temporary shelters out of tin, cardboard, wood, and plastic. This is because the primary material for the experiment is the newspaper, which was reused and easy to find at any recyclable material collector's store. The other supporting materials were bought in bulk once and can be used several times on the number of modules possible.

Observations

The below table is the observation during the procedure of making the module

Criteria	Before Drying	After Drying
Strength	Loose and Weak	Hard and Strong
Weight	Heavy	Light
Color	White/Light in color	Dark

The below table is the observation during stage 3 and tests against weather conditions.

Criteria	Module 1	Module 2
Treated with	Polyurethane (PU)	White-cement + URP
Weight	No change	Increase in weight
Cracks	No forming of cracks	Forming of cracks
Water-Proof test	Absorbs water	Does not absorb water
Fire-Proof test	Catches fire	Does not catches fire

Result

After casting, the modules are hard enough as stone, durable, reusable, lightweight, easy to handle, and eco-friendly. It does not break even after throwing it from a height.

Module 1, i.e. treated with Polyurethane coat, does not prove to be appropriate for the building of affordable temporary night shelter using 'Paper-mache', because it soaks water in and loses the stability. Also, it catches fire easily because the polyurethane coat is plastic in nature. While, Module 2, i.e. treated with White-cement + URP coat, proves to be appropriate for the building of affordable temporary night shelter using 'Paper-mache', because it is waterproofed and does not catch fire.

Conclusion

Paper-mache can be used as a basic material to build various kind of temporary structures which is affordable to homeless people, however, it needs to be treated with White-cement + URP to make it weather resistant.

Due to its light-weight and scale, it can be transported and stacked easily.

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Impact of Building Performance on Quality of User's Life in Housing Society in Pune City: Case of Yashashree Society

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Abstract: Building Performance Evaluation (BPE) is the process of evaluating the performance of the building post construction and post occupancy. Various nations carry out BPE's based on their cultural, institutional and other parameters. In Pune city, where lifestyle is constantly changing (modernization), housing is in demand. Implementing BPE is important. User satisfaction is one of the most important parameters, since it is one of the biggest investments of one's life. Yashashree society in Pune was studied in which, 25% of residents were interviewed using questionnaire method & Likert scale. Basic attributes like accessibility, safety & security, visual comfort, thermal comfort etc. are described, which would help architects for evaluating a building's performance and may become part of city's policies.

Key words – Building Performance Evaluation, Quality of Life, User Satisfaction

INTRODUCTION

Various nations have different light qualities, climatic factors, economic conditions and most importantly different lifestyles. Due to these and various other factors, performance of various buildings in all the nations differs. A person spends most of his or her time, if not quantitatively but qualitatively in his or her house. Due to this it becomes very important that houses perform well. But a modular housing system is followed in housing complexes as catering to every end user through design is extremely difficult and non-economical. Hence, in these scenarios, performance of buildings becomes increasingly crucial.

For the same there is need for theoretical framework to help architects / designers to design spaces that are more functional and which cater to all user groups. This research paper and the questionnaire prepared would help Architects who want to perform Building Performance Evaluation.

1.1 Building Performance Evaluation (BPE) and User Satisfaction

Building Performance Evaluation (BPE) is the process of evaluating the performance of the building post construction and post occupancy to reduce the uncertainties. Building performance evaluation is carried out in various nations based on their cultural, institutional and other parameters. There are internationally approved parameters and methods for conducting BPE. But even if this data is readily available for designers, it cannot be put to practice directly. As the region changes, a majority of this data becomes irrelevant as the lifestyle and the climatic factors go through a tremendous change. Due to this there is data exchange barrier. This creates a need for region specific and user specific BPE.

1.2 Importance in Architecture

With more and more BPEs being conducted and documented, a great database can be created for reference and can improve the quality of architectural education. Architectural education should promote architecture that originates from these concepts rather than these being compliance steps that are added later on. Architecture should focus primarily on the quality of space and then the aesthetics.

1.3 Pune and modernization

Pune is the educational capital of India, with students from almost all of the countries. It is also a huge IT hub (Hinjewadi). Apart from that it is located near the industrial area of Ranjangaon. On the other hand, Pune was the biggest administrative hub during Peshwa Era and still shows some similar characters. Basically, Pune has grown to house a huge Variety of users with striking differences in their lifestyles. Since there is a drastic increase in population in Pune, Housing demand increases and people of different regions and religions migrate. Designers design housings based on general parameters, in which they even forget some basics.

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At such a place, developing buildings that cater to specific user base in the best possible manner is unavoidable. A method to create such database is through the method of Building Performance Evaluation.

LITERATURE REVIEW

A house is a basic human need, this is the place where people spend most of the time. A challenging problem which arises in this field is giving quality of life to users. Housing is the biggest investment of one's life and one must get a better quality of spaces, indoor as well as outdoor. (Eziyi Offie Ibem, 2013)

A research paper- Quality of life- Meditation on People and Architecture, talks about promoting the importance of the concept of healthy living as an indicator of quality of life among architects by adopting a more familiar language to them. For this it uses an accepted historical theoretical framework. Architects are the one who designs for people, they should know what are the basic needs of the users so as to design spaces as per user satisfaction. Architects need to know what design strategies they should use while designing qualitative indoor air. (N Boschi, 2002)

This paper aims to give some categories which would help in housing quality analysis. These would be based on items related to spatial planning, location, aesthetics, cost attributes, physical or social barriers, etc. (Strossmayer, 2017). There is a growing appeal for constant assessment of quality of housing to meet the needs of users. A common strategy used to study this is Building Performance Evaluation. Various countries have different categories and tools of analyzing housing quality and knowing user satisfaction. There seems to be a common problem where nations have derived their own parameters of assessing the quality of housing, based on their cultural values or cultural context, institutional, user lifestyles and many other bases. (Fionn Stevenson, 2017)

As the industry moves towards providing better products in terms of houses and housing complexes, BPE becomes increasingly important. Worldwide, various housing performance evaluation tools are being used over the last decade. In the paper- Categories for Housing Performance evaluation (Ankita Srivastava, 2014), they have tried and assessed the degree of relevance of the identified categories in the popular tools used worldwide. An important conclusion from this paper was that there is a need of compressive indicators for housing performance evaluation in India, which could act as a basic reference to planners and designers in the field.

METHODOLOGY

The methodology to obtain the objective of this research paper were identification of attributes that would help in analyzing user satisfaction in a building, describing the characteristics of these attributes and preparing questionnaire. Attributes once listed would be vetted through opinions obtained by the users (residents) of the building, comprising of kids, teenagers, adults and elderly. Methodology includes rating scale (Likert scale) for each question. Effectiveness of questionnaire prepared and utility of data obtained depend on the choice of correct attributes, appropriate identification and description of their characteristics and converting them into easily understandable questions. Questions thus formulated need to be unambiguous, provide clarity to all possible types of participants and be amenable to analysis and interpretation. A near correct picture of actual performance of the built facility from the user point of view will enable facility managers to address pertinent issues.

Questionnaire would be similar for all user groups because every individual would have different opinions and would respond differently. From the total residents, responses of 25% of residents was considered for the survey; which involved 3 different age groups: 5-10 years, 25-30years and 60-70 years. Weekends were used for carrying out the survey, preferably evening time. Also, some observations were made by visiting different spaces in the society and apartments.

ATTRIBUTES FOR STUDY

Attributes for BPE	Characteristics of the attributes
Accessibility	Location of staircases and lifts
	Fire-fighting equipment's
Safety and security	Safety while using internal roads
	Safety in apartment due to railings, grab bars and grills provided
Illumination	Natural light affected due to orientation of house
	Provision of light in terms of safety while transiting between spaces

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	Provision of natural lighting in corridors, basements etc.
	Appearance of spaces
	Appearance and beauty of the open spaces around the building
Ventilation	Natural ventilation affected due to orientation of house
	Chances of choking or suffocation in spaces like parking, kitchen etc.
	Provision of ventilation strategies w.r.t energy saving
	Lack of vegetation around affects indoor air
Finishes and Aesthetics	Impact of internal and external finishes on inside due to outside peak temperatures
	Impact on finishes due to heavy rains

Table 1: Attributes of Building Performance Evaluation
Source: Author

Basic attributes which were analyzed by the questionnaire were related to illumination, safely & security, accessibility and aesthetics. One of the attributes considered in Building Performance Evaluation was accessibility, accessibility to different spaces and basic needs of users. On each and every floor, location of staircases and lifts becomes crucial. Another attribute was about safety and security. Do the users feel safe in the railings, grab bars and grills provides throughout the building? Also, the internal roads provided safe. Another attribute for BPE were illumination and ventilation: qualitative and quantitative.

Also, proper illumination in different spaces like lobbies, staircase, open spaces and internal roads contribute to safety of movement. This provision also improves appearance of the space. On the other hand, ventilation also gets affected. Lack of ventilation leads to suffocation and choking. Vegetation must also be sufficient for maximum ventilation in apartments. Provision of natural light and ventilation indirectly helps in energy saving. Finishes play an important role as far as aesthetics is concerned. Provision of good quality internal and external material finishes plays a key role. It also helps in temperature control inside the structure. When the outside temperatures are at peak, the finishes must stay. In case of heavy rain, as seen recently in Pune, the provision of good quality finishes plays an important role.

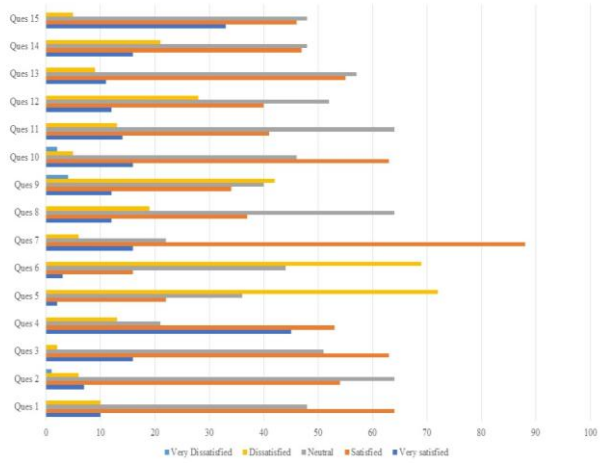

Figure 1: Graph showing responses by the residents for the conducted survey; Likert scale analysis
Source: Author

ANALYSIS OF RESPONSES

This study evaluated the performance of residential building constructed between 2010 to 2018 in Pune. The satisfaction level with accessibility within the building and safety & security in the housing was higher than any other aspects of the building, and the most important factor that determined user satisfaction was the apartment orientation: the quality and quantity of illumination and ventilation in the apartment.

Figure 2: View showing Yashashree society: considered for Building Performance Evaluation
Source: magicbricks

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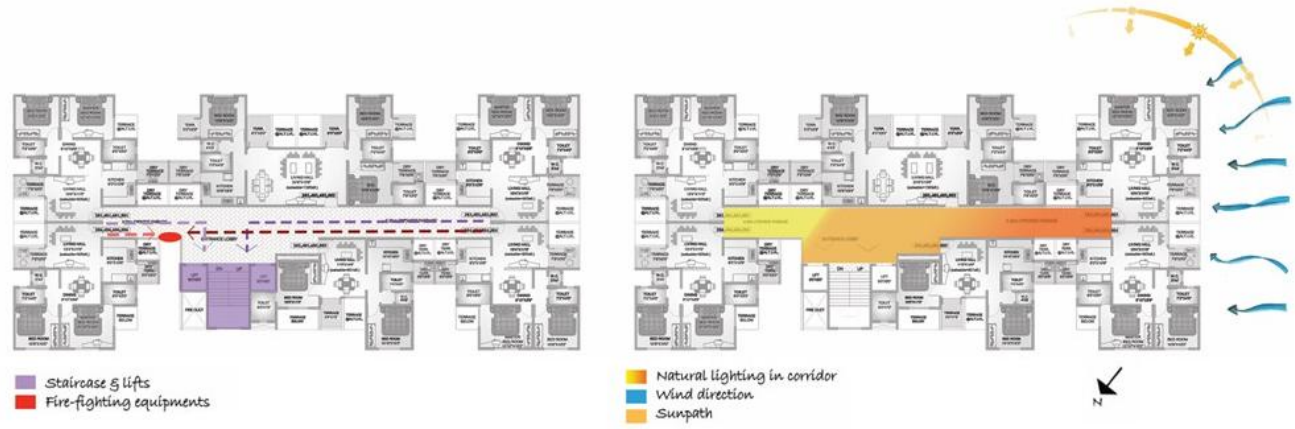

Figure 3: Plans showing basic attributes related to accessibility, illumination and ventilation
Source: Author, KNK developers

Findings from the survey show that in order to enhance the quality of life which the users have in the residential society in Pune city, and to meet the demands, expectations and needs of the occupants, several steps needs to be taken. First, there is a need to improve the quality of finishes used in apartment. Also, while designing lighting layouts and other such layouts, designer must keep in mind about movement, safety of users and aesthetics of the space. secondly, a significant improvement is required while designing and planning of housing societies to better reflect the current lifestyle of users and also address the status concerns of the target population.

The buildings evaluated happens to have long corridors, some apartments were close to them and some away. Similar happens when location of fire-fighting equipment's and daily services come into picture. In the buildings, the fire-fighting equipment's were places at a place which are closed to one apartment and away from another. This becomes critical in case of emergency. With respect to the safety and security factor, what was observed is the streets or the internal roads are very well used by people; by cars and by the pedestrian cyclists as well. Kids do play and adults do walk on these roads safely.

CONCLUSION

Generally seen, housing planning involves designing of a flat considering all spaces completely naturally lit and ventilated. But the flat on the opposite side of it doesn't get the similar benefit, as it is receiving opposite quantity and quality of light and ventilation. Thus, the concept of mirroring has this disadvantage. Architects needs to think of each and every material they provide in design in any building, that choice of material and finish would be governed by the climate and requirement of the finish. Every designer must think of while planning services like location of staircase, lifts and fire fighting elements, they must be centrally placed for ease of convenience. Provision of more plantation and equally dense vegetation is important as it affects the ventilation of indoor spaces of structure.

This research would help analyzing and modulating parameters for further designing. This would also standardize criteria for architects and developers, and may also become a part of city's policy making.

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Expression of Human Values in Architecture : Study of Institutions by Kanvinde

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Abstract: Post-independence the search for 'Indian Identity' was the single most important goal. The means to achieve it varied for most of the architects at a time when the modern architecture was becoming devoid of character. Kanvinde along with others were trying to achieve it through different means.Kanvinde expressed 'human values' by achieving the experience of architecture through form and space.Human values are of central importance to man's nature of being human. The expression of 'human values' can be traced through his architectural career. This paper through the analysis brings out expression of human values in the works of Kanvinde.

Keywords:Human values in architecture, father of campus planning in India, modern architecture in India

INTRODUCTION

"Over the years, I have come to believe that it is imperative that an architect develops sensitivity to human nature and respect for human values."(Kanvinde, 2017). When we talk about human values, we think of what is important to an individual in one's life. The human values differ from a person to person. A particular value could also be of vital importance to at least one person but unimportant to another.There are very diverse values among people. We can summarize the most features of the formation of basic values inherent from writing of many of the theorists and researchers which reveals that Values are beliefs; the beliefs that are attached to the emotions of a person.When values are related to architecture, they act as a motivational construct for people. Through the expression of people's values in architecture; it forms an ordered system of valuable priorities that characterize them as Individuals.Values guide actions, people and situations; which can be achieved by designing buildings such that the built form encourages them to explore themselves as individuals and grow in life.The most common human value that unifies people all around is the value of growth as every individual wants to have a growth in life which can be in terms of physical growth and mental growth. The expression of such values can be traced in the post-independence architecture of India when the growth of India was the ultimate goal and to help India achieve that architecture played a very important role.

The architectural history of post-independent India traces the success of the modernist architects like Laurie Baker, Charles Correa, B.V. Doshi, and Raj Rewalwho achieved an appropriate regionalist expression. The 'Indian identity' demonstrated to be the single most important goal, while the means to achieve it were different and questionable at different levels. With some distributed mentions Kanvinde is grouped into functionalist or Brutalist categories, implying that his works could not fit easily in the narratives of the period.(Sane,2017)When in the year 1945; Kanvinde returned to India, the modernism movement in architecture had already started in India. Kanvinde not only understood the principles of Modern architecture but also the cultural and social structure of Indian people which is reflected in his architecture since 1947.One constant term he stressed was 'human values' and the architects concern for activities and their human relationship. He expressed term 'human values' in architecture through form.Kanvinde expressed 'human values' through a form that go together with the idea of progress reflected in the evolution of technology.

In spite of being celebrated as an influential postmodern Indian architect,Achyut Kanvinde remains unacknowledged within history andhas conspicuouslyremained unsung in the modern

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movement of India. Most of the projects designed by him are institutional,spread across India which are not studied, though they have contributed to development of modern India. There are very fewer references or documentation of Kanvinde's works with an in-depth study and understanding of his institutional projects.

AIM

In the context of technological advancement when contemporary architecture is becoming monotonous, the expression of human values through architecture becomes even more significant. Hence, the study will develop an understanding of human values as expressed in the architectural vocabulary of AchyutKanvinde.

OBJECTIVES

- To analyze formal and organizational expression of human values through architecture
- To recognize growth as a basic human expression and its manifestation in the works of Kanvinde
- To discern the architectural vocabulary of Kanvinde

METHODOLOGY

The study relies on secondary sources like books, periodical and articles for the understanding of term human values to create the theoretical framework.Projects designed by Kanvinde were visited to gain the first-hand experience of the formalexpression and spatial qualities of the buildings. Drawings and the personal interviews (with professionals who have worked with him) have formed the bases for analysis to gain a comprehensive knowledge about the topic. Study is concluded based on the inferences drawn based on the expression of these values in his buildings.

CRITERIA FOR SELECTION OF CASE STUDIES

Kanvinde's oeuvre spans over five decades, the range and scale of these projects is vast, selection of case studies is based on

- The focus of the study is on institutional projects, as a representative case is studied.
- Since the experience of the buildings is of utmostimportance buildings located in and around Ahmedabad have been considered for this study.

DEVELOPMENT OF A PHILOSOPHY

Kanvinde in 2017 mentioned "Architecture is the crystallized physical expression of culture, projected into space.". Post-graduation from Harvard University when hereturned toIndia, he joined CSIR where he worked on the organisation in the design of Research laboratories. During his period of working with CSIR, one can clearly see the reflections of habits of design practised at Bauhaus In his early works one could see the influences of International style(Lall, 2017). Kanvinde as stated by him was surviving on his earlier knowledge gained in Harvard and that he was stagnant in his approach.Admitting this thought he started trying to search for deeper meaning and values associated with architecture. By analysing the works of known architects and writers, Kanvinde realised that an evolution of form is contributed by values and meanings associated with physical and psychological needs of the user. It was a constant search for a deeper understanding of values associated with the human environment to architecture rather than merely following clichés in the name of modern and also postmodern architecture as a pattern. (Kanvinde, 2017).

FIGURE 1.1

He tried to search for human scale and values through local materials for its efficiency associated with the region. He believed that the real strength of a building lies in how it gets recognized and accepted by people and that is what really mattered.

IDEA OF GROWTH AND ITS MANIFESTATION THROUGH MODULAR SYSTEM

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"An understanding that the true client of any work of architecture is mankind and the conviction and ability to put this belief into practice" (Broide, 1960) The basic requirement that man demands in his environment is growth; which is the common human value that unifies people all around.Each architectural conception, whatever may be its indicated use, effects many other purposes which turn into a part of reaching pattern of experience and growth.A basis for architecture relating to human values suggests that designing for a man's environment does not directly indicate the application of a rigid set of any kind of rules, but demands the opportunity for a continuous pattern of growth.Kanvinde while designing the larger campuses accentuated scale by breaking larger masses, divided into smaller units and connected them by corridors which allowed expansion and growth of human as well as the built form. The human pursue growth through the development of human persona and growth of their common shared value.

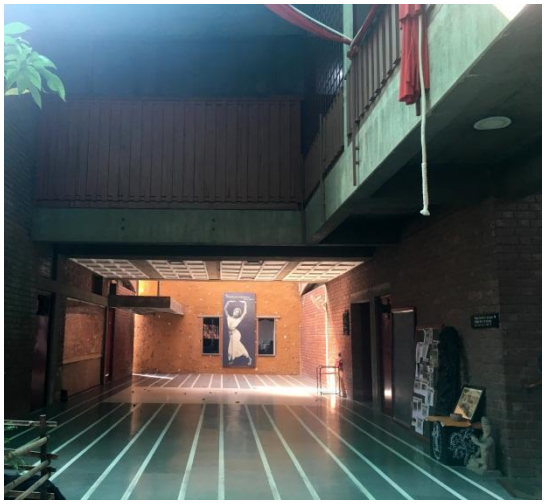

FIGURE 1.2

When we talk about growth as a human value in architecture, all the buildings are designed by keeping the usage of building in future and the need to expand the campus or building always arises. While expanding the campus, the task to keep the language same through architecture is always lingering. To achieve that ability, Kanvinde promoted the principle of modularity where the trick was to devise standard spatial and structural modules which could be attached horizontally and vertically.The method of using repetitive modules would create adirective. To overcome such an order, Kanvinde designed modules of different volumes which are twisted and connected through varied manner keeping the structural denominator same which helped in creating variations of spaces while maintain the commonalty and integrity.

EXPERIENCE THROUGH ARCHITECTURE

A. MODULAR IDEA OF GROWTH

Kanvinde used the system of modules in order to manifest growth – the very first human desire. Institute of Rural Management, at Anand is designed on a modular system which is based on a structural grid. The buildings are designed by repeating the same modules horizontally and vertically which is getting reflected in the plan of IRMA. The modules have been twisted and there is a volumetric play in the modules that adds a different experience of spaces even though they have been designed through the process of additive form. The library is arranged as four similar modules around a central atrium.Another institute located in Anand, Anandalaya School is based on orthogonal and diagonal grids; the institution is designed through L-shaped clusters which are formed by repetitive modules of classrooms, laboratories on one side and the administration, audio-visual centre on the other.

Darpana Academy in Ahmedabad is planned around an open central space which also acts as an extension of teaching space by the repetition of modules through different permutations and combinations. The form of the private residence of the director is dictated by the linear form generated on the lower levelthe following figure shows the modules used in the plan and the connections of modules through plinth.

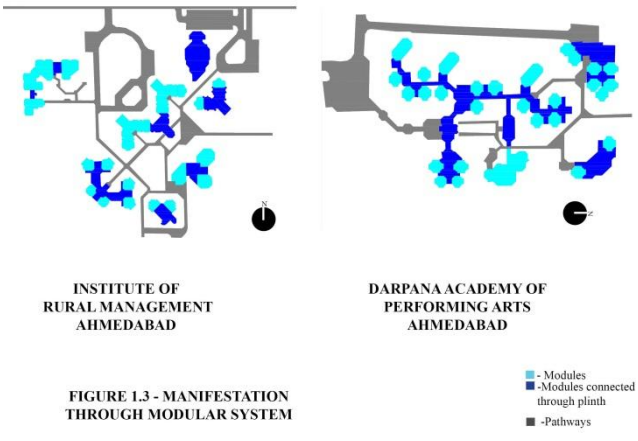

FIGURE 1.3 - MANIFESTATION THROUGH MODULAR SYSTEM

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B. SELF DIRECTION THROUGH MANIFSTATION OF ORGANISATION

IRMAcampus is planned as a system of continuous space that is linked through pedestrian routes demarked between all the buildings. The functional composition of the campus is done in a way that it divides the academic zone and non-academic zone. The academic zone is divided into three components – the teaching area which consists of lecture halls, a library, a computer centre and faculty blocks. The non-academic area comprises of administration, an auditorium and a cafeteria. Anandalaya School,campus linked through a system of covered walkways. The organization of the building that is reflected in the plan of the campus is done in a way that the flow of program can easily be decoded from the plan itself. The campus is placed around several interconnected courts. Darpana Academyis directed towards the Sabarmati River next to the academy. The academy is oriented towards the river by orienting a linear semi covered terrace towards it. The exposed brick infill walls provide sense of direction towards the more private spaces which is also reflected in the planar organisation of the academy. The following Figure shows the flow of functions and its organisation in the plan.

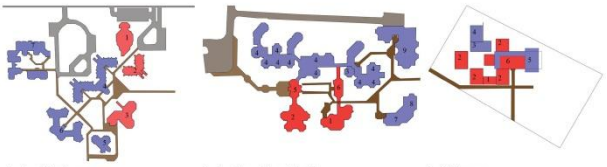
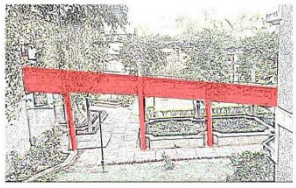


FIGURE 1.4- PLANAR ORGANISTAION

C. PEACE THROUGH ARTICULATION OF ELEMENTS

The articulation of elements of architectural language at IRMA has been done in such a way that they evoke the feeling of peace through its placement of the elements. A straight flight of steps leads from the stilted area to the entrance on the first floor. The administration and faculty blocks are connected through a bridge at the upper level. This connecting walkway creates a sense of entrance to the private buildings of the campus. While at Anandalaya, ramp is the main element of expression of the campus and it evokes a sense of peace as the ramp is sharedwith pergolas directly above it. When one walks through the ramp, peace can be experienced.Bay windows are created along the chamfered edges of the orthogonal and diagonal grids which are expression of connection of human to human.The two storey structure of Darpana Academy has the residence of the director on upper floor. The staircase to the private residence is kept such that the visitor is not attracted towards it and which served the purpose of the private entry to the residence.

INSTITUTE OF RURAL MANAGEMENT AHMEDABAD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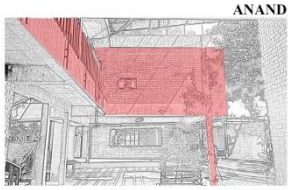
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FIGURE 1.5- EXPRESSION THROUGH ELEMENTS

INFERENCES

When we talk about values, decoding human values through any physical form gets tough. The architecture is unconsciously reflected by us through ages with the human environment, human movement and human moods. As Giorgio Vasari, an Italian architect said: “Architecture to communicate like important values of the human must appear like organic body.” (Broide, 1960) Human values have a range of meaning that reflects their feelings such as comfort, security, reassurance and friendliness. Human values in architecture can be traced through the works of Kanvinde where he consciously in the later works was striving to achieve that. As talked about, the human values differ from person to person and thus this paper talks about the values that unify people almost all around. As discussed in the expression of architecture the human values that are being reflected in the area growth, peace and a self-direction which are valued personally by people from the same or different backgrounds.

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Value of Growth in architecture terms as seen through the above cases has been reflected through the modular system of Kanvinde. The modular system helps for the growth of the campus with the growth of the people on campus or institute. The growth can be easily projected through modules which can be repeated horizontally or vertically but the module differs from project to project as per the programmatic requirement. Value of self-direction in human is a value that strives them to move ahead individually as well as collectively. This value is expressed through the planar organisation of the campus and the flow of the program can be decoded in the planar organisation of the campus. The organisation helps an individual to go through the campus on one's own journey as a man has to embark on the journey of life on his own.

Value of peace in a human's life is of utmost importance as all the activities or things that he does in his lifetime including the growth of oneself is aimed towards the peace that a man desires in his life. Peace through architectural forms can be attained through the kind of in-between spaces and the elements used in the expression of the spaces. The elements such as bridges where two buildings are interconnected through that and helps in the movement of a human directly from one building to another and the placement of such a connecting bridge evokes the feeling of peace in a human. Articulation of elements connecting the outside and inside through a ramp which acts as a buffer space between the chaos outside and inside of the campus or building gives a time of transition to the human travelling through that element. This is related to humans through the time that we work hard to achieve for ourselves through the eventful day by having a halt and reflecting back on the events and that arouses a sense of peace and happiness in a human.

CONCLUSION

Through the analysis of case studies, we can conclude that today because of technological development, the importance of values and expression of human values is essential. The significance of human values and its expression in architecture can be traced through the buildings studied of Kanvinde in the paper.

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I would like to take this opportunity to thank co-author and guide Prof. Naresh Chhatwani without whose encouragement and guidancewritingresearch paper would not have been possible. I would like to thank IDEA, Indus University for providing resources needed to carry out the research.

LIST OF ILLUSTRATIONS

Fig. 1.3, 1.4 Kanvinde, Sanjay. Akar - Achyut Kanvinde. Delhi: Niyogi Books, 2017.**p.**
Fig. 1.5https://www.google.com/maps/
All illustrations and photographs by author unless mentioned.

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Identifying Design Parameters for Dog Parks Using People's Perception as a Tool: Case of Pune

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Abstract: Indians have always had a strong history with animals. Today, relation between humans and animals have evolved due to restriction in open spaces. Dogs are the most widespread companions in the world. Dog parks presents an emerging class in urban context as environmental amenities. Hence, there has been a growing interest in improving inhabitancy of dogs in city. One of the reasons of this interest has been the lack of study regarding public spaces for dogs in India. The paper includes perception of people in Pune regarding public spaces for dogs through a survey method. Also, expert interviews are conducted to understand the functioning of the dog parks which in turn set the parameters for designing efficient it.

Key words – Human-animal Interaction, Companion animals, environmental amenities, Pet-friendly, open public space, dog parks.

INTRODUCTION

Human-animal interaction defines the experience of human existence. "Animals have accompanied humans for thousands of years, creating a strong interdependence between humans and other species" (de Waal, 2009). In India domestication of animals has been practiced for centuries. Over time these domestic animals became loyal companions to human beings. Today they are known as pets. "We are familiar with the interaction that we have with our companion animals, but human–animal interaction also occurs in the rural context" (Hemsworth P. G., 1997). Where a number of individuals used to pet cows, sheep, goat and lots of others in their homes. These animals had significant impact on their lives as they assist humans in several ways. Whereas today in urban context, relation between humans and animals have evolved. One of the primary reasons for this variation between human-animal relation is growth of cities. Today the world is being created for humans, keeping their foremost surroundings in mind, neglecting the major part that encircles them, 'other beings'.

"Dogs are highly adaptable and friendly, also they are the most widespread and abundant companions, occurring in most places where there is human population" (Yasemin Cindik Akinci, 2018). Today, there has been a significant rise in number of dogs living in urban areas. As per the 20th livestock census conducted by Animal Health Organization, there are 16,078 domestic dogs in Pune Municipal Corporation (PMC) while Pimpri Chinchwad Municipal Corporation (PCMC) has 16,100 (Hindustan Times, 2019).
Today, due to lack of spaces, these urban animals are kept within the four walls of the house. The question arises, if it is possible to build a space where companion dogs can adjust in city spaces? The space which can promote human-animal and animal-animal interaction. For this reason, there is a solution-oriented search for pets around the world in the form of parks and gardens. Outdoor recreation areas or grounds called "dog parks" are created for pets. "A dog park is a designated public area that's been set aside for dog guardians to legally exercise, play and socialize with their dogs off-leash in a secure environment. The park is fully enclosed or fenced and has amenities that make it clear that dogs are invited, not just permitted" (De Rosa, 2013)

LITERATURE REVIEW

1. Benefits of dog as companion

"There are numerous benefits to living with pets: decreased stress, decreased blood pressure and levels of cholesterol and triglycerides, as well as decreased feelings of loneliness" (Dog and Cat Management Board of South Australia, 2014). "Overall pet-ownership results in increased longevity, and desires for physical activity and socialization" (Centers for disease control and prevention, 2019). "In particular, pet ownership today places pets in a more important position for individuals in terms of health-therapy and social-friendship" (Yasemin Cindik Akinci, 2018). Thus, the number of pet owners in the world is increasing day by day.

2. Need for dog parks

"Human and non-human animals come into contact with each other in a variety of settings and wherever there is contact there is the opportunity for interaction to take place" (Hosey, 2008). Pets are not accepted in all environments which includes public areas, open spaces, etc. "It is emphasized that parks and open green spaces have great importance in terms of quality of life—social, economic, ecological, etc." (Öztürk, 2004). Dog parks are safe, enclosed spaces that are specially designed for dogs and people with

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similar interest to socialize as well as to meet their exercise needs.

3. Benefits of dog parks

3.1 Benefits for dogs

Dog parks provide opportunities where dogs can be physically and mentally fit. "Well exercised dogs are less likely to be aggressive and behave in a destructive or annoying way such as excessive barking" (Jessica, resq). "Exercise also helps in preventing premature ageing, improves insulin health and metabolism and pumps toxins out of body while maintaining a healthy bone density" (Cavaleri, 2014). Dog parks can provide opportunities for dogs to have frequent interaction with other dogs and people. "Dogs that are well socialized and exercised are healthier, happier and less aggressive" (Lee, 2007). Dog parks provide safe environment for dogs to play and not encounter cars, bikes and other obstacles.

3.2 Benefits for people

Dog parks can provide a common open public space where dog owners can interact with each other and form a community "It has been established that pets 'act as a lubricant or social contact' and pet owners are 'more likely to exchange favors with neighbors, to be involved in community issues and to have higher levels of social capital" (Wood, 2009). "Dog parks can provide a space where dog owners can feel connected with other human beings improving their mental and emotional health" (Planning Institute of Australia, 2013).

METHODOLOGY

The study is based on qualitative data collected through an online questionnaire on the basis of random sampling method and interview of experts. In the given time and resources, the data was collected from 61 respondents. Closed ended questionnaire was prepared to understand people perspective towards a pet. The questionnaire consisted of two parts. In first part included questions like gender, age and general views about pet friendly spaces. Further questions were based upon dog parks as a typology of open public space where questions like: reason for the visit, duration, time of the visit, etc. Second part of the questionnaire included questions based on their concerns regarding safety, aggression of dogs, etc. Literature review and interview of expert was conducted to understand the behavior and need of the dog and dog owners and propose design strategies for efficient functioning of the park.

DATA COLLECTION

1. People's perception

People perception about dogs and the spaces which could be pet friendly was tabulated through an online questionnaire. We distributed 100 questionnaires based on random sampling method and collected 61 valid questionnaires. The sex ratio was 47.5% male and 50.8% female, while the dominant age group was 18-25 years old (54.1%) followed by 25-40 years old (24.6%) and 40-60 years old (16.4%). On questioning if they like pets or not majority of them said yes which ranged to 73.8% and majority of the respondents said they would like to have a pet with a percentage of 80. 83% respondents said they are not afraid of dogs. 91% respondents are comfortable with pets in public. 70% respondent selected parks to be pet friendly. Also, more than 50% of participants don't know if pet friendly park exists.

34% participants visit parks which are dog friendly parks. The reason for visiting the park was majorly for walking and exercise (71.4%) and remaining 28.6% visited the park for dog walking. Mostly participants visited the park in the evening (52.4%) and on weekend and weekdays (66.7%).
Safety of people and dogs is perceived as a key concern in dealing with dog parks (Dog and Cat Management Board of South Australia, 2014). 75% of the sample presented their concerns regarding aggression of the dogs and safety issues in the public spaces. Research shows that injuries to people and dogs from dog bites at dog parks are rare (Arhant, 2011) however; the perception of risk remains significant and must be considered. While 88.5% of the sample responded as there should be an assigned monitor to supervise the dog parks.

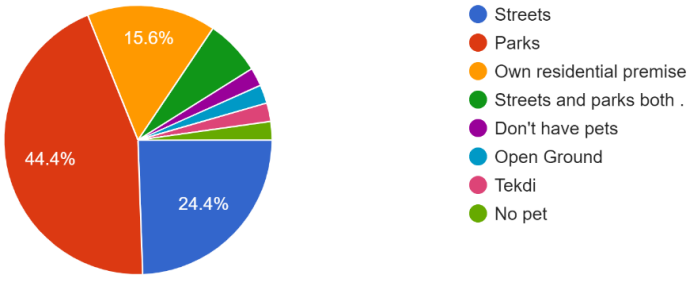

Figure 1 Respond to: where do people take/ prefer their pets to walk?

2. Planning

The data regarding the planning and designing of the parks was tabulated through literature review and interview of experts in fields related to dog care and practices. The design and planning principles considered were shape and size, seating, surface materials, signages, maintenance, dog activities, fencing, structures, water fountains, waste disposal, vegetation.

ANALYSIS

1. People perception

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The survey found that 91% of the people are comfortable with pets in the public spaces, where 70% prefer parks to be pet-friendly. As found up to 75% of people are concerned about dog's aggression. While 50.8% are concerned about smell and 80.3% are concerned regarding the safety issues.

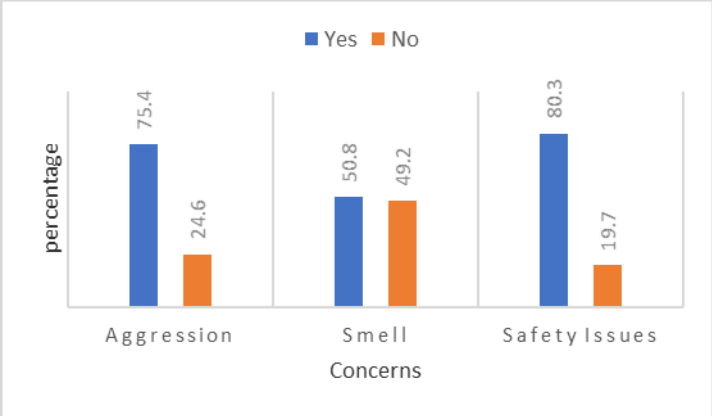

Figure 2 Analysis of survey regarding the concerns about dogs and dog parks

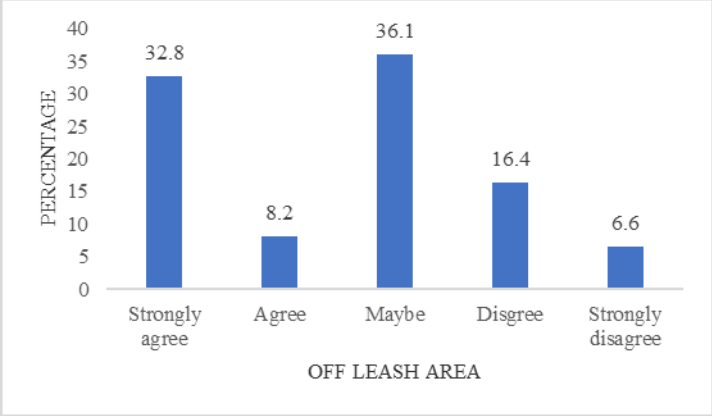

Figure 3 Responses for providing off-leash area in the park

2. Design strategies

Opinions of expert and existing literature was reviewed for proposing some design strategies for planning of dog parks.

2.1 Shape and Size:

Linear and organic (non-rectangular) shapes should be considered while designing the park. Where organic shape works better than linear creating smaller pockets for dog to take a break and get out of the traffic flow from main pathway (Jessica, Resq).

2.2 Surface material:

The choice of surface material should be done considering the hygiene and comfort. Grass should be avoided as it promotes the breeding of flees and ticks in them (Ar. Smriti Puranik). A combination of surface materials should be used to match the activity zones and corresponding intensity (Dog and Cat Management Board of South Australia, 2014).

2.3 Signages:

For management in the park signs regarding different rules and etiquettes that a person needs to follow shall be installed.

2.4 Maintenance:

88.5% of the sample responded as there should be an assigned monitor to supervise the dog parks. The involvement of park users in the daily maintenance of a dog park is a model that could be considered as this can facilitate a sense of ownership and provide a more immediate response to the issues (Dog and Cat Management Board of South Australia, 2014).

2.5 Dog activities:

There should be a variety of activity zones in park which activates their motor skills (Jessica, resq). Activity spaces or zones offer dogs a variety of opportunities including active running and quieter environments where they can sniff, play and interact with their owners, and play one-on-one with other dogs away from the high running areas (Dog and Cat Management Board of South Australia, 2014).

2.6 Waste disposal:

At appropriate locations waste bins should be located in and around park for cleaning up after dogs. Bag dispenser could be provided with a locking system to prevent unnecessary pulling out of bags.

2.7 Plantation:

Trees inside the park provide wonderful amenity as they provide natural shade and to the overall appearance of the park. It is important to ensure that plants are non-toxic and non-irritating to dogs (Ar. Smriti Puranik). Consider introducing plants with various textures to enrich the dogs experience at the park (Dog and Cat Management Board of South Australia, 2014). Also pit of the tree must be protected from dog urinating near them.

CONCLUSION

Captive animals are susceptible to stress which will cause to the decline of their health; the same way as humans does. Hence, in an urban environment, there is a need for a safe place where dog-owners can take their dog to run freely, play, and interact with other dogs. A dog park can be the solution, however, there must be proper supervision, enforced rules and etiquettes, consideration to the designing of the space, attention to the environment, concerns regarding dog health and behavior, and a plan to properly maintain the park. The design strategies proposed can be used while designing these spaces.

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Designed Outdoor Spaces for Better Educational Outcome

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Abstract : Most commonly used teaching practice today includes blackboard-centred learning bound within the four walls leading to restricted learning. Outdoor learning can be one of the approaches to make learning effortless and free the students from the routine pressure. The research is aimed towards studying the potentiality of outdoor learning as a solution to ameliorate educational outcome. The purpose of this study is to understand determinants of outdoor space facilitating improved learning experience. The study is carried out by means of amalgamation of books with literature review and case studies of schools. The research aims to provide set of guidelines that can be implemented for an apt type of space for effortless learning and applying learning in real life and making it more efficient and memorable.

Keywords – Gurukul system, Outdoor learning, Educational systems, Effortless learning.

I. Introduction

Over the period of time our education system has entirely reshaped from its roots. The history of Indian education commenced from Gurukul system – a system where the student resided in the house of their guru until the guru felt that he has imparted all that he could. Where the learning transpired admits of nature. The system was dedicated to highest ideals of 'all round human development', mainly practical, intellectual and spiritual. As against the commonly used teaching practice today, which includes black board centred learning within the four walls leading to restricted learning.These restrictions are leading in increasing peer pressure, lack of attendance and overall progress of the students.

Outdoor learning can be one of the approaches in bringing out better outcome in students. Physical environment plays a major role in determining the quality of learning, in kindling curiosity and imagination of children in teaching them how to live and interact together. Physical environment could not only become more congenial, sensitive and helpful but also contribute meaningfully towards learning and pedagogy. The natural world provides rich experience to children. Through outdoor learning students can explore the diversity of nature and can also associate what they study in books to what they see around them.

There are several factors which affects outdoor learning. The factors can be the weather condition, physical comfort, surroundings, structural comfort and so on. Outdoor learning requires open space away from all the chaos. The learning may also differ for different age groups of students. For smaller sections more playful learning can be implemented on the other hand for elderly crowd more of a self-realization method can be adopted. Space character and the surrounding plays a major role for espousing outdoor learning. Minor changes can be made in the building landscape to create such learning pockets for children.

Potential outdoor spaces around the school building are often neglected. These outdoor spaces by way of design interventions can be evolved to create active learning platform for students. These outdoor spaces can help in better health, decreased stress level, increase in motivation, etc.

The aim of this research is to verify if designed outdoor spaces can create considerable impact on the education outcome of a students. The purpose of this study is to increase participation of students in learning process leading to overall development of the child. Today everybody has limited themselves to the four walls surrounding them. As one grows his/her participation in nature or outdoor seems to be decreased. Outdoor learning can address this issue and help in boosting of self-esteem, finding calmness, focus, boosting the sense of communityetc.The goal of this paper is to study the difference between indoor and outdoor learning process through interview and case – studies. It will also deal with different outdoor spaces which can be later used as classrooms for students. The research also aims to provide changes that can be made in schools to incorporate outdoor learning in academics.

II. Methodology

The research will be done through the help of sampled case studies of three different schools having different context. The paper will also put forward teachers' and student'spoint of viewon the same. The inferences deduced from the interview of students and the teachers would be the base data for the results.

Rishi Gurukulam

Location- Near katharkhadak hills, Pune. with equal distant from two major cities – Pune and Mumbai.

Owner- It is belongingto the foundation SiddhaSamadhi Yoga.

It is a residential school with students studying there 1st to 10th standard. The school aims for overall development of the students following the gurukul system of teaching. The students are taught different art forms, spiritual knowledge, new innovative learning techniques etc. It follows CBSE pattern for academic's purpose.

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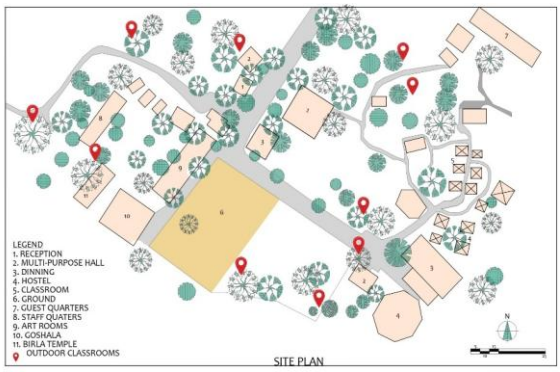


Gurukul plan indicating the outdoor classrooms

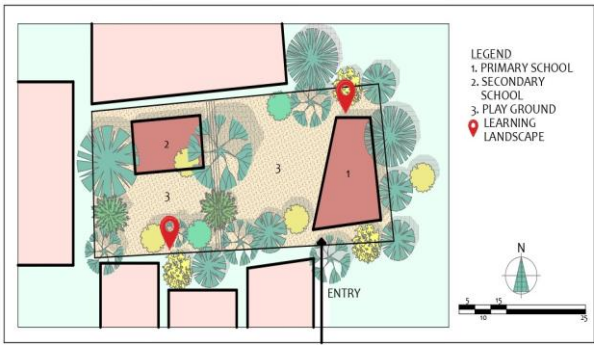
The classes are conducted outside in the open environment like the treehouses under a tree and in gazebos. The location of these open classroomswasdecidedon the basis of shade from the sun, silence-away from all the chaos and part intuition. The relationship between student and teacher is more intimate. It is more student centric class than a teacher centric class. The interaction between the student and the teacher ensue through discussions. These classes have basic amenities like a white board, portable tables for writing purpose and a raised seating for the teacher.It is a region of high rainfall. Thus, in rainy season the classes are conducted inside.

Class under a tree

Class in a tree house

Inferences from the interviews of the teacher

- Energy level of students and teachers is quite high compared to indoors.
- Live instances can be given to the students to make the learning simpler.
- Participation of students is more as compared to indoor learning.
- Students are sometimes distracted due to the birds and insects around, but it also acts as a learning aid to explore nature.



- Learning process becomes more interesting when outdoors.

Aksharnandan School
Location - Senapati Bapat Road, Pune

Owner –The school in Pune in 1992. It was established by N. G. Naralkar Foundation.

Aksharnandan site plan with indicated outdoor learning space

The school believes that Humanscale education needs schools that are small and firmly anchored in their communities, integrating the classroom with the world outside. Education is a process to awaken intelligence, not merely intellect, to cultivate independence of mind and to inculcate values to help children grow into wholesome, productive, creative and responsible human being. However, within this framework Aksharnandan has adopted innovative practices to make the curriculum relevant and linked to actual life. The campus is divided into two halves the primary and the secondary school with a huge playground in the centre. They have inculcated outdoor learning skills for the smaller class so as to improve their fine motor skills, communication skills, problem solving abilities etc. They are able to conduct very few outdoor classes for the secondary school students because of the space constraints. They have variety of plant species planted in the campus to aid the learning process. Mostly discussion and group-based learning is organised outside. They don't have any designated outdoor classroom designed where the learning can be conducted. The terrace of the school is used for farming done by the students. The terrace have small mud pits to plant trees.

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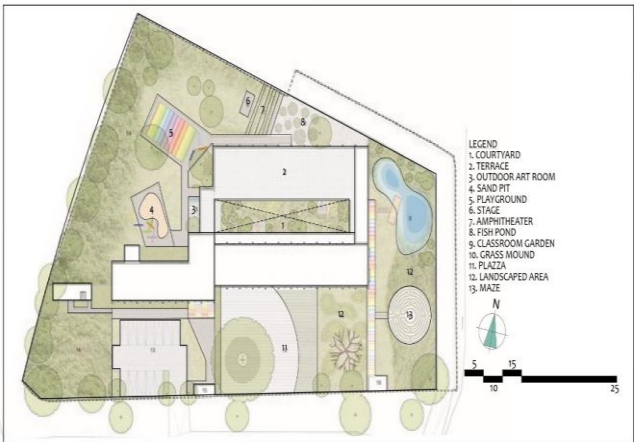
Class 6th and 7th students practicing self assisment

Inferences from the interviews of the teacher

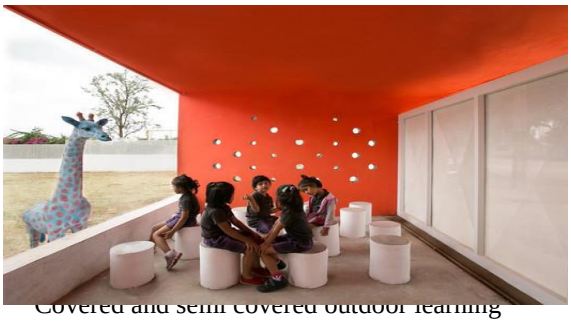
- Students grasp much more knowledge outdoors than indoors.
- They are very enthusiactic and attentive compared to indoors.
- As the number of students are more it is sometimes difficult to control them.
- The surroundig is very chaotic as the location of the school is in the heart of the city.The school has designed a learning cum playing pit for the primary students which helps the overall development of the motor skills.
- Nature aids the learning process therefore teachers too prefer teaching outside.

Ekya School
Location – Kanakapura Road, Banglore.

Owner – Ekya school



It is a exclusive preschool for both Montessori and Kindergarden. The school was developed from an abandened industrial shed. It covers an area of two acres. The primary goal of the school was to provide a constant interaction between student and nature. To achieve this, the boundries are blurred between inside and outside with the 13 learning classrooms accessed from covered walkways. The courtyard is connected to the outdoor learning landscape through four controlled access points. The outdoor space includes an art room, amphitheater, playground and individual classroom gardens. The outdoor classroom gardens are well connected with the indoor spaces for easy access, supervision and maintenance.



Covered and semi covered outdoor learning classroom

III. Observation and Findings

After doing the study of the above cases it is found out that outdoor learning not only affects the educational outcome, also the overall progress of a student. Thus education can be redefined as the knowledge that includes all the subjects from acadamics to play activites.

Design interventions for adaptiong outdoor learning-

- Outdoor learning needs shaded area to sit and learn. Thus spaces under a tree or tree houses can be developed in the vicinity of the school building.
- Students may need portable tables in case of writing purpose.
- Students may also require seating chairs for back support. According to the above cases it was observed that backsupport plays a major role in attentiveness of a student.
- The ‘between’ spaces created in two blocks can be used to have a stuctured classes.
- Natural learning materials can be used as resoures for counting, craftwork, pattern makingand recognising colours. Selecting only those plants species from which natural materials fall on their own or can be gathered withput harming the plant.
  A few suggested species are:
  1. Amaltus
  2. Curassia gulmohar
  3. Imli
  4. Kanak champa
  5. Kaner
  6. Neem
  7. Ratti
  8. Siras etc.
- Selecting and planting species that will invite more birds, bees and buterflies is to promote a

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diverse and fuller interaction of children with nature in school.

Some example for these plants are:

a. Guler
b. Jamun
c. Palash
d. Ber
e. Shehtut
f. Banana
g. Siras

2. There must be some story telling-session areas which should be able to accommodate larger groups, others must be suitable for smaller groups. For these sessions seating can be designed in a circurral manner either under a tree or under a semi-covered area.

- At times children also need private moments to reflect, and spaces to be alone. Small cozy book corners can be developed keeping in mind that such corners are not lonely or entirely secluded.
- Recycled materials can be used for making the outdoor furniture. For example the table or the par can be made out of used glass bottles, chairs can be made of tires and so on. Thus teaching studnets about the 3 R's.
- The choice of materials aims to promote play and enhance the school's territory and culture. Long-lasting organic materials that allow students to experience different texture and smell can be used.
- The roof material used outdoors should be well insulated from the sun.
- The design approach can be minimalistic, with very little harm made to the nature.

A learning landscape communicates the community's knowledge, traditions and values; it also promotes active free play, healthy lifestyle habits, positive relationship and wellbeings.

IV. Conclusion

The 21st century requires polyfunctional educational spaces that provide opportunities for hands-on learning and foster the physical, socioemotional and cognitive development of students.. From architecture, we can give the school outdoors another meaning and contribute to the student's learning, wellbeing, school motivation and sense of belonging.

Acknowledgement

I would like to thank B.K.P.S College of Architecture for allowing me to participate in this woderful opportunity provided by D. Y. Patil College of Architecture. I would also like to thank all the instutues for granting me permission for the case-studies. And lastly my friends and family members for supporting me throughout.

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Tale of a City: Story Telling as a Medium of Spatial Experience

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Abstract: Buildings tell stories that create a level of meaning and connection for the user that can be appealing and provoking. The viewer can learn something beyond the noticeable causes before keeping them behind. However, the act of architectural storytelling is critical to the building of spaces that convey meaningful messages. However, looking at Indian context and the background of our rich culture Ajmer is a historical shell. A thousand years of infrastructure, roads, arches, and gates still contain the function they had done a thousand years ago. The plan of Ajmer truthfully speaks of its growth, values, and self-esteem at different times PERIOD: Mughal and British. These narratives ARE formed by visiting the old city, observing, gathering information and looking up to the stories which make up the history, conveying it visually as well as through text.
Keywords: Spatial experience, narratives, an image of the city, spaces as storytellers, Ajmer

INTRODUCTION

We use signs, images and words, moulded to make sense of our world, or to communicate with others. We are imaginative beings, driven by curiosity, and 'stories' are often the shape that we use to process the matter that we see and experience. We have our perceptive understanding of stories. From stories in our daily conversations to fairy tales and legends, story-telling was used by the oldest cultures to educate, entertain and propagate knowledge. Similarly, different places have different people with various tales and the people have accepted them and adopt their living around those tales. However, the act of architectural storytelling is critical to the building of spaces that convey meaningful messages. Within the outline of the idea that the architect storyteller is someone who makes buildings and spaces that speak.

Talking about the city I felt Ajmer city, full of life, chaotic, engaging city, 130km southwest of Jaipur and just 13km from the Hindu pilgrimage town of Pushkar. This city is often known as the Holy City, and rightly so. Ajmer is the most sacred place in terms of Islamic history and heritage. It contains one of India's most important Muslim pilgrimages, the shrine of Khwaja Muin-ud-din Chishti. Moreover, the amalgamation of colours, the hauntingly beautiful ruins, forts etched with battle scars, the welcoming natives, and the wealth of the kingdoms and of course, the breath-taking Nasiyan Temple all adds to the holiness of this place.

AIM AND OBJECTIVES

the paper/study/research aims to take up multiple narratives as a method to study the identity of Ajmer and analyze the factors that were evolved through time and what stories made up the grand narrative of the city for what is now.

- To explore the key questions of structure, material and age and the roles they play in the evolution of the city.
- To comprehend beauty and religion along with evolution this adds to the present scenario of the city.
- To understand the adaptability of the people that occurred due to changes in the development of the city.

METHODOLOGY

The method includes the study of the past and present with the roles talking about the stories which make up the history of the city and reading literature which has been written on the city and its focal points. Once all this data will be collected, the tales will be analyzed to form a grand narrative. The tales will be selected on the bases of facts and understanding the literature and observing the city. These narratives will talk about various experiences met during the study visually and experienced and transforming them into memory sketches as well.

AJMER; THE CITY OF HOPES

A million pilgrims of all religions visit Ajmer with a billion prayers. With high held of Dargah Sharif, Ajmer has a lot many things and places in its nest. Beautifully is a small word to describe this place, this town is like a potluck of stories where you find mountains, Serene Lake, amazing food. Here in this paper**,** I've picked up three focal points of the city which I found the most attractive in terms of its history and the beauty which adds up to the experiences which this city has to offer.

Dargah Sharif: Ajmer Sharif Dargah is the most primeval Sufi Shrine in India. A belief is heard across the country that the ones who pray with the Apure heart at Dargah get all their wishes fulfilled. This shrine of Persian Sufi saint, Khwaja Moinuddin Chishti was built by Mughal Emperor Humanyum in 1236 (AD). The initial insight on entering the Dargah is the series of mammoth doors approach to the shrine. Then it the Nizam gate which through its colossal volume depicts as if you are entering somewhere monumental. The sudden change in the senses is perceived through the fragrance of attar. A narrow bustling street with people and the elements offered to Allah like the Chadars and the flowers keep on hovering above your heads. The ingress to the Buland Darwaja suddenly changes the whole of the surroundings. A huge

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courtyard surrounded by shops and mosques on two longitudinal sides which leads to the tomb of Moinuddin Chishti, a marble carved structure. The tomb is plated by gold on the top and is guarded by a railing of silver and marble screen. The Dargah complex is also enriched by several other mosques' that add more holistic values to the place. What makes the place most enriching along with the emotions of the people? The hopes and the beliefs of the people who came to pray to Allah are guided by these beautiful transitions of the space. The whole of the surroundings is beautifully chaotic along with the mixture of emotions of the devotees around. Space is an architectural spectacle connecting to your spiritual identity. The passivity and tranquillity of this place are what attract the beliefs of the place**.**

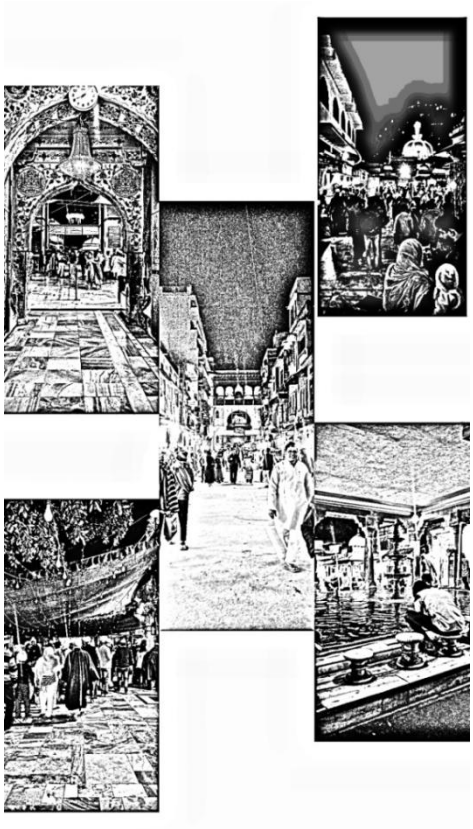

Fig 1.1 Beautiful chaos's at Dargah Sharif

Adhai Din Ka Jhonpra: : Design by an architect Abu Bakr of Herat. This massive shelter was constructed in two and a half days based on an indo-Islamic architecture which signifies high domes with pillars around it, large open Courtyards. Red sandstone used to be a preferred material to build these Indo Islamic structures, and rightly so as this structure showcases the beauty of architecture which continues to inspire, however, the highly decorated front facade with yellow limestone watches is approximately 60 feet high and it is added with 6 smaller urges structure with floral motives mergers and inscriptions from Quran it signifies the boldness of design. entering the main building which comprises of pillars of wearing designs still retain the charm which remains in the older ones which are bold in history and culture.

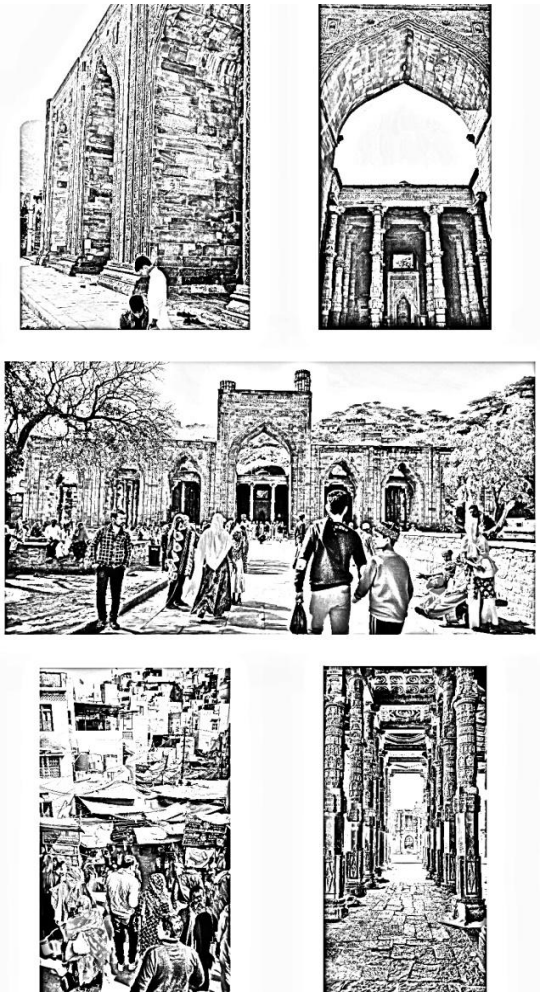

Fig 1.2 Gateway from the bustle to tranquillity at Adhai din ka Jhonpra

Akbari Museum and Fort: It used to be once the residence of Prince Salim, the son of Emperor Akbar but now converted into a museum and comprises of collections of Mughal and Rajput armor and sculpture. Exquisite enter the fort the exhibit is divided into seven categories from the collection of various excavations, Ancient coins, Sculptures of stone and metal, Inscriptions of stone and metal and Armoury and miniature paintings, etc. The fort is divided into these seven parts. The journey here was quite different as it was a silent place, hardly can you find people roaming in here apart from the tourists. You keep on walking looking at the exhibit adoring the small niches through which light rays coming in and the arches on the roof had its beauty whereas white plastered walls and artificial lights added to the whole journey. Once you finish visiting these exhibits you come out and encounter another atmosphere which is full of trees around and benches to sit with a central dome where mannequins are exhibited. It was gracefully articulated with yellow sandstone then maintained well in the present day.

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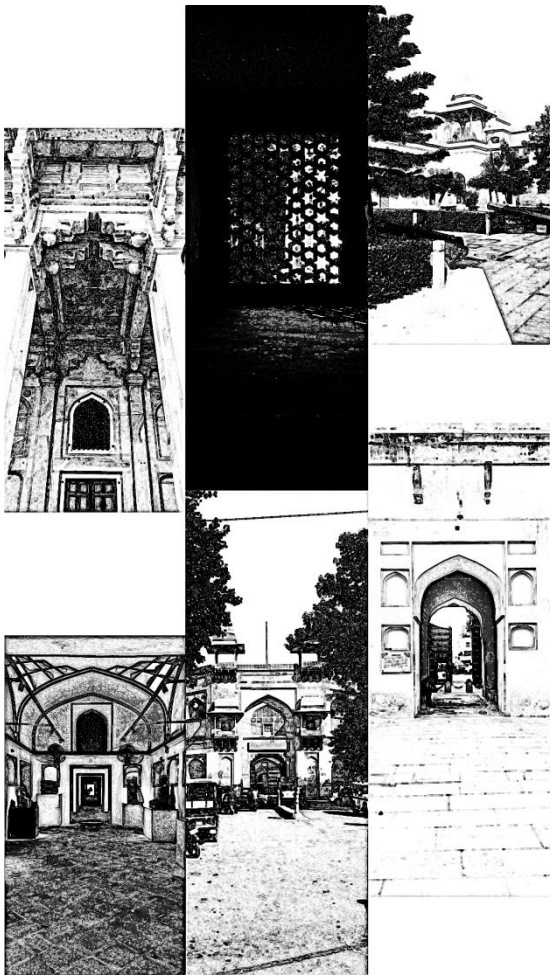

Fig1.3 hushed spaces with exhibits at Akbari Museum.

OBSERVATIONS

Old yet exquisitely managed even though it is a popular tourist attraction that is not biased for Hindus and Muslims, which brings you to experience the beauty of this place. Although being a bustling city it has silent places. This place looks like a blend of religion, community, culture which is coexisting and flourishing in harmony. Also**,** the city is surrounded by the expansive lake of Ana Sagar which changes the view from chaotic to serene. In the same way, this city offers to allot one needs to visit and experience this chaotic yet serene city.

CONCLUSION

From This experience in moving around in the city and being around these architectural monuments helps us learn new thing every time and these learning may be in different form can be experiential through touch, senses, light, and texture hence when we talk about a city and the stories related to it are never-ending also different people have different perceptions so the way they perceive the city and the narratives to it will be different which adds up another layer.

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Waste to Worth: Potentiality and Use of Recycled Construction & Demolition Waste in the Construction Sector

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Abstract: India's construction sector is a vital driver of the economy but it is also extremely resource intensive. Also, substantial amount of waste is generated from the construction and demolition process of buildings and infrastructure. Poor management of Construction and Demolition(C&D) waste results in illegal dumping, causing nuisance and environmental degradation. Properly processed and recycled C&D waste can be used as a raw material for construction. The objective of this study is to assess the generation and current management status of C&D waste in India and draw conclusions on the potential of C&D waste as an alternative to primary raw materials for the construction sector.

Key Words: Construction and Demolition waste, Recycling, Waste Management, Secondary Raw Materials, Construction Sector, Sustainability.

Introduction:

Construction and Demolition (C&D) waste is defined as 'Waste comprising of building materials, debris & rubble resulting from construction, re-modeling, repair & demolition of any civil structure' (Draft Solid Waste Management Rules) (MoEF&CC, 2015). Literally all material waste coming out of the construction and demolition industry is considered as C&D waste.

Due to rapid urbanization, India's construction sector is projected to grow at a rate of 7-8% over the next 10 years and is likely to become the world's third largest by the middle of the next decade. As per the recent estimates, almost 70% of buildings supposed to exist by 2030 are yet to be built. The boom in construction industry of India is leading to the generation of enormous quantities of C&D waste and this trend is likely to further increase in the decades ahead. The impact on environment due to construction and demolition (C & D) waste are increasingly becoming a major issue in urban solid waste management. Problems such as increase in the flood levels due to the illegal dumping of construction and demolition waste into the rivers, resource depletion, shortage of landfill and illegal dumping on hill slopes are evident in the metro cities. Especially in the older cities, significant demolition often precedes construction, as older buildings are demolished to make way for newer ones, typically high-rises.

A 2015 survey of C&D waste generation in 10 cities across India:

City	Population (Census 2011)	Daily C&Dwaste generation (tonnes/day)	Annual CDW generation* (million tonnes/annum)
Mumbai	12,442, 373	2,500	0.75
Delhi	16,787, 941	4,600	1.38
Bengaluru	8,443, 675	875	0.26
Chennai	6,500,000	2,500	0.75
Kolkata	4,496, 694	1,600	0.48
Jaipur	3,471, 847	200	0.06
Patna	2,514, 590	250	0.08
Ahmadabad	6,063, 047	700	0.21
Bhopal	1,917,051	50	0.02
Coimbatore	2,618,940	92	0.03

* Daily generation has been multiplied by 300 to calculate annual generation since CDW generation is not constant throughout the year, almost disappearing during the monsoon rainy season

Current C&D waste management practices:

Management of C&D waste is still a challenge for urban local bodies. Most cities do not have formal demolition permits and developers hire local contractors for demolition. Even government agencies like PWD invite bids for demolition based on what contractors would pay for recoverables. The recoverables of immediate secondary market value, such as metal rods, pipes and fixtures, wooden frames, etc., are salvaged by the informal sector, typically from demolition sites, leaving behind the "rubble" composed of bulky materials such as concrete, stones, bricks and mortar, etc. A small fraction of this rubble is used for back-filling in construction projects, both for private projects and public works, and the same demolition contractors arrange for its transportation to sites where it is needed. It is estimated that such uses may account for only 10-30% of generated C&D waste depending on the site and region.7 The remaining fraction of C&D waste is disposed, either in designated landfills/dump sites or often in unauthorized places such

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as road sides, river beds and low-lying areas causing a host of nuisance, safety and environmental problems.

Case Studies-

C&D waste management in Delhi and Ahmadabad, India:

Scientific processing and utilization of C&D waste has achieved isolated successes in India.

- Delhi was the first city to implement a C&D waste management plan through a pilot processing facility developed under a public-private-partnership (PPP) in 2010. After the initial success of the pilot plant processing waste at 500 tonnes per day (TPD), the capacity of the plant has been increased to 2,000 TPD. To minimize transportation distances and associated costs, Delhi planned to have a distributed network of processing facilities in different zones of the city. Accordingly, two more smaller(500 TPD and 150 TPD respectively) plants have recently come online (2017-18), with planning for more under way.
- Ahmedabad was the second city in India to implement C&D waste processing, by adopting a similar PPP model as that in Delhi. A 300 TPD processing facility was launched in 2014, the capacity of which was increased to 600 TPD 2016 after successful operation and now to 1,000 TPD in 2018. Table 2. summarizes the key features of the Delhi and Ahmedabad C&D waste management plans.

Table 2: Key features of the Delhi and Ahmadabad C&D waste management plans

Feature	Delhi	Ahmadabad
Year established	2010	2014
Model	Public Private Partnership between Delhi Municipal Corporation (New Delhi Municipal Corporation – NDMC and East Delhi Municipal Corporation-EDMC) and IL&FS Environmental Infrastructure & Services Limited	Public Private Partnership between Ahmadabad Municipal Corporation and Amdavad Enviro Projects Private Limited (AEP)
Number of processing plants	3 in operation (more in planning stages)	1
Capacity	First plant: 2,000 TPD Second plant: 500 TPD Third plant: 150 TPD	300 TPD (increased capacity to 1000 TPD)
Tipping Fee (INR per tonne)	For NDMC Service Area: 147/tonne (with annual escalation of 5%) For EDMC Service Area: 375/tonne (with annual escalation of 3%)	178/tonne
Products	Recycled aggregates, manufactured sand, paver blocks, curb stones, tiles, hollow blocks/bricks	Paver blocks, tiles, hollow blocks/bricks, pre-fabricated structures like frames, manhole covers, benches, etc.

Procedure adopted:

In both Delhi and Ahmadabad, Design Build Operate Finance and Transfer (DBOFT) model is being followed. The Municipal Corporation contracts a private party and this authorized agency is responsible for both transportation and processing of the C&D waste and develops the necessary infrastructure with its own financing. The Municipal Corporation offers land to the contracted party for establishing the processing facility and also designates a series of intermediate collection points at favourable locations throughout the city. The authorized agency collects C&D waste from these designated collection points as well as from unauthorized dumps, as directed by the urban authority, and transports it to the processing facility. The municipal corporation pays the authorized agency an agreed fee per tonne of waste that is collected and transported. The authorized agency may also collect fees directly from large generators (such as Metro Rail) for waste collection; however, if generators bring waste to the processing facility at their own expense, the agency accept it without charge. Therefore, the private partner has two sources of revenue – the "tipping fee" from the ULB and the sale of recycled products made from C&D waste. This ensures the viability of the enterprise. However, in both Delhi and Ahmadabad, market uptake of recycled products made from C&D waste remains an ongoing challenge.

Potential for C&D waste utilization in India:

Recycling and products

Characterization study of C&D waste in India by TIFAC (2001) shows that most fractions including bulky material (concrete, bricks) and fines (sand, excavation soil) are

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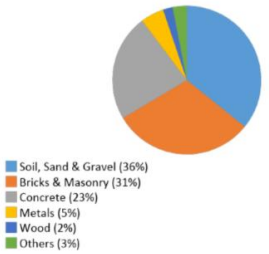
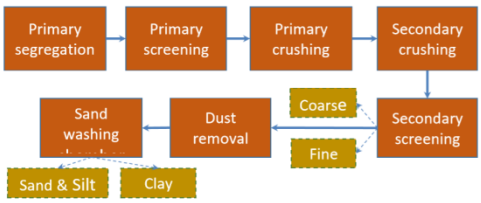
amenable to recycling with proper processing equipment and techniques. Figure 1 shows the typical composition of C&D waste in India.



Recycling of C&D waste starts with segregation of unwanted residual material such as plastic, wood, metal fragments, etc (constituting 10% of the total waste as per the TIFAC composition). The remaining bulky waste is fed into crushers and reduced to smaller and smaller sizes, with size fractions separated depending on end use. Fines are typically best recovered with a "wet process". A simplified diagram depicting C&D waste processing is shown in Figure 2. Below-



These coarse and fine aggregates of various sizes can be used directly as recycled aggregates in construction or used to manufacture a range of pre-cast products. A selection of products made from recycled C&D waste is shown below-

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Street furniture from processed C&D waste

Bollard

Fence Post

Pre-cast compound wall

Planter

Drain Cover

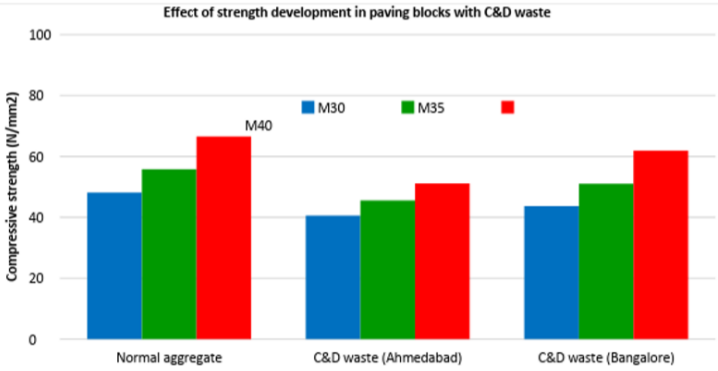
Park Bench

Pre-cast structures from processed C&D waste

On-site assembly type toilet *(Model developed by AEP Pvt. Ltd.)*

Repeated testing by the companies in Delhi and Ahmedabad, as well as by independent researchers has demonstrated that products made from C&D waste meet or exceed minimum standards for their intended applications. A study by GIZ and Development Alternatives (2015) tested compressive strength of paver blocks made from C&D waste collected in Bangalore and Ahmedabad as per BIS 15658:2006 protocol. The results are depicted below-

Test results comparing paver blocks made from natural aggregates versus recycled aggregates from C&D waste:



Products made from recycled aggregates typically tend to have a cost advantage over conventional products since natural aggregates are transported over long distances in most places. This holds true as long as the collection and transportation cost of C&D waste does not become exceedingly high due to long transportation distances. The GIZ-Development Alternatives study modelled production costs for paving blocks made from natural versus recycled aggregates using actual cost figures from Delhi (assuming collection and processing cost at Rs. 400/tonne). The results below show cost advantages of 19-22% for blocks using recycled aggregates.

Cost comparison of paving blocks made with natural vs. recycled aggregates:

Cost and quality:

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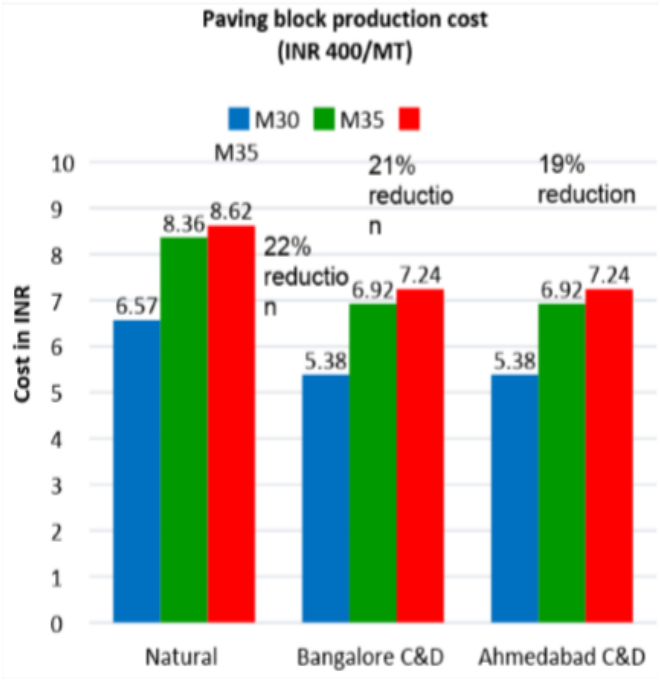

Case Study of Mumbai:

In Mumbai, the Brihanmumbai Municipal Corporation (BMC) formulated Debris Management Regulations, aimed at taking care of the 2,000 tons of construction debris produced every day. However, the regulations failed to have the desired effect, owing to the sluggish attitude of the Building Proposal department, which was in charge of the task. The responsibility for implementing the regulations have now been passed on to the Environment Engineers, who will monitor the new constructions along with being in charge of taking the debris management plan from prospective builders and issuing no-objection certificates for their construction activity on the basis of the plan. As per the existing regulations, builders and developers have to now compulsorily submit a Debris Management Plan along with giving details like the amount of C&D waste likely to be generated during the construction activity, arrangements for its proper storage on site, transportation of debris to a suitable disposable location, etc. The plan will further be submitted to the assistant engineers (Environment) of the Solid Waste Management Department, who will issue the required no objection certificate to the builder.

Highlights of C&D Waste Rules 2016:

Recognising the problems arising from C&D waste, the Government of India has notified the "Construction and Demolition Waste Management Rules" in 2016. These rules are quite comprehensive and address responsibilities of different stakeholders including generators, municipal bodies, state Pollution Control Boards, Urban Development Departments, etc.

Rationale/Justification for C&D Waste Strategy:

Although the C&D Waste Management Rules were notified in 2016, little progress has been made in the intervening two years in terms of widespread adoption of C&D waste processing and utilisation in India. In case of the first two cities with processing facilities – Delhi and Ahmedabad – their facilities actually pre-dated the 2016 Rules. Despite the enabling policy framework, not much progress has been made on the implementation 2016 Rules.

Therefore, it is necessary to identify the challenges and roadblocks so that an effective implementation strategy can be adopted.

Assessment of Challenges and Roadblocks:

There remains a host of challenges and roadblocks faced by both government agencies and the private sector that are hindering a wider and quicker adoption of C&D waste management initiatives. It is important to properly understand these challenges so that proposed actions can target them effectively.

Municipal bodies/Local authorities

Local authorities/municipal bodies have the most important role in planning and implementing C&D waste management in their respective jurisdictions under the 2016 Rules. Even if the collection, transport and processing is actually contracted out to a private entity, the local authority is ultimately responsible for the overall performance of the management scheme. However, local authorities/municipal bodies appear to be the weakest link hindering rapid adoption of initiatives and face several challenges. Several factors are responsible for this, including:

a) City officials may understand the broader aspects of C&D waste management but require support to develop tailor-made solutions to their specific circumstances

b) Cities do not have adequate capacities and trained personnel to take up the initiatives

c) Cities do not have financial resources to hire a consultant for an initial feasibility study and/or a DPR

d) Cities are not convinced how the business case would work in their circumstances, and are apprehensive about the model being a drain on their budget

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e) C&D waste management is considered a low priority (the public is more concerned about Municipal Solid Waste), especially in the absence of strong coordination/facilitation by state-level agencies.

Lack of awareness and concern

The construction industry is entrenched in its ways and is historically used to turning a blind eye to how C&D waste is disposed; getting them to change their ways is likely to be a difficult and gradual task. At the same time, there is little awareness about C&D waste recycling and utilisation beyond using rubble as a filling material.

Dominance of the unorganised sector in demolition

The demolition sector is overwhelmingly dominated by small players in the unorganised sector, the only exception being a handful of specialised companies whose niche is high-tech demolition related to large infrastructure projects. This naturally makes it difficult for urban officials to monitor and regulate small demolition contractors who are typically not registered and are used to getting away with disposing of C&D waste in unauthorised locations.

Lack of confidence in recycled products

The experience in Delhi and Ahmedabad has shown that the market for recycled products made from C&D waste is still quite weak in India. Engagement with the construction industry repeatedly demonstrates that potential buyers are hesitant about such recycled products that they perceive to be inferior in quality. Even when informed about the updated BIS standard (383) that allows recycled aggregates in many applications, potential buyers appear risk averse, pointing to their clients who seem to prefer "conventional" products.

Poor economic viability of recycled products

Currently aggregates are taxed at 5% and manufactured products are taxed at 18% making the use of recycled products economically unviable for customers. GST relaxation for C&D waste recycled products including manufactured products such as tiles, paver blocks, bricks, sand and aggregates may be considered.

Conclusion:

Use of secondary raw materials like C&D waste presents a win-win approach for resource efficiency. Utilizing a waste or by-product eliminates the problem of waste management, especially for bulky waste that needs a lot of expensive land to store in non-productive ways. Simultaneously, by reducing pressure on virgin resources, it aids in reducing environmental degradation and pollution.

Acknowledgement:

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Comparative Analysis of Regionalism and Critical Regionalism as an Approach to Counter the Problem of Placelessness in a City

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Abstract: ***Today due to globalization and the concept of modernism we have started to lose the architectural character of the city, as the buildings constructed are not just high rise, they are also constructed using the modern materials which gives them a modern look. Which is now leading to lack of identity and placelessness in a city. To counter this issue regionalism and critical regionalism were the two approaches adopted worldwide. The paper puts forward a comparative analysis between regionalism and critical regionalism. The possible adoption of better option between regionalism and critical regionalism is mentioned. The paper tries to prove the hypothesis that critical regionalism is better approach compared to regionalism.***

Keywords: Globalisation, Critical regionalism, regionalism, city identity, placelessness, region.

Introduction:

Globalisation has made every product available in all parts of the world, right from a nail to the huge machinery. All types of building materials are available, information and implementation of new building technologies is now possible due to globalisation. This has led to many changes, good and bad, in the field of architectural design.

People have started using modern materials available in market which look aesthetically pleasing and give a visual feeling of luxurious lifestyle. Modernism is the new concept adopted by the architects and the clients, this is now leading to lack of identity.

Every city has its own character its own identity. Use of these modern techniques and materials has made all the buildings look similar, as if they are coming out of a same mould. The cities have started losing their character, leading to the problem of placelessness in a city.

To counter the problem of placelessness, regionalism and critical regionalism were the two approaches brought up and are now adopted by the architects worldwide.

In the 1980s during the postmodern era, the architecture started lacking the social individuality and uniqueness of the place where the buildings belonged The architects believed that, people just mimicked the classic style and the actual historicity of the style was lacking. In contrary to the postmodern ideology, regionalism gave importance to identity of a building, ecology, culture and social qualities of that region. As said by Octavio Paz, "To be truly modern, we must first reconcile ourselves with our tradition".

While on the other hand critical regionalism is considered a form of post-modern style of developing the cities. Critical regionalism is different from regionalism, which tries to inculcate the regional character with the modern qualities in a building. As put forth by Tzonis and Lefaivre, critical regionalism need not directly draw from the context, rather elements can be stripped of their context and used in strange rather than familiar ways.

Research background:

The identities of cities is bound to be lost in a time where the most common trend is following international design that mainly preaches the concept of 'form follows function', that's why critical regionalism can be reconsidered as a gateway to maintain a city's identity while adhering to international approaches. (Zeini I.,)

It is clear that Architecture is shaped by the ecology of the place, if we achieve Ecological regionalism; inevitably regionalism in architecture is achieved. It also helps to conserve natural and regional identity in Architecture. (Yadav M.,2008

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Research gap:

It is stated by many researchers that regionalism and critical regionalism are the two approaches which need to be adopted to counter the problem of placelessness in a city. But which approach is better to be adopted and is acceptable in the era where international design is what everybody wants is still not clear. To understand the better possible option which can be adopted, a comparative analysis of both approaches is needed.

Methodology:

The research focuses on the comparative analysis between regionalism and critical regionalism. Regionalism being depicting the regional character of a city and critical regionalism being a blend of regionalism and modernism, it is important to know which is the better approach to be adopted in today's time. The locations chosen were on the basis of the building character and language.

Institutional building:

Figure 1 MIT College, Pune

The comparative analysis was done between MIT college and IUCAA. MIT college being constructed in Pune has adopted Maratha architecture as its style, corridor has been designed with openings which have Maratha style arches. There is a dome and the whole building of MIT college looks like a palace. It is observed that MIT college is designed using regionalism as an approach.

Figure 2 IUCAA, Pune

IUCAA is located in the campus of pune university. It has an entrance which leads into a courtyard where all the rooms open into the courtyard. An interesting element is the toilet duct which is turned into a courtyard with a tree at the centre. From all the observations it can be said that IUCAA is an example of critical regionalism.

IT hubs:

The second case study was of IT parks in Pune. IT parks now being one of the main public zones and main source of income for many citizens in Pune, it is important that architects are sensitive about the regional character and also about the functional quality needed for an IT hub. To understand this Cerebrum IT park and Suzlon One Earth were studied.

Figure 3 Cerebrum Tech. Park

Cerebrum Tech Park was built by Kumar Builders in 2006. The building has got lot of ornamentation. Though the building is trying to inculcate the regional qualities, which can be observed in widow design style and the dome, climate responsiveness is completely missing. Thus it can be stated that Cerebrum Tech park is an example of regionalism.

Figure 4 Suzlon One Earth

Suzlon One Earth derives its inspiration from large Indian historical campuses like Fatehpur Sikri and the Meenakshi temple complex in Madurai both have strong horizontal elements that tie the complexes together. Western portion was built with a central court surrounding with built spaces. It can be said that the architect has adopted critical regionalism as an approach while designing this campus.

Regionalism does preserve the character of the region and gives the region its identity, but sometimes the approach goes back to conservatism.

It can be thus stated that critical regionalism tries to keep the regional character in the design in a modern way, which is minimalistic but also counters the issue of placelessness. It takes some elements in the region as a representation of that region.

Conclusion:

The paper concludes that critical regionalism is a better approach compared to regionalism, as it is a blend of modernism and regionalism. Critical regionalism approach does not mimic the regional

character in the design but includes some elements which are identity of the city.

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Parking And Festivals: A Catalyst In Celebration Or Conflict?

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ABSTRACT : In Maharashtra various festivals such as Ganesh Utsav, Navratri, Diwali, etc. are celebrated at family as well as at community level, causing social interactions. Nowadays parking is a major issue that is faced in festivals. It is noted over the last few years, Ganesh Utsav has impacted on Environment and Architecture due to the adverse effect of unplanned Mandal's. Current study focuses on parking during Ganapati festival of 10-11 days. It's important to understand the effects of use of public places for parking during the festival and its efficiency for public utility. Paper concludes that, there is definite relation between rituals during the festival and parking in the publicspaces.

KEY WORDS

Festival, Parking, Temporary Structure, Pedestrian and Vehicular movement, Public places, Indian culture and tradition,

INTRODUCTION:

Civilization was created through the ages where they neither becreatednorbedestroyedduetothephysicalandvisual impact. Organization of human civilization and belief system lead to the formation of social morphology also known as societies through the edges leads to the formation of culture.The culture formation is based on different regions such as Maharashtra, Tamilnadu, Gujrat, etc., this results in formation of various social boundaries for specific civilization. These civilization includes differentsocietiesduetovariousexposures, which results into formation of various religion and culture. But due to this, the society distributed among themselves and started their own culture andtradition.

In India, there are different type of religion at North, South, East and West. Maharashtra, North-West zone of India, has strong culture, religion and tradition. But some festivals are celebrated in all religions with equality and unity. Considering PandharpurWari which originates from Alandi. Procession takes one day halt in Pune.Duringthis wari,thewhole procession route is made free of vehicle. Entire city stops functioning and participate in procession. Therefore the spaces which are created for specific purpose, temporarily convert into various ceremonial events. A similar function for which Maharashtrian culture is known for is Ganpati festival, there are some conflict faced by various facts. But nowadays there are issues faced due to parking. Rajgurunagar description and issues duringfestival.

RESEARCH BACKGROUND

Apublicmulti-culturalthemecelebrationatwhichpeople of different ethnicities including the dominant have cultural experience(lee&Songshan,2015).Inthistypeofresearchthey say thatfestivalshave aroleinsupportingculturaldiversity and promoting social harmony. They have their own motive about the local resident rather than visitors. Also, the aim iscommunity development.

Themed and inclusive community event or series of events which have created as a result of an inclusive community planningprocesstocelebratetheparticularwayoflifeofpeople and groups in the local community with emphasis onparticular space and time (Allan & Alan, 2012). In this research they studied about the role of local communities played in making decisions affecting their festivals. They had studied about the inclusive and exclusive method about communityfestival.

(Allan, Wiltshier, & Clarke, Community Festivals: involvement and inclusion, 2004) studied about the involvement and inclusion in community festival where it is seen that the vehicles are attracting more tourist into the region.

(Charles Arcodia, 2006) defining festivals are celebrations of somethinglocalcommunitywishestoshareandwhichinvolves public participants in the experience. They had studied aboutthenegativeimpactsofthefestivalsoncommunitywhere these impacts are economic, physical, political, and socio- culture.

(WaldemarCudny,2012)festivalsaredividedintoruraland urban, which is another division based on social class structure, power, and socialroles.(Derrett,2003)concludedthattheyprovide avehicleforcommunitiestohostvisitorstosharetheactivities.

From all literature the research paper studied it is evident that it is the vibrant topic. There are multicultural

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festivals which assumes in future for better development and also the community festivals which stated about the different methodologies. They also had stated about the negative impact of festivals on economic, politics, environment, and socio- culture. The research paper shall be stated about the festivals and its uses and benefits, where parking is the main issue in the urban as well as rural area. Hence the research willbeheldonparkingissueswhicharefacedduringthesocial festivalcelebration.

MATERIAL AND METHODOLOGY

Theresearchis a typeofCaseStudyofGaneshMandal at Rajgurunagar observed on the basis of comparativeanalysis, where it shows the footfall at specific area surrounded near mandap, densities of the peoples in area at different interval of time, different types of activities, accessibility, visual connect, etc. Visual and photographic analysisshouldbedoneforthedifferentactivitiesofpublic places such as dekhava. The parking should be analyzed and observed for the pedestrian and vehicular movement. Also observed for the spacesinfrontofshops,residentialbuildings,etc.

SCOPE AND LIMITATIONS

The outcome of the study shall provide the movement of pedestrian and vehicle which are perceived as negative and generate the concerns such that social sustainability is thought of, and positive coexistence is seen.

GANESH CHATURTHI

Ganesh Chaturthi is also known as Vinayaka Chaturthi and is atthebeginningoftheBhadrapadaShuklaChaturthi,isaHindu festival of celebrating the arrival of Ganesha to earth from Kailash. The festival is marked with the installation of ganesha clay idols privately in homes or publicly on elaborate temporarily stages. Then there are daily prayers which are held in morningandevening.Also Modaka also distributed as a it is believed to be favourite to be lord. The festival last for 10 days, when idol is carried out for public procession with music and group chanting, that immersed in a nearby water body such as river or sea. Thereafter the clay idol dissolves and ganesha is believed to return to mount Kailash to Parvati andShiva.

RAJGURUNAGAR: A CASE STUDY

Rajgurunagarisamoderatesizedtownlocatedinnorthside of Pune city which has historical background of Rajguru who was the freedom fighter. There are different locations in Rajgurunagar where the mandals install the Ganesh idol. Like

- **Juna Motor Stand MitraMandal**
- Wageshwar Mitra Mandal
- Ekvira MitraMandal
- **Sambhaji Groupcha Raja MitraMandal**
- **Shivchatrapati Groupcha Raja MitraMandal**
- Swarajya MitraMandal
- Vetaleshwar Mitra Mandal
- Navyug MitraMandal
- Krantiyug MitraMandal
- Yogeshwar MitraMandal
- Ranapratap MitraMandal
- Ahilyadevi MitraMandal

These mandals are well known as of their areas. According to the location of mandals the case examples are selected. Where at Juna Motor Stand Mitra Mandal have fruit market shifted elsewhere. Similarly second one is Sambhaji Groupcha Raja Mitra Mandal have temporary structure placed onhalf of the road and third one is the Shivchatrapati Groupcha raja Mitra Mandal have placed temporary structure on the road and the roadgetsblocked.Thesethreearethecaseexamplesselectedf or theresearch.

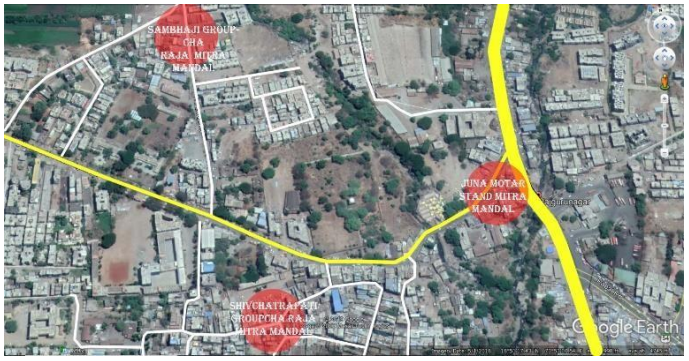

FIG. 1: location showing the three Mandal's of Rajgurunagar.

SCHEDULE

The week before, there are arrangement of temporary structures (Mandap), decoration is done. The installation of Ganesh idol is on the first day of Ganesh Chaturthi, and then the prayer part is taken twice in a day. After installation work started for the Dekhava.Thescaleofthedekhavadependsontheavailability of the space near the mandap setup. During these temporary installations the transportation of vehicles gets denser in that area. This work is done during daytime. Dekhava is held at least for 2-3 days. After that Mandals arrange other competitions for the entertainment purpose. On the last daythe Ganesh idol is taken out for the processional route for visarjan on the nearby Bhīmariver.

SAMBHAJI MITRA MANDAL

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In this case study, mandap is constructed on the half of the road and its surrounding area gets converted for festival purpose. Normally there are shops which are used on the basis of day-today requirements such as medicals, food stalls, bakery,etc.andthushaveasusualactivities.Also,their customers park their vehicles in front of shops for easy access and convenience. But during the festivals these places get convertedintopedestrianpathwaysbutthereisnoawarenessin community for safety as they park their vehicles on pathways also on the roads.as they do not have open land in surrounding area they park their vehicles in that land. The usual footfall is quite normal but during Ganapati festival these areas get highly crowed in evening and low crowed in the morning as they have their dailyschedule.

The pedestrian movement is not specific, but there are not the foot paths for the walkways. They walk on the barrel space among shops and the roads. During festival these are not specific for pedestrian pathways also for the parking. As decorative purpose in front of Mandap the avenue created towards the Ganapati idol. Also these decorative purpose impacts on the festival and parking.

Normal day activities are that street is on time movements and less densities of footfall and during festivalthedensitiesoffootfallis higherthannormaldays.And it gets a specific landmark for the festival in such area. Also in back side of Mandap there is the arrangement for the Mela during festival days as it is the highly dense area in RajgurunagarduringGanapatifestivalforthose2-3daysbefore the visarjan of Ganapati idol. Also in activities mandal arrange somecompetitionssuchasdance,speech,etc.forentertainment purpose. This mandal performing the dekhava as a drama of "Janata Raja". To see dekhava people comes from different area and it gets crowed due to parking, pedestrian and vehicularmovements.

FIG. 2: ***activity mapping at Sambhaji Mitra Mandal***

SHIVCHATRAPATI MITRA MANDAL

In this case study, mandap get constructed on the road and the vehicular movements gets blocked during Ganapati festival. This area gets more congested, where there are no open spaces, notified for parking. It is a residential and commercial zone, with existing parking issues. But during Ganapati festival the vehicular movement pattern get changed and vehicles as usual get parked their vehicles in front of shops. There is no space for the pedestrian movement as theypark their vehicles on both edges of the road. The road width is approx. 5-6 m which is not suitable for easy movements.

Activityduringnormaldaysis as explained earlier.Thereare such types of activities occurred during festival where People gets attracted and visited or involved Ganesh festival. As they called up for the celebrities and also they organized some competitions for. These activities directly affect on parking due to lack of open places and un-notified parking

FIG.3: ***Activity mapping at Chatrapati Mitra Mandal***

JUNA MOTOR STAND

In this case study, mandap get constructed in fruit market due to which fruit stalls get shifted outside the market area. The area is located near the Pune-Nashik highway and most of the surrounding zone is commercial. In this mandal pre-existing offices are converted into ganpati mandap. Also the mandap decoration is done till the fruit market boundary.

DuringGaneshfestivalthereistherestrictionofvehiclesi n the evening. The parking of the existing buildings is allowed. This mandal is well organized about the parking, pedestrian and vehicular movement can't affect the existing once. During the festivals, the area near the Juna Mortar Stand getsaffectedduetothevariousamenitiesinsurroundingwhich are vegetable market, fish market, fruit market, commercial buildings, residential buildings, ST stand, etc. This causes congestion and damages the socialsustainability.

Activities in this mandals are the dekhava and competitions. These activities affect the surrounding zones in respect to pedestrian, vehicular movement, public transport, etc.

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FIG.4: ***Activity mapping at Juna Motor stand***

CONCLUSION

In festival these should be awareness with in people about culture, religion and tradition which are getting affected by some issues which are not relevant. Architecturally there should of have sense towards the sustainability also the importance of our culture and traditions will get loose day-by-day.

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Usability of Outdoor Open, Semi Open and Dead Open Spaces in De-Addiction Centre

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Abstract: ***The topic outlines the parameters necessary to increase the usability of outdoor open, semi open and dead open spaces in de-addiction centre. In case study, the semi open spaces are mostly used because of various parameters which increases the quality of that space resulting in maximum usability.Its observed that, while designing an open, semi open , dead open space-location, vegetation, accessibility, shading pattern, natural material, seating arrangement,function etc parameters shall be considered to increase the usability of space.The results revealed that semi open spaces are mostly used in the de-addiction centre because of Location, Vegetation, Shading Pattern etc.***

Keywords-open, semi open, dead open, usability, space quality, Function

Introduction

a de-addiction centre deals with psychological, physiological and social condition of patients.It may use different types of spaces to treat patients in different stages of addiction conditions. This research is undertaken to understand usability of different type of spaces in buildings such as open, semi open and covered spaces.The focus is to assess the parameters on which the usability of open, semi open and covered spaces depends.Outdoor environment is the environment which is a complimentary space outside the building in which physical activities can be carried out. Outdoor environment have important qualities that has positive effect on health and there are negative effects as well. The experiences of the outdoor open, semi open and well treated dead open spaces,even views of greenery brought in through a de-addiction centre window can have a positive effect on addict's emotional and mental functioning which cause positive effect on his health. Outdoor open spaces promote healthy behaviours by providing an accessible, affordable and enjoyable place to be physically active.Open spaces encourage walking and outdoor activities such as outdoor games, meditation, interaction with other addicts and cycling, which is the best way to improve physical health and mental wellbeing. So outdoor open,semi open spaces are necessary in the de-addiction centre.Also, the covered spaces can be provided in such a way that it is useful for patients for recovery.

The outdoor open, semi open and dead open spaces promotes addicts for outdoor activities and exercise, have natural daylight, and natural ventilation and the aesthetic experiences that affects positively on the addict's physical health. Negative effects such as in the larger open space, addict may feel isolated from the world which would impact his health negatively resulting in aggression, stress etc. So, the space quality is important. The usability of these spaces depends on spatial quality of these spaces.

Usability in architecture is often understood as the functionality or the space's ability to carry out the function for which it has been designed.Space usability becomes comprehensive to assess how people utilise the space to meet their needs and on which spatial characters,the usability of different type of spaces depends including how the usability of dead open spaces or spaces which are not being used or used less,can be increased.

Need and justification of research

- To study the usability of outdoor open spaces in de-addiction centre.
- To assess the parameters necessary for increasing the usability of an open,semi open and dead open spaces in de-addiction centre.

Aim

To study and analyse the usability of outdoor open, semi open and dead open spaces in de-addiction centre.

Objectives

- To study the open and semi open spaces in de-addiction centre.
- To study the parameters for outdoor spaces to increase its usability in de-addiction centre.
- To study the significance of outdoor open spaces in de-addiction centre.
- To analyse the problems faced by users, its causes and solutions regarding outdoor open spaces to increase its usability.

Scope

- To understand the pattern of use of outdoor open, semi open and dead spaces in de-addiction centre.
- To analyse the parameters on which the usability of outdoor open and semi open spaces depends.

Limitations

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- The study is limited to day time observations after an interval of 30mins from 9am to 6pm.
- To study the usability of open spaces, the identified parameters are taken from the literature review.
- The study is limited to the age group preferably from 25years to 50 years.

Methodology

- These are the following methods that will be used for analysing the usability of outdoor open and semiopen spaces in de-addiction centre.

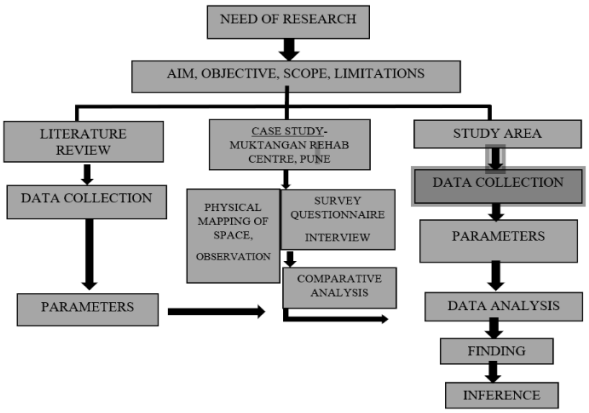

Chart.1 methodology flow chart

The research methodology adopted was divided in three phases according to the informationgathering technique.

- From literature review the parameters for studying the open, semi open and dead open are developed.
- The case study is done to observe the usability of outdoor spaces used in the de-addiction centre by different user group in same space at a same time.
- Activity mapping in the open,semi open and dead open spaces in de-addiction centre on different timings by different user groups is done to understand the flow of use of the space.
- When establishing the criteria for space quality, it was necessary to consult the user's subjective evaluation. For this reason, the questionnaire technique, which is the most suitable method in field study was applied. The interview of different user groups by preparing a questionnaire based on parameters studied in literature review is carried out, which gave the data necessary for analysing the pattern of use of outdoor spaces in de-addiction centre.
- Then open, semi open and dead open spaces are compared from which we get to know the characters of each space.
- From activity mapping. The pattern of use of the space is understood from which the mostly used space is identified and from the comparative analysis. Because of which characters. The space is being used is understood.

Case study- Muktangan rehabilitation centre, Pune

Architect- Shirish Beri

Completed- 2000

The drug rehabilitation centre designed by shirish beri is designed to accommodate a central courtyard that creates transparency, openness and fluidity between spaces and between patients. The de-addiction centre is the combination of indoor and outdoor spaces in which the nature plays a very important role, which helps addict to interact with another releasing the stress, feeling of isolation.

A balance was struck between the sense of freedom and disciplinary control. The design having transparency becomes expressive of this freedom and increases the physical and visual interaction, reducing the feeling of isolation. Even the main entrance is transparent. The transparency ,the cut outs, the terraced balconies, and the seating encourages the patients to open up.

Methods-

- On site observations
- Activity mapping
- User interview - 1.staff 2.patients

Observations on site

Spaces studied –

- Open space - open air amphitheatre
- Semi open space -seating space in entrance lobby
- Dead open space – building setback

Fig.1 Plan showing spaces to be studied

- Open air amphitheatre –
- Seating space in entrance lobby-
- Building setback

Parameters for studying the usability of open, semi open and dead open space

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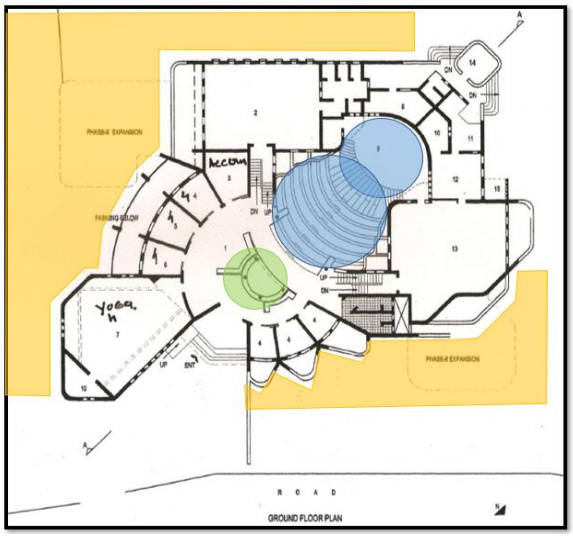
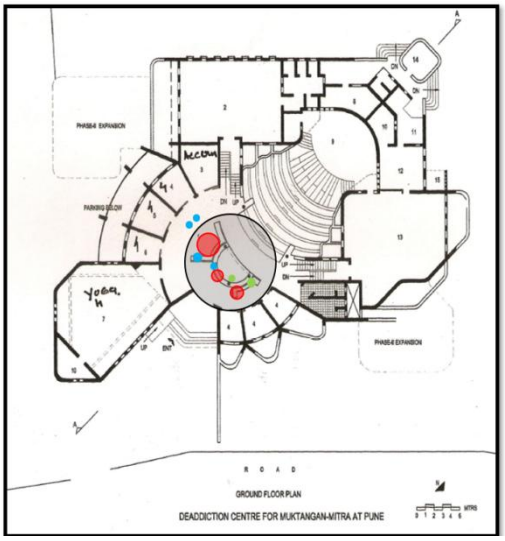


In this study, usability of open, semi open and dead open spaces is evaluated in regard to parameters which are identified in the literature study. These parameters are developed by the study of related literature about the space quality on which usability depends.

- Mapping of spaces
- Circulation
- Orientation
- Entry / exit
- Spatial characteristics
- Material
- Function/activity
- Time of use
- Seating arrangement
- Shadow patterns
- Natural light and ventilation
- Visual impact – views from the space
  -views towards the space

Observations

Table.1 Comparative study of open,semi open and dead open spaces shows the spatial characteristics of the space related to time,context and design.



Activity mapping- user footfall and activity

Users-

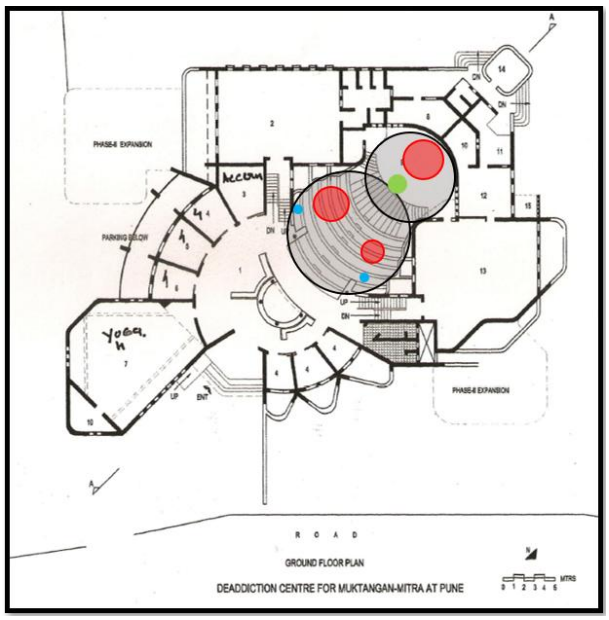
- Patient
- Doctor/counsellor
- Patient's family

In this study, the users are distinguished into three groups as patients, doctor/counsellor/staff member, and patient's family members.

Patients-

The patients were defined as the recipients of rehabilitation treatment in muktangan rehabilitation centre, pune.

Doctor/counsellor/staff members -



Doctor/counsellor/staff members are the people who accompany patients during their treatments in the rehabilitation centre or take care of patient's daily living in the rehabilitation centre.

1.open air amphitheatre

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Fig.2.A User footfall and Activity mapping of open air
Table.2.ATimewise activity mapping in specific space anduser

2. Semi open seating

Fig.2.B User footfall and Activity mapping of semi open seating

Table.2.B time wise activity mapping in specific space and user

3. Building setback

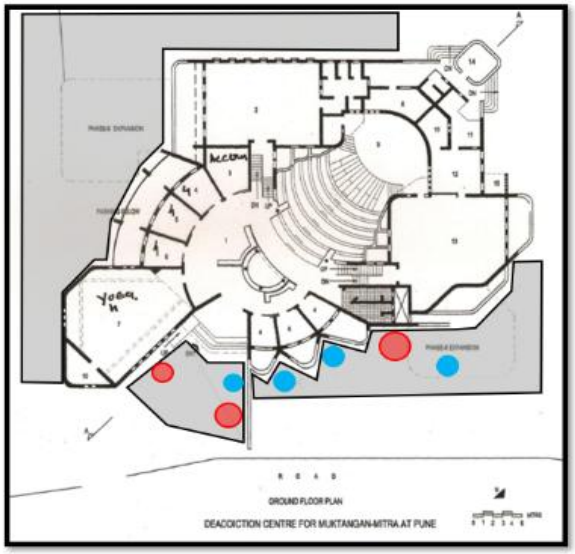

Fig.2.C User footfall and Activity mapping in building setback

Timing	Space user	Activity
10am - 12pm	• Patient • Doctor/counsellor • Patient's family	-yoga, exercise -meditation -yoga, exercise -meditation, sitting, interacting
12pm - 2pm	• Patient • Doctor/counsellor • Patient's family	-dining, sitting - -sitting
2pm-4pm	• Patient • Doctor/counsellor • Patient's family	- - -interacting
4pm-6pm	• **Patient** • **Doctor/counsellor** • **Patient's family**	**-interacting, workshops -relaxing** **-workshops -interacting**
10am-12am	Patient Doctor/counsellor Patient's family	-walking - -sitting -interacting

Timing	Space user	Activity
10am-12am	• Patient • Doctor/counsellor • Patient's family	-interacting -relaxing -sitting - -sitting -interaction
12pm-2pm	• Patient • Doctor/counsellor • Patient's family	-dining - -sitting -interaction
2pm-4pm	• Patient • Doctor/counsellor • Patient's family	- - -sitting -interaction
4pm-6pm	• Patient • Doctor/counsellor • Patient's family	-sitting -interaction -relaxing -sitting -interaction
12pm-2pm	Patient Doctor/counsellor Patient's family	- - -sitting -interacting
2pm-4pm	Patient Doctor/counsellor Patient's family	- - -sitting -interacting
4pm-6pm	Patient Doctor/counsellor Patient's family	- - -sitting -interacting

Table.2.CTimewise activity mapping in specific space anduser

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Space	Usability	Time	Reasons of usability
Semi open space	Most	-morning - afternoon -evening	-location -vegetation -shading pattern -accessibility -view from the space -natural ventilation
Open space	Moderate	-morning -evening	-location -vegetation -accessibility -natural material -natural light and ventilation -seating arrangement -view from the space -function
Dead open space	Least	-morning	-shading pattern -spatial character(openness) -vegetation

Data analysis

Reasons of non usability	Solution
-natural light (less as compared to amphitheatre and setback area)	-the **roofing material** of the double height atrium could be changed to the **transparent/opaque** material. -
- excess sunlight -shading pattern	-shade giving trees could be planted to give shade. -shading devices like pergolas could be added.
-view from the space -function -seating arrangement	-the space is dead, the space has not allotted the proper function, so planning proper activity in the space could increase the usability of space. -attractive landscaping and sitting arrangement could invite users.

Table.3.ATable showing Usability of the space and its reason

Table.3.BTable showing Usability of the space and its reason

The table 3A and 3B shows the usability of the space, time of use, reason for the utilization of the space and solution to increase its usability. Therefore, the open air amphitheatre has good spatial character but because of shading issue, it is less used. On the other hand, the semi open seating is mostly used. And dead open space is less used as compared to open and semi open space, so to increase its usability, mentioned parameters could be used.

Results

This research shows that people in de-addiction centre having a open and semi open spacehave a greater impact on people in de-addiction centre. They spend maximum amount of their day time in outdoor spaces.so the spatial relationship of indoor spaces with open spaces can have connection to them. It is seen that the semi open spaces are mostly used,which could be evaluated on different spatial characters.in my case study of muktangan,on the basis of observation, the semi open spaces are mostly used in design because of various parameters which increases the quality of that space resulting in maximumusability.

This paper describes a research that contributes towards understanding the characters of open, semi open and dead open space designs in de-addiction centre. The results revealed that semi open spaces are mostly used in the de-addiction centre because of location, vegetation,shading pattern, accessibility, view from the space, natural ventilation.

Conclusion

It could be observed that,while designing an open, semi open , dead open space,following parameters shall be considered to increase the usability of space. -location, vegetation, accessibility, shading pattern, natural material,natural light and ventilation, seating arrangement, view from the space, function.

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Flood and Landslide Resistant Structures: Western Ghats

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Abstract: Natural calamities occur due to rapid changes in environment like geophysical, hydrological and climatological etc. calamities such as flood, landslide, hurricane, cyclones etc. are considered as natural though hidden reasons can be manmade. Natural calamity which is the source of largescale destruction can be invited by the haphazard development, increasing population and urbanization. Collapsed structures, buried lives under the debris, soil erosion, economical destruction etc. are some of the major effects after these calamities. Disaster resistant structure preparation is the need of current situation to stop damage. Flood and landslide hazard mitigation is required, on which the paper focuses.

Key words – Natural calamity, Flood, Landslide, Haphazard development, resistant structures, flood mitigation.

I. INTRODUCTION

Flood and landslide are normal phenomena that have been affecting human settlements. Nature has been warning people about the consequences of unwise occupancy.In India, 12% of geographical area is flood prone and over 12% of total land mass falls under the landslide-prone zone.[i]Flood and landslides are classified according to duration and location. Flash floods, slow on set flood, and rapid onset flood are classified according to duration. Coastal, lake, and canal flooding are according to location.

Rapid flows of landslide are fastest and slump and debris slide is slowest type of landslide. These calamities have several aspects such as climate, social, economic and technical that is differently addressed for rural and urban conditions. In urban condition, problems are increasing due to the different reasons. Uneven settlement pattern, filling up natural drainage channels, and high value of urban land for living are the causes of urban flooding. In the present paper, an attempt has been made to study the encroachment on the river bank in Pune city and seek for the hidden reasons behind that and mitigation requirements.

Pune city lies on Western margin of Deccan plateau, on leeward side of Sahyadri mountain range. It is an altitude of 560m and it covers total geographical area of 15.642 square kms. The city is blessed with Mula and Mutha rivers that originate from Sahyadri ranges. Pune city is part of tropical climate and hence shows variation in temperature as well as rainfall conditions. Heavy urbanization in Pune from past few decades has led to haphazard development along the river and extend at the edge of the river.

Causes and impact of flood and landslide in urban area:

- Flood is natural phenomena, but may also be cause by manmade activities. Massive rainfall, climate change are the natural causes. Deforestation, urban drainage, broken dams etc. aremanmade reasons of flood. Floodplain areas are subjected to hydrostatic (standing water) and hydrodynamic (flowing water) pressures during floods. Flash flood damage roads, Direct loss of buildings, houses, vehicles, livestock, crops, and infrastructure.
- Main causes of landslide are increase of shear stress and decrease of material strength. Intense rainfall, soil erosion etc. are the physical causes and excavation, mining, quarrying, land use pattern are human causes of landslide. Crowded settlement patterns have also contributed to toehold erosion in many places. Due to heavy rainfall, clay soil and stones are moving down and this creates massive landslide. Stone quarrying results in formation that are unstable and could cause sudden landslide. The human activity is common in the inhabited areas of the hilly terrain that produce landslide.

II. METHODOLOGY

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Case study: AmbilOdha (Canal) flood (Aranyeshwar, Pune.)

Pune, which had not seen floods in years, was hit twice by this disaster in 2019. Most of the devastation and economic loss was experience near the banks of the river. AmbilOdha originates from the hillsof Western Ghats., in the southern part of Pune in Katraj. It flows in the north direction towards the city Centre, and many Streams join ambilodha before it meets the Mutha river.

On 25thSeptember heavy rains covered the major portion in just four hours, city recorded 106 millimeters of rainfall. On comparing survey of India maps, built up area had increased to 47% in 2015 from 37% in 1991.Streams existed till 1999, then they started disappearing. "These Changes happened when the width of the odha (canal) was reduced to about 8 feet from more than 20 feet, and the depth was reduced to 3.5-4 feet from about 12 feet, said by survivor."[iii.]

Fig- 1 (Source- google earth)

As per the observations, in 2005 canal was wide but due to encroachment the width has been reduce which resulted in disaster. Illegal and unplanned construction, settlements near the canal,dumping of construction debris and household waste, divert its path. no proper drainage, increased runoff owing to cement, concrete roads and encroachments near canal etc. are main reasons behind the ambilodha flood.

Fig- 2 (Source- google earth)

Malin landslide 2014 (Ambegaon taluka, Pune)

A massive landslide exterminated a village and it was identified ecological sensitive area. Culprits of landslide were heavy rainfall, deforestation, levelling of land for cultivation, human interference in nature etc.

The region receiving heavy rainfall, "data suggests 600mm precipitation may have affected this area prior to the landslide occurring." [iv] There was continuous heavy rainfall, soil-soaked rainwater and developed loose mud. After gaining some momentum, soil flowed down and sweeping, houses in village.

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From the study, we came to know landslide happened due to human intervention such as excavation, poor construction techniques, deforestation, and changed agriculture pattern etc.

Net case study:

Ar. G Shankar designed house which effectively resist flood and natural calamities in Thiruvananthapuram. The house has 3 stories, stands on pillar built with treated bamboo, mud and concrete. Mud bricks which could be interlocked are used to build structure, cement plastering done on wall prevent from seeping in moisture. Recycled mud tiles, coconut shell and treated bamboo were used in plastering.[v]

Aum houses (design and built by Autryville earth institute) was created disaster resistant and cost effective houses that could precast and transport anywhere, area about 23m^2, stabilized rammed earth foundations, plinth and walls constructed by hollow interlocking earth blocks (CSEB) and reinforced concrete ring beams, CSEB tiles for flooring, ferrocement used for doors and roof.[vi]

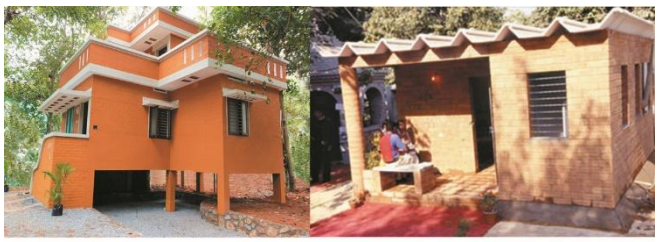

Fig- 3 Flood resistant model house. (Source- delhipostnews.com)

Disaster resistant structure. (Source- earth.auroville.com)

III. RESULTS

Construction within the flood line:

Avoiding the impact of flood is sensible development layout which reduce the need of resistance and resilience It is necessary to consider flood line during construction near the river bed. Flood lines are marked along the river bank indicating a potential threat of flood. No construction is allowed up to blue line, only restricted construction is allowed in between blue and red lines.

According to DC rules,

1. Area between the river bank and blue flood line shall be prohibited zone for any construction except parking, open vegetable market, garden, lawns, open space, cremation and burial ground public toilet, or like uses, provided the land is feasible for such utilization.
2. Constructions within river bank and blue flood line, may be permitted subject to conditioned that, the plinth height of the building shall not less than 0.45 m. above the R.L. of red flood line.
3. If the area between the river bank and flood line forms the part of entire plot in development zone i.e. residential, commercial, public-semi-public, industrial, then FSI of this part of land may be allowed to be utilized on remaining land.[vii]

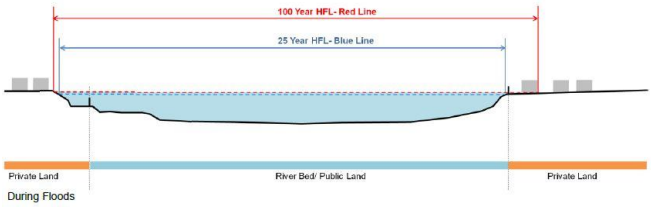

Fig-4 Demarcation of flood line (source-www.pmc.gov.in)

Design consideration for flood

- Properly design of embankments, drainage sluice, spilling section, anti-erosion works, diversion of flood water, catchment area treatment, in combination with other works such as reservoir, channel improvement, drainage improvement structure, etc. will be long term solution for flood problem.
- In wet flood proofingmain aim is to allow water to pass through lower level of houses.
- In dry flood proofingmain aim is to watertight the house includes sealants, coatings. Use one-way valves to prevent water from entering. Walls and foundation should resist flood pressure. Boundary wall and fencing can be designed to create flood resistant barriers.
- Levees and flood walls are made up of cement block or poured concrete, sump pump has to be installed to control the seepage and infiltration.
- Closed cell insulation should be used for pipes which are below the predicted flood level. Non return valves are recommended in drainage system to prevent back flow, are General services need to consider.
- Flood resistant flooring material such as concrete, clay, terrazzo, pressure treated tiles etc. use metal door and cabinets.[viii]

Design consideration for landslide:

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- Heavy rainfall is main reason for landslide, construct retaining wall, fill slope and soil nailing, construct ground anchor wall, horizontal drain to dewater are the landslide mitigation techniques. There are various direct methods, Erosion protection, channeling, vegetation, ground improvement, earth ramparts, stabilization of slope, berm provide at base of home, etc.
- Sheet piles, ground, soil and rock anchoring for resist soil.[ix]
- Foundation should design to carry the building load according to the soil bearing capacity.
- load bearing walls are preferred to carry flood water pressure. Construct timber crib wall, gabion wall, material behind the wall should be well drained.
- In Drainage system water should not allowed to flow down, should drain through pipes.[x]

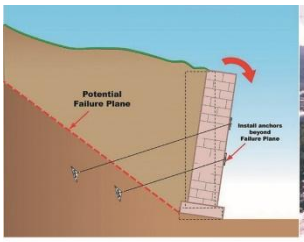

Fig- 5 Soil nailing
(Source- cirtx.com.au)

Retaining wall construction
(Source- nidm.gov.in)

IV. CONCLUSION

In recent years, flash flood and landslides frequencies have increased due to encroachments. Flood and other calamities Are increasing at an alarming rate. To overcome these issues, feasible planning as well as sustainable construction techniques should be put forth. This could be the first step towards better future.

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It is my pleasure to thank all who helped me in completion of this paper and the resources I utilized. I would like to thank my guide **Prof. Shubha shree Upasani**, **Principal Kataria** Sir for their valuable guidance and encouragement.

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Study of Cooling Strategies of Animals and its Application in Habitable Spaces in Arid Climate

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ABSTRACT: Bionics', the science of emulating nature's strategies, has remarkably contributed to solving many of human problems in different fields. This paper discusses the use of various strategies and adaptations that animal species in arid condition use for better living and survival. Emphasis is on animal behaviour and then study expands to the living patternsinto five viewpoints which consist of form, material, way of construction, function and process. Ultimately by expanding the results into architecture finds new solution to get sustainable architecture.An analytical study is done to understand which strategy can be used for natural cooling and further studied in detail. This strategy further can be implemented to reduce energy consumption by humans used forcooling in desert regions. Analysis of selected thermal strategy or adaptation, existing in animal species is done.A hypothesis is built on the conclusion of the comparative and analytical study of strategies. Bionics and architecture are strongly related and hence bionics can be used in architecture to make it more sustainable and energy efficient.

KEYWORDS:bionics, arid, thermal strategies, natural cooling, skin, energy efficiency, sustainability.

INTRODUCTION:

Bionics is an interdisciplinary science crossing biology and technical science, developedwithin the recent 30 years.The term 'bionics' can be traced back to the 1950s. An American major, Jack E. Steele, coined this term in 1958 and further expanded its usage in 1960 with many other bionics' scholars at the first bionics seminar, held in America. This seminar marked bionics as a formal subject and laid the foundations of bionics. At that time, 'bionics referred to transferring technologies into life-forms, also known as biomimetics, diagnosis, biomimicry or biotical creativity engineering. Later, the term was also applied to bionic design, which is the harmonious relationship between the human and nature in industrial design, and also a major path to systematically study and improve the way of life.Human thermal comfort is defined as a condition of mind, which expresses satisfaction with the surrounding environment. High temperatures and humidity provide discomfort sensations and sometimes heat stress (i.e., reducing the body's ability to cool itself). Moreover, discomfort and heat stress reduce productivity and may lead to more serious health problems, especially for aged persons. In hot summers of arid regions, high outdoor air temperatures due to intensive solar radiation and low relative humidity are present. Consequently, discomfort sensations and heat stress are expected. Therefore, persons should take care when they go outside in hot summer to protect their health from heat and/or sunstroke.The indoor environment also plays an important role on the person's comfort and in arid conditions it is more important to work on the indoor habitat and energy consumption is high to keep the space lively and comfortable. To reduce the energy consumption and start a walk towards sustainability using the natural techniques that animals use in arid zones. Bionics is somewhere it not only implements the strategies but also puts in the research and development of that built environment.

METHODOLOGY:

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An analytical study is done based on secondary data, building a hypothesis at the end as a base work for further area of research

Humans and their adaptation in hot arid conditions.

Humans are physiologically very good at keeping cool, but rather poor at conserving water. Sweating is the primary method of cooling the body; the evaporation of this sweat from all over the body cools the naked skin. During a really hot day in the desert, however, a human will lose as much as 12 litres (a little over 3 gallons) of water through sweat. Humans have a special mechanism for cooling their big brain: The blood cooled by evaporation of sweat on the face and head penetrate the skull through tiny emissary veins, thus delivering freshly-cooled blood to the brain. This cranial radiator is unique among primates. Humans' upright, two-legged stance also confers some advantages for keeping cool. When the sun isdirectly overhead, only the head and shoulders are from the desert surface is much less than that of quadrupeds. Being upright also exposes more of the body to cool air currents, and thus body heat can be lost by convection. Nakednessis also an advantage. Without insulating fur, heat can be lost more easily through convection, and sweat can be more easily evaporated. And that patch of thick hair on top of our heads is more than mere decoration-it shades the head and its heat-sensitive brain from the sun. Unlike other desert mammals, humans have come up with many cultural and technological adaptations to the desert heat and aridity.in full sunlight-a four-legged animal has its entire back, shoulders and head exposed to the sun. Humans therefore gain much less radiant heat than four-legged animals. Also, by standing upright, most of the body is raised above the hot desert floor; this means that humans' rate of heat gain.

Desert iguana: Active in daylight, desert iguanas change colour to regulate body temperature. They are darkest in the morning to absorb more heat from the sun, and they will turn nearly pure white by early afternoon to reflect sunlight. These lizards can stand hotter temperatures than most, remaining active in up to 46º C (115º F). In extreme heat they seek the shade of a creosote bush. During breeding season, theirbellies turn pinkish. Theimportantfeatures chameleons have regarding skin colour are located in the dermis. It is within the dermis that the blood vessels, nerves, skin muscles, and special cells named chromatophores are present. The chromatophores contain guanine crystals and are subdivided into differing types including iridophores, xanthophores, erythrophores,guanophores, and melanophores.

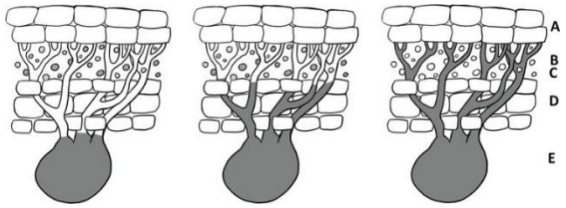

Figure 1 Dermal section.

A. Keratin layer, B. Xanthophores, C. Erythrophores, D. Gonophores, E. Melanophores. The three figures show how coloration is achieved through their extensions.

Desert ants: A single ant is capable of carrying up to 50 times its own weight, so working together as a colony means they’re able to accomplish impressive feats. In fact, within a week a large army of garden ants can construct an underground city big enough to house thousands of insects. Established deep underground, ant nests are made up of multiple chambers and connecting tunnels. Each chamber has a different use; some store food while others are used as nurseries for the young and resting spaces for busy worker ants. You’ll find the queen ant in the central chamber where she will lay her eggs. Porous turrets are also built above ground to ventilate the nest and maintain an even temperature inside

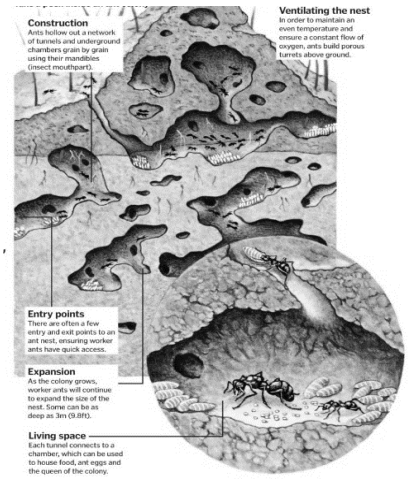

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Figure 2 Ant's Nest

Caterpillars:The temperature can influence how much the caterpillars eat and grow. Larvae are pupated and emerge while being affected by heat or cold. This thermoregulatory behavior can be implemented.Other strategies are the creation of a cocoon around the animal to minimize water evaporation or to produce an appropriate environment for a specific process, e.g. the metamorphoses of the caterpillar. In the cases analyzed, the cocoon material is always self-created by the animal. In HVAC systems, these actions inspire the possibility of using new organic materials or components.

Figure 3 Larvae pupating going through metamorphosis.

. **Honey Bees:**Residing in temperate environments, honey bees (*Apis mellifera*) work especially hard to maintain brood comb temperature between 32 and 36 °C. Heat shielding is a social homeostatic mechanism employed to combat local heat stress. Workers press the ventral side of their bodies against heated surfaces, absorb heat, and thus protect developing brood. While the absorption of heat hasbeen characterized, the dissipation of absorbed heat has not.

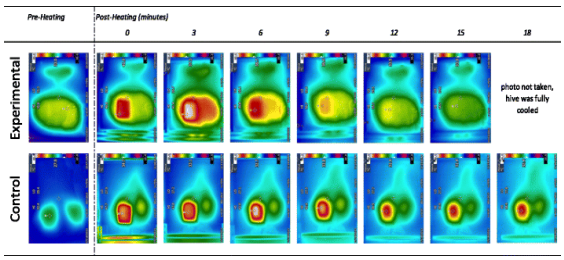

Figure 4 Heat dissipation in honey bee.

Desert Snails: The shell of some desert snails helps them survive extreme heat using light reflectance and architecturally-derived, insulating layers of air. Sphincterochilaboissieriwhich occurs in the deserts of the Near East. Live specimens of this snail, withdrawn in the shell and dormant, can be found on the desert surface in mid-summer, fully exposed to sun and heat. The surface temperature of these deserts may reach 70 °C and more than a year may pass between rains. The maximum air temperature, reached at noon, was 42.6 °C, and the maximum soil surface temperature in the sun, reached at 13.00, was 65.3 °C. Under the snail, in the space between the soil surface and the smooth shell, the maximum temperature was 60.1 °C, or 5.2 °C below the adjacent soil surface in the open sun. The lower temperature under the shell is expected, for the shell provides shade for that particular spot of the soil surface on which it sits. Inside the shell in the largest whorl, located in contact with the ground, the maximum temperature was 56.2 °C. In the second and third whorls the temperature was lower, reaching a maximum of 50.3 °C.

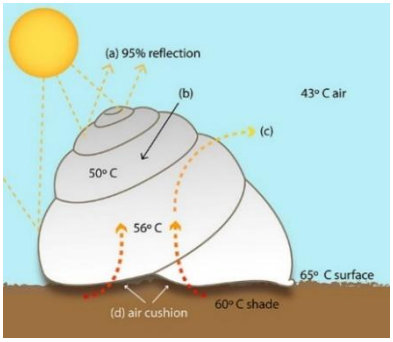

Figure 5Fig (5) The surface of the shell is highly reflective, resulting in 95% reflectance within the near infrared, 90% in the visible spectrum (a). While the maximum air temperature might reach 43 °C (109 °F) surface temperatures can reach 65 °C (149 °F). However, shading and the rough surface of the soil results in a temperature of 60 °C (140 °F) (d). During the heat of the day, the snail retreats into an upper whorl where the temperature is an even cooler 50 °C (122 °F) (b). Heat flows in the direction of lower temperature, result in heat flow through the shell, with resultant decrease higher in the shell (c

All the above studied strategies have a strong potential to be implemented. It will further help the construction and technical world to understand the working of natural species reducing the gap between natural and synthetic living.

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FURTHER AREA OFRESEARCH: Building up a prototype of structure on the analysis of shell of desert snailSphincterochilaboissieriand testing it in a software.

CONCLUSION:

This paper has analysed various cooling strategies in animal species and also found immediate use of those strategies within the architectural boundaries to attain energy efficiency and sustainability. While the entire analytical process various research opportunities rose for many other fields.The study has validated the solution-based approach methodology proposed.

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Table (1) Analysis of various animal strategies.

Desert animals	***Desert iguana***	***Ants***	***Caterpillar***	***Honey bee***	***Desert snail.***

Adaptation compared to normal species	Thick skin with scales to protect from sun.	Construction technique for their dwelling space	Change in its form.	Social behavior.	Pure white shell, with curvature having high reflective indices.
Strategies used by them	Color changes according to temperature.	Thatched nest construction with holes to protect the larvae and fungus kept inside.	Indoor temperature maintained by change in the spatial configuration	Indoor temperature control in bee hive by social organization.	Cooling inside of the shell to avoid harsh temperature outside.
	Designing a façade with changing color according to temperature	Construction technique and materials can be used for building structures.	Construction can be done with geometrical experimentations.	Cellular division technique can be used.	The structure and material of shell having reflective index can be used.

Table (2) Based onthemodelsanalysed, several technologicalhypotheses wereproposedandclassified depending on scale.Table consists of factors, theevolutionary strategy and the animal response mechanisms.

Biological Domain				**Goals**			**Technological Domain**	
Animal	**Strategy**			**Energy Management**			**Objectives**	**Application Scale**
	System	**Process**	**Action**	**Heat Gain**	**Heat Storage**	**Heat Dissipation**		
Desert Iguana	Solar control	Color change	Darker/ lighter	YES	NO	NO	Material or façade that changes its color depending on temperature.	Building
Ants	Air control	air movement	Force flow	YES	NO	YES	Ventilation. Openings optimization	Building
Caterpillars	Air control	surface to volume	Construction	YES	NO	NO	Passive ventilation control	Building
Honey Bee	Air control	Air movement	Obstruction	YES	YES	YES	Division of elements in atrium spaces to diminish losses caused by air currents.	Building
Desert Snail	Air control	Air movement	Force flow	YES	NO	YES	Implementation of indoor air micro currents for temperature control.	Building

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Role of Transit Hubs in Social A Developing Smart City

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Abstract:The literature review shows, that among the three facets of sustainability; environmental, economic and social, the third has always been the neglected one by scholars and policy makers. This paper draws attention on the relation between transit and social sustainability. The paper argues, while considering transit's sustainability, only transit systems are studied whereastransit hubs are equally significant. A survey was carried out to find, how people of different age groups, gender and economic class perceive these transit hubs in terms of equity, quality, interconnectedness and access. Paper concludes by elaborating the relation between transit hubs and social sustainability.

Keywords: *sustainability, transit, social sustainability, transit hubs, smart cities, transit oriented developments*

Introduction

Sustainability has been a wide subject of interest for scholars for past few decades, which is further subcategorized into three dimensions which are, Environmental, economic and social (Partridge, 2012; Lucas , Marsden, Brooks & Kimble, 2007; Gomaa & Sakr, 2015). Though the term sustainability has included the social aspect, for two decades this aspect of the sustainability has been neglected(Vallance, Perkins, & Dixon, 2009). Few scholars define social sustainability as development which leads towards harmonious evolution of the society(Gomaa & Sakr, 2015).

This paper argues that the social dimension of sustainable development is also important in order to achieve sustainability as a whole. Social sustainability still lacks the recognition whereas it's an independent dimension which is Equally significant to the economic and environmental sustainability (Omann & Spangenberg, 2002).

The literature review shows that there's a relation between transit and social sustainability. Transportation system is a very important factor which shapes the city and which impacts all three aspects of the city's sustainability. (Bamwesigye & Hlavackova, 2019).

Literature review suggests, that more research needs to be done on transit system's sustainability in general and social sustainability in particular. The social elements are in-fact significantly affected by transit systems.

(Pucher , Korattyswaropam, Mittal & Ittyerah, 2005; Lucas et al., 2007; Mattioli, 2015).

Transit oriented development (TOD) has been an emerging topic in urban India. The study shows that the cities in India which have tried to incorporate TOD, have failed to consider social sustainability.(Joshi, Joseph, Patel, & Darji , 2017). Joshi (2017) suggests that TODs in India shall be inclusive of social sustainability to achieve their goal.

This research argues that, while considering sustainability of transit systems, only macro level planning is taken into account, where the micro level aspects are also equally significant. Here, transit systems and transit corridors are termed as macro and transit hubs such as train stations, bus stands are termed as micro(Elshater & Ibraheem, 2014). Few scholars argue that TODs worldwide and in India have not really focused on the transit hubs. Transit hubs are nodes where different modes of transport are exchanged(Elshater & Ibraheem, 2014).

The government of India recently announced "Smart Cities Mission" where transportation has been given a great importance(Bamwesigye & Hlavackova, 2019). Few scholars argue that very less is done in order to promote public transit in these cities. They claim that the transit routes that are developed are unknowingly encouraging the usage of private vehicles among people (Ramos , Vicente , Passos, Costa & Reis, 2019).

This research proposes, that Maximum focus shall be given on increasing the amount of public transit usage and reducing the number of private motor vehicle users in India. This reduction of private vehicles will result in low carbon emission, safe environment, social equity and economic sustainability of these cities. This paper argues, that equal importance shall be given to the transit hubs and how they affect social sustainability of that city. (Srinivasan, 2019).

Research background

Partridge (2012) has discussed main principals of social sustainability which are quality of life, equity or social justice, inclusion or inter connectedness and access. Pucher (2005) emphasizes on the relation between transport crisis and the economic class of the people. He argues that the mode of transport changes as the economic class of the user changes. Mass public transit is most commonly used by poor and middle class. The paper argues that the lower income group of the society remains to be the most neglected one. The argument raised is about accessibility and social discrimination. Ramos (2019) focuses mainly on the negative aspects of people's perception which lead to not adopting the public transit. Ramos (2019) concludes by stating, that the users' needs and expectations shall be considered while developing transit services in order to achieve sustainability.

Joshi (2017) in his research states that transit oriented development is taking its shape in India. While explaining TOD, paper provides a definition by Calthrope (1993): '*Mixed use communities within an average 2000-foot walking distance of a transit stop and a core commercial area. TODs mixed residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot or car*.'Paper further states that TOD comprises a mix of commercial, residential, and institutional developments built to support a transportation hub and to encourage non-motor vehicle mobility options.

Mattioli (2015) draws relation between social sustainability and transit. Author discusses the relation between transport system and economic groups in the society. It claims that, individuals who have lack of access to car or public transit are more at risk of social omission. This issue of accessibility has also been addressed in Pucher's (2005) work. Author argues that ensuring fair levels of access to everyone will result into achieving a rapid reduction in transport emissions and energy consumption in developing countries. Author also argues that there is a tension between the need and the want of people as the satisfaction of transit has come to depend upon the usage of private vehicles.

Bamwesigye (2019) relates smart cities and sustainable transport. Paper expresses importance of sustainable transport in all three aspects. Elshater et al. (2014) discuss various definitions of hubs. They discuss hub in urbanization field asa node for exchanging the transit mode.Gomaa's (2015) research directly connects social sustainability with a transit station named as El-Raml. It mainly focuses on maintenance of socio cultural characteristics. Lucas (2007) talks about assessing social sustainability in transport. She claims that the research can be of relevance to other countries. She discusses a set of merits of social sustainability which are, poverty, accessibility, employment, health and education, quality of life.

Srinivasan (2019) in her research relates social inequity and public transport infrastructure. She exclusively focuses on transit hubs and their impact on social equity. She argues that infrastructure of transit hubs has an impact on social sustainability. She points out the factors such as safety, gender, economic and cultural are very much affected by these transit stations. She suggests that these transit stations shall be made more inclusive in order to achieve social sustainability.

Scope and limitations

The scope of this study is limited to, only one transit hub (Swargate, Pune). Strata are limited to gender, age groups and economic class of people,and the sample was limited to 85 respondents.

Methodology

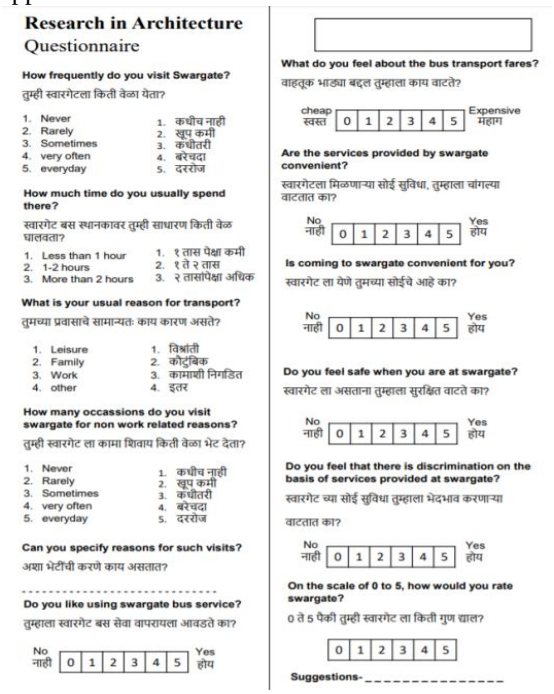
Research focuses on Swargate bus stand in Pune. This methodology views Swargate in lenses of four elements of social sustainability which are; equity, quality, interconnectedness and access. Stratified random sampling of 85 people was done. Strata 1 was Gender: Males, Females; Strata 2 was Age groups: 18 to 39, 40 to 60, 60+; strata 3 was Economic class: Lower, Middle, Higher. Indicators used were; Frequency of travel, Time spent at Swargate, Reasons for transport, affordability, convenience, safety, discrimination, and liking.Data was collected by using primary data. A survey was carried out by the means of questionnaire consisting of 12 questions.

Results and Analysis:

The survey was analysed in a pixel format to understand the results better, in a broad as well as micro fashion. Every pixel in the table of any indicators, represents a single person.

Every hierarchy was shown with the help of gradient. In the case of frequency of travel, the darkest colour represents highest frequency, and the darkness fades as the frequency decreases. For the time spent at transit hub, the darkest colour represents highest amount of time spent and the darkness fades as the amount of time decreases.Reasons for transport are broadly classified into four types which are, leisure, family, work and other. Red represents leisure, yellow represents family, green represents work and the blue represents other.

In case of all the qualitative indicators which are, liking, affordability, quality, convenience, safety, discrimination and overall rating; the darkest colour represents negative perception of people and the lightest colour represents positive perception of people. Purple colour represents 'not applicable'.



Research in Architecture
Questionnaire

How frequently do you visit Swargate?
तुम्ही स्वारगेटला किती वेळा येता?

1. Never — 1. कधीच नाही
2. Rarely — 2. खुप कमी
3. Sometimes — 3. कधीतरी
4. very often — 4. बरेचदा
5. everyday — 5. दररोज

How much time do you usually spend there?
स्वारगेट बस स्थानकावर तुम्ही साधारण किती वेळ घालवता?

1. Less than 1 hour — 1. १ तास पेक्षा कमी
2. 1-2 hours — 2. १ ते २ तास
3. More than 2 hours — 3. २ तासांपेक्षा अधिक

What is your usual reason for transport?
तुमच्या प्रवासाचे सामान्यतः काय कारण असते?

1. Leisure — 1. विश्रांती
2. Family — 2. कौटुंबिक
3. Work — 3. कामाशी निगडित
4. other — 4. इतर

How many occassions do you visit swargate for non work related reasons?
तुम्ही स्वारगेट ला कामा शिवाय किती वेळा भेट देता?

1. Never — 1. कधीच नाही
2. Rarely — 2. खुप कमी
3. Sometimes — 3. कधीतरी
4. very often — 4. बरेचदा
5. everyday — 5. दररोज

Can you specify reasons for such visits?
अशा भेटींची करणे काय असतात?

Do you like using swargate bus service?
तुम्हाला स्वारगेट बस सेवा वापरायला आवडते का?

No नाही 0 1 2 3 4 5 Yes होय

What do you feel about the bus transport fares?
वाहतूक भाड्या बद्दल तुम्हाला काय वाटते?

cheap स्वस्त 0 1 2 3 4 5 Expensive महाग

Are the services provided by swargate convenient?
स्वारगेटला मिळणाऱ्या सोई सुविधा, तुम्हाला चांगल्या वाटतात का?

No नाही 0 1 2 3 4 5 Yes होय

Is coming to swargate convenient for you?
स्वारगेट ला येणे तुमच्या सोईचे आहे का?

No नाही 0 1 2 3 4 5 Yes होय

Do you feel safe when you are at swargate?
स्वारगेट ला असताना तुम्हाला सुरक्षित वाटते का?

No नाही 0 1 2 3 4 5 Yes होय

Do you feel that there is discrimination on the basis of services provided at swargate?
स्वारगेट च्या सोई सुविधा तुम्हाला भेदभाव करणाऱ्या वाटतात का?

No नाही 0 1 2 3 4 5 Yes होय

On the scale of 0 to 5, how would you rate swargate?
0 ते 5 पैकी तुम्ही स्वारगेट ला किती गुण द्याल?

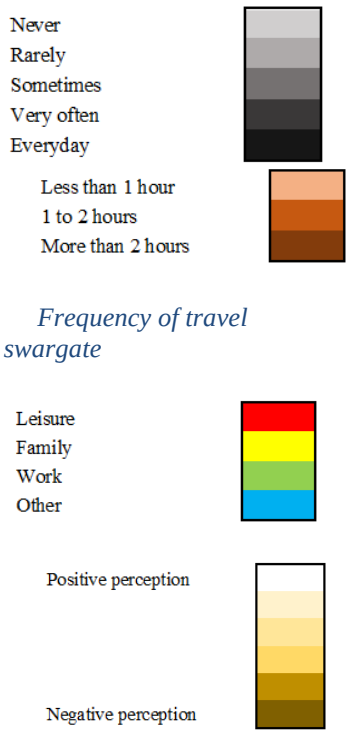
0 1 2 3 4 5

Suggestions-

Figure 1: Questionnaire

Gender	males									Females								
Age groups	18-39			40-60			60+			18-39			40-60			60+		
Economic class	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Frequency of travel																		
Time spent																		
Reasons for transport																		
Liking																		
Affordability																		
Quality																		
Convinience																		
Safety																		
Discrimination																		
Rating																		

Table1: Results



Frequency of travel *Time spent at swargate*

Reason for travelling *Perception of people*

Figure 2: Legend

Discussion

Study shows that people from lower and middle economic class are more likely to use swargate bus service than the people belonging to the higher economic class. It is observed that even if people like using the bus transportation system, they tend to not use it because of the current condition of swargate. The lower economic class, which is apparently the most important user of swargate bus station, can't afford the current transit fares. But the higher economic class which can easily afford the current fares, doesn't use it because of the condition of the swargate bus station.

Maximum people perceive the quality provided at swargate negatively, hence most of the respondents believe that the quality of facilities, planning, services etc. provided at swargate are not satisfactory. Discrimination is the factor which people perceive much positively;which means, most of the respondents don't believe that there is any sort of discrimination at swargate with respect to gender, economic class and age group. The overall rating that respondents gave to the swargate bus station is average.

Female respondents were not happy with the conditions of toilets and other infrastructure facilities. Women also perceive the station to be not very safe during night time and also many respondents were afraid of theft. Even if

most of the respondents do not perceive the transit station to be discriminatory in nature, the people who rate it to be discriminatory, belong to the lower economic section of society. When the suggestions or opinion of people was asked at the end of the questionnaire, most of the respondents expressed their problems related to safety and security, congestion, lack of planning, lack of management and punctuality, traffic etc.

Conclusion

In the conclusion it may be said that, the elements of social sustainability which are interconnected, need to be worked uponto make these transit systems sustainable in a true sense. Which shall promote the equal participation and usage by all the classes of society, ultimately enhancing the current nature of inclusion at these transit hubs. The paper ends by proposing that social sustainability through transit hubs shall also be taken into account to get a broader idea of sustainability of transit systems itself.

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Understanding Building Image Perceptions through Associated Adjectives

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Abstract : Buildings constructed of different materials, styles and patterns are referred to by different adjectives, probably understood uniformly by people related to the building industry. However, they may be interpreted differently by laypersons, who are also the end-users.Their perception needs to be analysed to understand how the impressions formed which would also depend upon the person's upbringing, cultural background, education and exposure. Different responses from interviews can be analysed and categorized in various ways which would be significant in understanding users' impression in a particular context about a building of specific materials, style, pattern and function.

Keywords: Building terminologies, layperson, perception, adjectives, impression

I. Introduction:

Architects design buildings with a certain image which they try to project to the masses. Putting forth an image to be associated with a building usually is done through usage of variety of surface finishes, landscape elements, textures, colours, materials, and so on. The architect can certainly attempt to create an impression that he wants in the peoples' minds about the building, but what people actually feel about that building is an individualistic perception. Different building-related terminologies invoke different images and responses in the mind of an individual who is not directly related to the building industry. This response depends not only on the building, but also the upbringing, background and exposure of the person. For example, the description 'a stone building' might bring forth images of grand *wadas*to word impression means the initial feeling and the image stored by the person's memory about a person or something-cognitive experience. [i]
Creating an impression of a building is a conscious attempt of the designer to impress or imbibe an a long-time resident of Pune, whereas the same description might remind a senior Mumbaikar of the British era and colonial buildings. The context changes the impression of a specific description.

Research has been done previously on perceptions of individuals based on first-hand responses of people to a particular material, texture or colour.[ii], [iii].When all of these come together on a building façade of a considerable scale, the perception might be entirely different.

This study works closely together with psychology and language along with architecture to gain an insight into what the end-users actually feel about a particular type of building with respect to the materials used. For instance, an elderly person might say a wooden building seems warm and homely, but a youngster might say it is unfamiliar or traditional. This research attempts to find a common thread between all the different associated adjectives for material-based building descriptions expressed by individuals of different backgrounds, with respect to profession and exposure to other cultures and places.The study would be beneficial to practicing architects to understand the association of different materials and its related perceptions for common man.

- **Perception and Impression**

The term perception is derived from a Latin origin "Perceptio" means to feel, to comprehend and to take hold of.The perception is the way through which the man contacts his environment. [i]
Perception depends on the awareness andattention. The impression is an effect, feeling or preserving an image due to the experience. The experience or characteristic(s) onto the users' minds. Getting an impression is entirely dependent on perception.

- **Building Materials:**

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Building materials have at least one of the two functions: structural or finishing. The materials used on building facades are the primary impression-creating elements. Up to the mid-20th century, the form of construction was primarily load bearing. Therefore, these buildings came to be associated with masonry units, bulkiness, small openings and dim, cool interiors. The impression was a result of the construction methodology. In Pune, *wadas* were the predominant buildings. These were constructed of stone or brick in combination with timber frames. Again, the available materials and known technology dictated the aesthetics and 'feel' of the building. As time progressed, newer materials and construction technologies were put to use. RCC became the most common and preferred material for building construction. It became possible to explore glass and steel, which have now become a common feature on facades of buildings in metropolitan cities.

The typology of building and the age, profession and exposure of end users are variables which would affect the impression of the building based on the materials used.

II.Methodology:

This research considers perception of people as the unit of analysis. Descriptions in the form of short phrases were asked to get an idea about the impression of a building of a particular material. Using only words and not pictures as the form of communication ensured that an unbiased response based only on previous impressions and exposure was obtained.

The sampling selected consisted of 31 individuals across a range of financial and professional backgrounds. The profession of a person and the education required for it shapes the way an individual senses his/her surroundings. The financial background decides how much a person is exposed to other cultures and places, usually in the form of travelling.

The methodology adopted was interviews with all open-ended questions which gave material -based building descriptions. The first few questions gained information about profession and exposure. The remaining questions attempted to obtain impressions about building descriptions.

III. Observations:

The sampling included 31 individuals within the age range of 20 to 55 years and having varying professions ranging from student to housewife to businessman. 22% were engineers, 6 % were lawyers,6% were teachers, 6% were students, 10% were businessmen26% were housewives and remaining 30% were of other professions. All the people in the sample have been residents of Pune for at least 20 years.

Individuals who had widely travelled in India and abroad had different opinions about a particular building description than those who had been less exposed to other places.

IV.Results and Tables:

The obtained data was analysed based on two criteria: the frequency of an adjective used for a particular type of building, represented in the form of percentages, and categorization of adjectives based on visual impression, structure and/or strength, and physical experience. For instance, the adjective 'cool' for a stone building is most probably based on the experience of being inside a stone building, whereas the adjective 'antique' is based on its aesthetics.

The frequency of an adjective used for a particular building description determined the understanding of an overall impression, represented in table nos. 1 and 2. According to colour used, adjectives are categorized as:

- Impressions based on aesthetics
- Impressions based on structure
- Impressions based on experience

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Categorization of different adjectives under three headings: experience, structure and aesthetics showed that except for steel structures, the impressions formed of buildings were primarily based on their aesthetical appearances. (Fig.1)

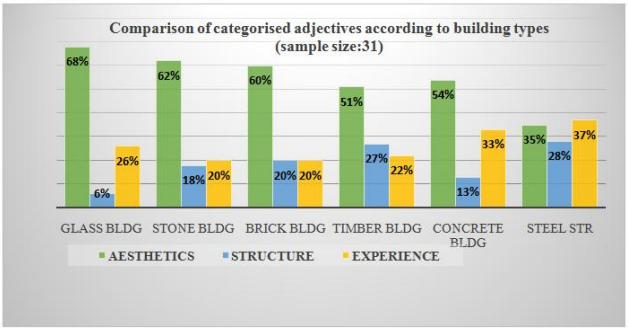

Fig.1 : Comparison between categorised adjectives for different building types

V.Conclusion:

This research shows that in a particular context, in this case Pune, impressions about different buildings by individuals of different age, professions and exposures are largely variable. However, as the cultural background is similar, there is also some commonality observed in these associated adjectives.

VI. Discussion:

This research is a pilot study to gain insight into common man's perception of buildings. The sampling was limited to residents of Pune, therefore this study would be helpful only in the context of Pune city. The impressions obtained were adjectives based on past experiences of users. A study could be done further to obtain responses of people actually using that building at that point of time. This study will be useful for designers to use those materials in and on a particular typology of buildingwhich the users would find comfortable, likable and desirable.

Acknowledgements:

I would like to thank my guide Prof. Atul Bhagwat for giving valuable inputs and feedback regularly for writing the paper. I would also like to thank all my family members, friends and acquaintances who actively participated in the interview process thereby largely contributing to the paper.

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Table no.1- Adjectives associated with glass, stone and brick buildings

Type of Building	Stone		Type Of Building	Glass		Type Of Building	Brick	
Adjectives Used	Frequency	%	Adjectives Used	Frequency	%	**Adjectives Used**	Frequency	%
Antique	9	30%	Artificial	2	6%	Ancestral	1	3%
Attractive	3	10%	Attractive	9	30%	Average	1	3%
Brittle	1	3%	Beautiful	1	3%	Brittle	3	10%
Bulky	1	3%	Boxy	3	10%	Closed/Boxy	1	3%
Cave-Like	1	3%	Breakable	2	6%	Cool	2	6%
Classic	2	6%	Bright	8	26%	Cosy	1	3%
Collapsible	1	3%	Classy	3	10%	Crude	1	3%
Colonial	3	10%	Clean	4	13%	Dignified	1	3%
Commercial	1	3%	Commercial	7	22%	Dilapidated	3	10%
Cool	16	52%	Common	1	3%	Dull	1	3%
Crude	2	6%	Cool	1	3%	Earthy	2	6%
Dark	1	3%	Corporate	5	16%	Easy Reconstruction	1	3%
Decorative	3	10%	Decent	1	3%	Exotic	2	6%
Difficult To Rebuild	1	3%	Decorative	1	3%	Fast Construction	1	3%
Elegant	2	6%	Delicate	9	30%	Fire-Proof	1	3%
Exotic	3	10%	Dramatic	1	3%	Generic	4	13%
Expensive	1	3%	Dynamic	1	3%	Heat-Absorbing	2	6%
Fort	3	10%	Elegant	2	6%	High Maintenance	1	3%
Haveli	1	3%	Elite	1	3%	Homely	3	10%
High Maintenance	1	3%	Esteemed	1	3%	Informal	1	3%
Historical	3	10%	Exclusive	1	3%	Insulating	2	6%
Imposing	9	30%	Expensive	5	19%	Leakage-Prone	2	6%
Indestructible	1	3%	Foreign	1	3%	Leisurely	1	3%
Insulating	1	3%	Formal	1	3%	Long-Lasting	2	6%
Long-Lasting	6	19%	Fresh	2	6%	Low-Cost	4	13%
Low Cost	11	35%	Glare	2	6%	Modern	1	3%
Low Maintenance	1	3%	Good Views	3	10%	Moisture-Absorbing	1	3%
Low Rise	1	3%	Graceful	1	3%	Official	1	3%
Mysterious	1	3%	Heat-Absorbing	3	10%	Old	2	6%
Naturally Beautiful	1	3%	Heavenly	1	3%	Residential	2	6%
Nostalgic	2	6%	High Maintenace	7	22%	Rich	1	3%
Old	1	3%	Impressive	2	6%	Rough	1	3%
Privacy	1	3%	Interesting	1	3%	Rural	1	3%
Rare	8	26%	Lightweight	1	3%	Safe	1	3%
Residential	1	3%	Modern	3	10%	Shabby	4	13%
Rigid	2	6%	No Privacy	4	13%	Sleek	1	3%
Safe	2	6%	Open	2	6%	Small	2	6%
Strong	2	6%	Palatial	1	3%	Staggered	1	3%
Sturdy	8	26%	Permeable	1	3%	Standardized	4	13%
Sustainable	13	42%	Posh	1	3%	Strong	4	13%
Traditional	7	22%	Prosperous	1	3%	Style Statement	2	6%
Under Developed	1	3%	Reflective	2	6%	Temporary	1	3%
Unprocessed	5	16%	Scarring	4	13%	Traditional	2	6%
Vernacular	1	3%	Simple	1	3%	Unfinished	6	20%
Wada	1	3%	Smooth	1	3%	Unpleasant	3	10%
			Sound Proof	1	3%	Unreliable	2	6%
			Spacious	1	3%	Unstable	1	3%
			Suffocating	1	3%	Vernacular	1	3%
			Timeless	2	6%	Wada	1	3%
			Transparent	7	22%	Weak	4	13%
			Unsafe	8	26%	Workable	1	3%
			Wonderful	1	3%			
Total number of Stone building:45 Adjectives used	**Glass building : 52**		**Brick building: 50**					

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Table no. 2- Adjectives associated with timber, concrete buildings and steel structures

Type Of Building	Timber		Type Of Building	Steel		Type Of Building	Concrete	
Adjectives Used	Frequency	%	Adjectives Used	Frequency	%	Adjectives Used	Frequency	%
Expensive	8	26%	Industrial	10	32%	Apartments	3	10%
Antique	1	3%	Assemblable	6	19%	Artificial	2	6%
Artistic	2	6%	Cheap	3	10%	Commercial	2	6%
Attractive	5	16%	Cold	1	3%	Congestion	1	3%
Breakable	1	3%	Collapsible	1	3%	Convenient	2	6%
Classy	2	6%	Commercial	2	6%	Dead	2	6%
Cool	2	6%	Convenient	1	3%	Designed	1	3%
Cozy	3	10%	Cool	1	3%	Dull	2	6%
Damageable	1	3%	Corrosion	5	16%	Durable	4	13%
Decent	1	3%	Costly	1	3%	Easy Maintenance	1	3%
Decorative	1	3%	Curious	1	3%	Finished	1	3%
Deteriorating	3	10%	Dark	1	3%	Flexible	1	3%
Dim	1	3%	Dinstinctive	1	3%	Generic	6	19%
Earthquake Resistant	2	6%	Durable	5	16%	Heat Absorbing	7	22%
Eco-Friendly	2	6%	Exhibitions	1	3%	Heterogenous	1	3%
Exotic	1	3%	Eye-Catching	1	3%	High Maintenance	2	6%
Fire Hazard	4	13%	Factory Shed	3	10%	Infrastructural	2	6%
Foreign	1	3%	Flexible	2	6%	Large Scale	1	3%
Fragile	1	3%	Hard	1	3%	Leakage Prone	1	3%
Fragrant	3	10%	Heat-Gaining	9	30%	Low Cost	5	16%
Fresh	1	3%	Heavy	1	3%	Modern	2	6%
Heritage	3	10%	High Maintenance	3	10%	Necessity	1	3%
High Maintenace	7	22%	Huge	1	3%	Not Insulating	2	6%
Historical	2	6%	Illegal	1	3%	Not User-Friendly	5	16%
Impressive	2	6%	Immovable	1	3%	Quick Construction	1	3%
Insulating	3	10%	Infrastructural	1	3%	Residential	1	3%
Leakage-Prone	1	3%	Intricate	2	6%	Rigid	2	6%
Light-Weight	5	16%	Leakage-Prone	1	3%	Rough	2	6%
Limited	1	3%	Light Weight	2	6%	Safe	1	3%
Natural	2	6%	Low Maintennce	2	6%	Simple	3	10%
Not Eco-Friendly	1	3%	Mechanical	5	16%	Solid	2	6%
Not Sound-Proof	2	6%	Monumental	1	3%	Solid	1	3%
Not Sturdy	1	3%	Necessity	1	3%	Strong	10	32%
Old	4	13%	Noisy In Rains	3	10%	Unchangeable	2	6%
Pleasant	2	6%	Not Homely	2	6%	Unfinished	4	13%
Portable	1	3%	Open	1	3%	Unpleasant	5	16%
Quick Construction	1	3%	Portable	1	3%	Unsafe	1	3%
Rare	4	13%	Raw	1	3%	Various Forms	1	3%
Recreational	1	3%	Reliable	1	3%	Weathered	1	3%
Resilient	3	10%	Reusable	1	3%			
Rich	4	13%	Safe	1	3%			
Rural	1	3%	Strong	4	13%			
Shikara	1	3%	Temporary	1	3%			
Shiny	1	3%	Unpleasant	1	3%			
Strong	1	3%	Utilitarian	2	6%			
Sustainable	1	3%						
Termite-Prone	2	6%						
Traditional	3	10%						
Unsafe	1	3%						
Vernacular	1	3%						
Wada	3	10%						
Warm	7	22%						
Workable	1	3%						

Total number of Timber building:49 Adjectives used	**Steel structure : 43**	**Concrete building: 39**

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Water Towers and Forgotten Value of Public Space in Old Kalyan

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Abstract: Municipal Water Towers are always looked at as a service building provided by the local corporation. Recently refined bylaws have changed an environment and image of water towers in a city. Most of the towers have their defined space bounded by compound walls unlike in earlier time where there was the most possible scenario of the encroachment of nearby slums or markets. But this policy is well executed in newer or expanded part of the city, whereas in old or core part of the city it creates a different picture. To explain this; research will focus on the Old Kalyan as a case study which is always under struggle of finding an open space. And add on to this situation, population and building growth demands for service base infrastructure and overhead water tanks are one of them.

Research's objective is to question the brutal mono-functional service infrastructure of water conservation and explore the scope of sensible infrastructure in today's era of environmental crisis and decade long problem of open & healthy environment in the suburbs.

Key words – Water Towers, Service buildings, core city, public open space, Kalyan city.

INTRODUCTION

Site for research was chosen by the parameters of urban fabric (settlements in old cities) and space impact of overhead tanks within the context. Based on this, PARNAKA region of Old KALYAN city was selected as a case study. Before explaining an exact scenario of site, let's have a look on overall contextual situation of PARNAKA, Old KALYAN. Earlier, i.e. pre-independent period, core Kalyan consist of Wadas, Chawls as residential typology and some old structures from Maratha Empire. PARNAKA which is one of the important landmark of old city, has its own character, it has a vibrancy of socio-cultural spaces like markets, schools, community hall, eateries, residences, temples and lastly the PAAR, from which the name derives PARNAKA.

Currently, city is undergoing 'Development' and multi-storey residential apartment starts affecting an overall skyline of old city which were constructed after demolishing an old wadas in a region. Still, old city has its own vibrancy because of central public space (paar) in a dense settlements, and ruins of old structures in the surrounding.

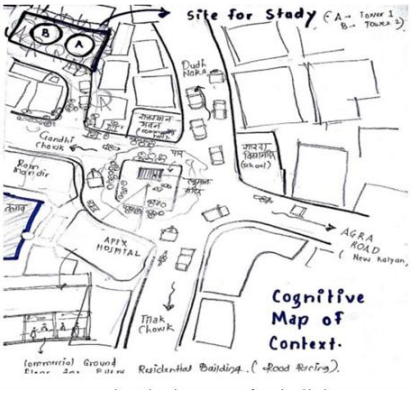

Figure – 1- Site situations explaining through cognitive map of Parnaka, Old Kalyan (Source – Author)

Within this context there are two adjacent water towers which play an important role in overall environment of core area.

But before this water towers; there was a Sarakar Wada which was actually an administrative building with open ground around it. After demolishing a Sarkar Wada, first water tower of 15 mil. litre capacity constructed in 70's and remaining open site was used for the same purpose for which it was known for, i.e. as a Maidan for children and senior citizens of locality.

According to Development Plan of this region of the city, it was declared as Reserved Area for Public Utility, on the basis of which water tower was constructed with the public park on adjacent open Plot. After the years, because of increasing demand of water supply, there was a need to

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build another water tower for the area. According to Central Government Rules and Regulation for Water Towers-2000, if municipality has enough space; funding will provided by central authority. In this way, local corporation decides to construct another water tower next to old one, for the cost of Public Open Space. That was an only open space remaining in a dense packed old city, whereas spaces like Paar gets stuck in the chaos. Now in present time, community wants an open space to breathe, to interact. New city is developing according to ideal city planning which responds to open space requirements of city, but what about old cities? Is there any need to go beyond norms? Objectives of research are as follow –

•To understand value of municipal water towers as a footprint and not only a service providing structure.

•To analysing how its existence affects overall character of ground in a dense built environment of core city.

•To understand existing situation of water towers and its neighbourhood by documenting their behaviour responding to each other.

•To question a norms; which doesn't allow an official public access and make that space as an abandoned pocket.

1. **2.**

1. Overhead tanks(Source – Author)
2. Old Photo of sarkar wada, before construction of water tanks
(Source - Sanjay Udamale Architects, Kalyan, Conservation of Urban Heritage Of Kalyan) (https://sanjayudamalearchitectsmumbai.weebly.com/kal-heritage-conservation-of-kalyan-city.html)

LITERATURE REVIEW

To understand a concerns more briefly, research covers a few reference studies, which are selected based on following factors –

•Attempts done for changing a perspective of water towers in an Urban context.

• Water towers as an identity of city.

1. A guide to Water Towers of East Anglia:

Author - The Water Tower Project,Holton House, South hold Road, Halesworth Suffolk. (https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Documents/Disciplines%20and%20Resources/Information%20Sheets/Water-Towers-of-East-Anglia.pdf)

• Although knowing the fact that, no life exist without water and no society prospers without plenty water supply, it has hardly been acknowledge as an architectural element of society.

• It was period 18's and earlier of 19's when there was high demand of water towers in town, because of industrial civilisation in European countries. After that era there is no any significant change in use of building and its existence in changing society, construction technique is only thing which is evolving as per quantity demands.

Future of water towers in East Anglia likely lies in their imaginative or adoptive reuse. Their visibility gives a commercial value.

2. More Than A Water Tower: The Art, History And Utility Of Alhambra Reservoir:

Author – Melody Stone, 4 November, 2016 (Capardio)
(http://www.capradio.org/84523)

• The Alhambra Reservoir, as its known in the Sacramento utilities department, is one of the largest reinforced concrete elevated tanks ever constructed.

• The first floor of the tower was converted into offices for blood bank employees. They stored bags of plasma in the large cavernous part of the tower, because the water keeps it a really low temperature, so you just keep the plasma in there and there's very little refrigeration.

3 & 4 – RCC overhead tank at Alhambra (Source – Melody Stone, More Than A Water Tower: The Art, History And Utility Of Alhambra Reservoir)

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3. The urban infrastructural landscape in transition: Lauttasaari water tower, from technological monument to recreational place –

Author -(2015) Saari, Heini-Emilia Department: Arkkitehtuurin laitos.
(https://aaltodoc.aalto.fi/handle/123456789/18585)

• The research addresses the qualities of infrastructure as part of the collective memory of a place, and seeks to uncover its potential in enriching the experience of urban realm.

• The project is an exploration of a water treatment environment as a place of recreation, integrating the hidden city to the landscape of everyday.

4. The Water Tank Project, New York:

Author – Mary Jordan, Project Head
(http://www.thewatertankproject.org/)

• The Water Tank Project is part art exhibition, part awareness campaign in New york. For the duration of the project, art above will be complemented by action on the ground through educational programs, public tours, social media activities and a symposium dedicated to inspiring fresh views on global water issues.

5. **6.**

5 & 6 - Art showcasing water issue
(Author – The Water Tank Project Team)

METHODOLOGY & OBSERVATIONS

Since research is more orient towards the public overhead tanks and its impact on the immediate neighborhood. To understand the existing scenario, research is carried out on the basis of photographic survey along with some add on graphics.

Here are the observations represented through photographic and graphical method –

• The earlier scenario; when the park was there on front ground of first water tank (Superimposed graphics)-

7.
(Source – Author)

• After the construction of another tower just next to existing one, entire jogging track and nearby public space declared as a restricted zone for residents, as followed by the updated norms for water towers to assure safety and avoid any encroachment.

• But its implementation on ground was not as idealistic as it supposed to be. These tanks are no more just the tanks, they are urban infrastructure which is taking considerable amount of footprint in a dense fabric.

• Hence if we look at the present situation of the site, these are the few observations –

1. Dumping Zone - The space below the tanks and other premises become the dumping zone.

8. **9.**
(Source – Author)

2. Encroachments – This is another observation coming out from this. It's not always about residential encroachment but also about space use for different types of activities whether the intention is good or bad.

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8. Residential use 9. Commercial use
(Source – Author)

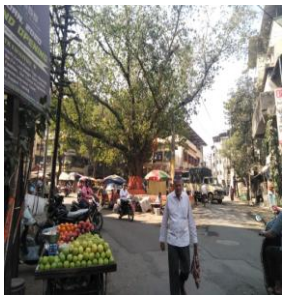
3. Ignored Ecology – Because of presence of moistness in land of water tank and also microclimate of water tank's area new ecology is generated or existing one is get enhanced. There are huge green canopies on the site which has the great potential of green pocket for public in the core city.

10. 11.
Ignored Green Zone of the context
(Source – Author)

4. Observations from the context – One can understand the vibrancy of the context and may leads to rethink on this urban infrastructure.

- Religious Node: Since the site has the old settlements and had saw the transition of wadas to the apartments. One thing not changed yet is that religious culture. It is epicenter of celebrations of festivals in old Kalyan.
- Street Market: It is the zone of street vendors and has the typical character of street in the old city.

12. Urban temple 13. Old Temple
(Source – Author)



14. 15.
Paar and street market
(Source – Author)

Analysis & Result

Analysis of the research is divided by the three major component – a. Site specific analysis

b. Policy level analysis

a. Site specific analysis :

- Water tanks are the structures which creates the sense of comfort and leads people to use for different purpose.
- Any official unused space in dense fabric led to trigger the different type of space usage by different types of people
- Hence in anyways norms are not getting followed, thus it is need of time to discuss about the norms for the public infrastructure instead of making the abandoned pocket by inserting standardized rigid mass in vibrant surrounding.
- Context has the issues of traffic because of street markets; and vendors are not ready to settled at space allotted for them because of the fact that they are not getting rod front.
- This makes to imagine the scenario where public infrastructure is responding to contextual requirements.

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16. Adda at night time **17. Urinal at day time**

(Source – Author)

18. **19.**

18 - Traffic and street market
19 - Substitute space for vendors
(Source – Author)

b. Policy Level Analysis :

- Safety Concerns -

I. Public Water Tanks are the highest tensioned infrastructure and hence safety concerns are at the top priority.

II. But there are examples where safety concern and accessibility of water tanks for community are handled hand in hand.

III. Hence by just creating the compound walls; concern is not going to satisfied.

- Questioning a standardized prototype –

I. We can compare the water tanks with the step wells on the basis of its function. Are step wells standardized? They have the layers of community attachments because of the architectural character. Whereas water tanks are the just heavy dead concrete body.

II. As a function, it is a part of pipeline water supply system which is very smooth functioned and maintenance friendly. But when this prototype inserted in certain context, it is no more just service building .

III. Hence there is requirement to relook at this infrastructure as not only engineered service building but as a thoughtful, sensible site specific architectural insert which should not be standardized.

- More than the Water Tank –

I. Providing the multifunctional aspect to any space is the smarter way of ownership based environment for community.

II. Can water tanks go beyond the mono functional aspect? –

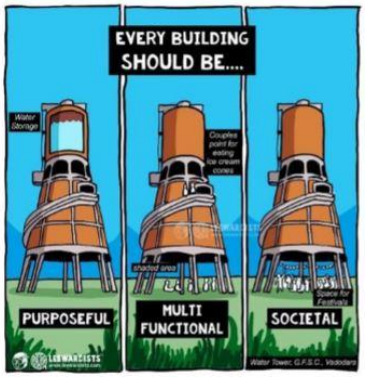
A. Can it be a structure in urban context which is dealing with the modern environmental issues?

B. Can it be the self-sustainable structure; which deals with the solar energy, wind purifying function and bigger rainwater catchment area?

C. Can it be a recreational space?

D. Can it be view point for the urbanites?

E. Can it be a catalyst for boosting local economy? (eg.- urban farming, fish farming)



20. Water Tower designed by Ar. B.V. Doshi for G.F.S.C., Vadodara, Gujrat

(Source – Graphics by Ar. Anuj Kale, Leewardist)

(https://www.facebook.com/leewardists/photos/pcb.1993006867378355/1993004350711940/?type=3&theater)

CONCLUSION

If policies are tackled sensitively; then the Service buildings might become a one of the celebrated public space in dense settlements of suburbs. Collaborating a public space and service providing infrastructure will create typical character of Indian way of creating a spaces – Purposeful, Multifunctional, Sociocultural.

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Evolution And Development Of Spaces Around Temple Complex In Pune : Case Study-Ram Mandir, Tulshi Baug

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Abstract: Pune is known for its heritage and culture along with the exquisite Maratha temples built during the Peshwa reign (1720), traces of Mughal invasions, followed by British Colonization and subsequent modernization in the city which gave it its architectural identity. After several years, some of these temples and complexes from the 'Golden period' came under conservation. Till then the surrounding vicinities of temple complex's had developed to a prominent level. A distinct architectural style of evolution is observed in some of the temples. This development observed is in the form of residential as well as commercial and a number of buildings are of mix used typology. A detail analysis will obtained after further study, with help of data collection majorly primary live case study, surveys and questionnaire's, accompanying the descriptive collection with photographs etc. with respect to architectural material, elements and construction type. This research paper will try to analysis how this development affected the area and surroundings with respect to traffic/congestions, culture, economy and lastly on the people and also to understand and explore the meaning of 'genius loci' and how it has still been preserved till date and focuses on preserving the existing form and space.

Key words:- Ram Mandir, Development, Evolution, Style of Architecture, temple complex, Tulshi Baug.

INTRODUCTION:

Pune, also called **Poona**, city, located in west-central Maharashtra state, western India, at the junction of the Mula and Mutha rivers.The name Pune comes from the Sanskrit word – *"Puṇyanagara"*. It means "city of virtue". Pune is also known as the "Oxford of the East." Pune was once the center of power for the Maratha Empire. It is known to have existed as a town since 847 AD. Pune was the first capital of ShivajiMaharaj. (Editors of Encyclopedia britinicca)

The city is known for the exquisite examples of heritage monument and structures such Maratha temples, *Wadas* and *Peths* built during the *Peshwa* reign, traces of Mughal invasions, followed by British Colonization cantonments and majorly the establishment of Camp area and subsequent modernization in the city which gave it its architectural identity .The city is also famous for having a reputation of being the cultural capital of Maharashtra. (Editors of Encyclopedia britinicca) (Didde & Gupta, 2003)

As time progressed, most of the heritage structures of Pune came under conservation meaning all the monuments such as temples, *wadas* and churches etc. were repaired , finished, maintained and preserved as they were in all their glory when first constructed. But some of these heritage structures are located in one of the city's noisiest and very densely populated areas such as TulshiBaug, Narayan Peth,ShaniwarPeth, SadshivPeth etc. where tremendous growth and development is observed over the period of time, since its establishments some of the heritage structures had planned growth and development keeping the heritage structure as their focal point and the development around them is both in form of residential as well as commercial. Whereas, the development around some of these structures was neglected and the growth was hap hazardous.

This research mainly focuses on "**Ram *Mandir***" and its changes in architectural pattern and style, its immediate adjacent surrounding vicinity, which is located in Tulshibaug to study in detail and document the changes and developments it has underwent till now in the context of architectural style and what it reflects in terms of history to current situations. The scope is to understand the dense

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urban fabric and its impact on its social, economical, cultural shift along the surroundings, vicinity.

Background

Location of Ram Mandir in Tulshi baag.

Source: Google Earth

Naro Appaji Khire, an administrator in the Peshwa Court, decided to build a Ram Mandir in 1763. The Temple was made extensively of wood and stone work in **Maratha style of architecture** and ornamented with elements such as wooden '*Mahirapi'* arches, wooden *'Kelphuls'* carved on to the columns, wooden floral carved roofing and stone carved '*Shikhara'*.

He owned a garden/ orchard called the Tulshibaug in Shukrawar Peth. The Ram Mandir came up in the corner of this garden. It symbolically reminds the people of the glory of the Maratha Empire and to boost their morale in some way, the *Shikhara* of the temple was intentionally kept high. It is still the highest in Maharashtra. (ref:-Tulshi Baug –Mandai: loss of symbolism) to symbolize the establishment and start of Peshwa empire and reign. Over the period of the temple grew in importance in social life of "punekars". As it became a place for ladies to engage in social activity such as exploring the market, shopping of utensils, cloths and jewellery etc. who were mostly indoors and engrossed in their daily chores. And also because of change in skyline, due to high "*shikhara*", it gives a sense of orientation. The Ram Mandir became the focal point of Tulshibaug.

Later on in 1818, the British took over the peshwas and the city came under their rule. Giving rise to political disputes, during these times it became difficult for the **Tulshibaugwalas** and **Khasgiwalas** to maintain the huge gardens. Maintaining the temple complex too became difficult for Tulshibaugwalas. The ***"Owrya"*** or the spaces in the outer walls of complex were rented out as shops for revenue generation. (Holkar) (Didde & Gupta, 2003)

Post independence, the boundaries of the city began to grow and expand as the population of the city thrived. The markets continue to prosper at a greater speed as more and mores shops came up to generate revenue making the area of Tulshi Baug one of most densly populated part of the city. The development that occurred during this time was still around the Ram Manidr, Tulshibaug. Maintaining Ram Mandir as the focal point of market. The growth that occured was both of commercials complexs likes shops, markets and residential settlements of the shop keepers or the owner and locals for employment of work etc. This area of TulshiBaug ganined a lot of cultural and social importance as more and more temples and wadas were constructed (Didde & Gupta, 2003) (Holkar).

Image courtesy:- Research paper:- Tulshi Baug –Mandai: loss of symbolism

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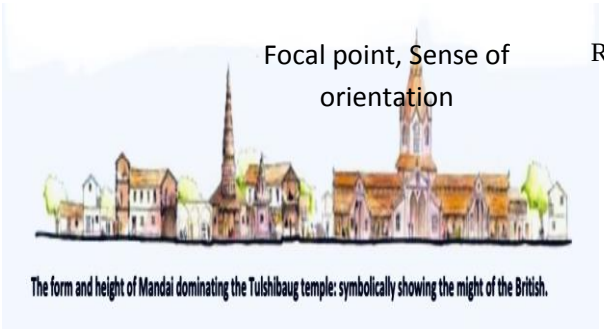

To help me explore and clarify my research topic better, I have selected 5 relevant documents to my research topics such as articles, research papers, books and verified webpages etc.

In the year 2008 Ar. Kiran Kalamdani and his team was sanctioned to conserve the Ram Mandir. The repairing and conservation work of the temple is still progressing. The research is focus on the way the conservation work is done and how the area / precinct is deprived by restoration.

Following are the reviews on these 5 documents:-

1. 'A Guide to City's Peshwa history'

This article is written by Siddhart Joshi and was published online on 3rd December 2016.

This article basically talks extensively about the Ram *Mandir's* rich and magnificent history, how it got established, the reason of its establishment and the importance it held during the *Maratha* reign.

The article majorly focuses on the history and establishment of the temple. It is observed is that the author talks very passionately about this *Mandir's* heritage and even now how well it has been conserved. The article also somewhat covers the importance of this particular Mandir complex with respect to people and location as it is located in one of the noisiest parts of the old city. But the article lacks in explaining the architectural style, construction type and architectural features which adds up to the beautification of the complex and correlating it to its history.

2. Article Review on 'Nageshwar temple by PMC

The article is documented and published by authorized authors on the official PMC site. Accessed on 7th August 2019.

The article covers the heritage and the information related to the establishment of the temple complex in detail. The changes the temple complex that has underwent due to negligence and time. The conservation strategies and process is disused very much in detail and photographic description is provided to understand the works carried out by the authorities to restore the place as it was first constructed. The overall language of the article is kept simple which helps the reader's to understand the authentic archival material, facts and current situations clearly

3. Literature Review on TulshiBaug - Mandai:- The Loss of Symbolism.

The paper is written by Amol Sampatrao Holy and submitted to Dept. of Architecture and Regional Planning Indian Institute of Technology, Khragpur. And accessed on 26th July 2019.The paper covers the vast and divine history, culture and heritage of the heart of Pune city that is the TulshiBaug and *Mandai* region. This paper covers the changes it has undergone since its establishment, through the British colonization, modernization and urbanization.

The paper majorly focuses on the history and establishment of the temple. It is observed is that the author talks very passionately about this *Mandir's*heritage and even now how wellit has been conserved. The article also somewhat covers the importance of this particular Mandir complex with respect to people and location as it is located in one of the noisiest parts of the old city. But the article lacks in explaining the architectural style, construction type and architectural features which adds up to the beautification of the complex and correlating it to its history.

4. On Hindu temples and development of Localities in Tamil Nadu (South India)

This research paper is written by Pierre Yues Trouillet and was published on 20th January 2018 and was extracted from "In Subaltern Urbanization in India: An Introduction to the Dynamics of Ordinary Towns."This research paper is based on six case

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studies taken into the regional context of Tamil Nadu (the "Tamil country" in South India), the article demonstrates that Hindu temples take part actively to the development of their settlements in many ways, and that they locally produce some centrality which is able to trigger phenomena of local development.

This research paper majorly focuses on the development of locality in correlation with temples of Tamil Nadu. The author has put intensive work on surveys and case studies to collect all the authentic history and heritage information, facts and current situations. This is a very well documented research paper which helps to understand the importance of how the locality and development of temple towns-old as well as revolves around, making the temples or their complex's as their focal/ central points. The paper also focuses on the changes and developments observed over period of time of 'old temple cities' and Urban Morphology of the temple city.

5. Book Review on 'Pune, Queen of Deccan'

The book is written by jaymalaDidde and Samita Gupta. It was published on 1st June, 2003.A simple biography on life of Pune, which rapidly evolves into a gripping trove of anecdotes and folklores alike. The authors take you on journey of weaving timelines of the history of Pune city, without a doubt proves the authenticity of their extensive research. The book starts off with establishment of golden period that is the Peshwa Dynasty during which Ram *Mandir,*Vishrambaugwada, omkareshvar temple, nageshwar temple etc such magnificent monuments came into existence, traces Mughal invasions, followed by British Colonization and subsequent modernization in the city which gave it its architectural identityThis book majorly covers the architectural, geographical and political significance of the city and its growth over the centuries, the impacts and impressions left on the city. Also talks about the city's transformation from rural to urban. It's a delight to read as the language is kept simple and eloquent yet the matter has been put aptly and to the point.

From the above detail studies of each document, we understand the need to study the development and growth around the temple complex of Ram Mandir in correlation with its immediate surroundings (locality) and the affect it has on people.

Methodology

Qualitative and exploratory study was made by conducting a live case study of the Ram Mandir in Tulshi Baug, Pune. The study included, photographic documentation of current scenarios, observing distinctive architectural styles (elements), understanding the significant historic value and the impact it has on the visitors by interacting with the locals; some who visit regularly, some who visit occasional, some tourists and the shop keeper/ owners.

Observations

While surveying the complex and interacting with the locals it was observed that usually the peak timings of visiting the temple complex is around 8am to 9am in the morning's and 5pm to 7pm in the evening's, on average about 10-15 regular locals and 5-6 tourists. During socio-cultural activities such as festivals like Ramnavmi, Dussehra and Gudi padva etc. the number people visiting increases in greatly averaging to more than 100 visitors throughout the day. While surveying the complex and interacting with the locals it was observed that usually the peak timings of visiting the temple complex is around 8am to 9am in the morning's and 5pm to 7pm in the evening's, on average about 10-15 regular locals and 5-6 tourists. During socio-cultural activities such as festivals like Ramnavmi, Dussehra and Gudi padva etc. the number people visiting increases in greatly averaging to more than 100 visitors throughout the day.

After interacting with some of the shop keepers it was understood that all the shops have been in the family for several generations and are being passed down to next in kin eventually. The shops inside the Mandir complex are in the same family for roughly 80-90 years. None of the shops were newly opened or newly purchased and some were leased. The utensils, clothes, and jewelleries etc. that were sold

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by the shop keepers were all in context of religious value. Above the shops there are few rooms which were used for the purpose of storing before it started deterioration due to age. Currently the rooms are being restored by Ar. Kiran Kalamdani and his team.

Construction in modern day technique of R.C.C

(Mural paintings on the complex wall and stone seating below.)

Near the entrance of the Ram Mandir, there is a seating made of stone and above the seating there is a mural painting made on the wall of temple complex depicting the storyline of **Ramayana** in vivid and vibrant colors making it eye catching and simultaneously contributing to the historic value of the complex. (Image attached above)

1. The **'*Mahirapi'*** arch at the entrance constructed in stone with stone steps raised at a plinth level of 600 mm, reflects the Maratha style of architecture.

On the other side of temple complex, above and adjacent to the shops there are rooms, place allocated for storage of instruments played by the musicians during '*poojas'* and '*artis'* called as **'*Nagarkhana'***, in red with faded paintings in white, in Maratha style of architecture with '*Mahirapi'* arch entrance below on right made of stone where the musicians and their family resides, also constructed in stone and brick masonry with wooden window frames and shutters.

Next to ***Nagarkhana***, towards left after the wooden staircase in continuation of complex façade there is residency of ***Tulshibaugwalas*** above and behind some shops.

he most interesting feature of this particular complex facade is that you can **observe evolution of 3 different distinct architectural styles** evolved over large period of time resulting in a very eye catching and exquisite amalgamation.

British style influence: wooden

Marath style influence: Mahirapi arch

2. The '***jail work'*** above doors constructed in brick masonry on the first floor with a balcony, resembles British colonized influence style of architecture.

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3. The recent most addition of second floor constructed in **modern day technique of R.C.C** can be clearly differentiated with its visible beam band and sliding windows
4. The temple complex of Ram Mandir is majorly occupied of commercial shops, with only residential areas of; residency of the '*Tulshibaugwalas'* and adjoining '*Nagarkhana'* residency of musicians.

Analysis and Conclusion

According to study, the complex should be given as much importance as the main structural body of temple or shrine (Ram Mandir), which has come under conservation. But the complex surrounding should also be conserved, preserved and seen in a different light because even the complex facade shows the clear evidence of evolution which should not be neglected or ignored as that is what is contributing in creating, protecting, and preserving its historical values, ethics, peaceful sanctuary, revival of spirit of place which is also known as 'genius loci', etc.

Even though the Mandir is located in one of the most hustling and bustling market place of Pune it still manages to achieve and preserve a different kind of calmness, serenity and peaceful environment due to all the above mentioned architectural features, aspects and factors.

Once entering the temple complex, the people visiting experience a positive and peaceful impact with sense of calm serenity and can feel the revival of spirit of place (genius loci) in comparison to its densely populated and congested locality.

Acknowledgement

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(*Images on the left showing ongoing work of restoration on the Ram Mandir)*

(Didde & Gupta, 2003)

Courtesy- Ar. Kiran Kalamdani. (https://www.behance.net/gallery/3774586/Conservation-of-Tulshibag-Pune)

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Spirit of Outdoor Spaces between Urban Heritage Buildings-A Case of Pune

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Abstract : Heritage means inherited civilization of predecessor, which is not limited to language or literature alone, but it also includes physical elements of the community, which includes spaces along these buildings. Heritage buildings are very important because it provides a sense of identity and continuity in a fast-changing world for future generations. The character and identity of these urban spaces can be differentiated into two main characteristics- positive and negative spaces. Positive outdoor spaces are lively and are being used to its full potential, while negative spaces are leftover spaces that are often not used despite having potential. The physical characteristics are influenced by tangible and intangible factors in urban space, which affect the human perception of those spaces. This paper will present the study and analyse these spaces around urban heritage. It also tries to put forward the analysis of positive and negative spaces and strategies for them to develop.

***Keywords*: Heritage, positive and negative outdoor space, character, analysis, strategies.**

1. INTRODUCTION

Heritage means a property that is or may be inherited. These inheritances could be cultural, traditional, social, architectural etc which come from past and are still important. Heritage structures are the ones which hold architectural, aesthetic, historical and cultural values. These structures are very significant as it can positively influence on the way a community develops. This is because, heritage places can be a potent driver for community, there is increase in community values; heritage buildings by their form, layout and material can often give a sense of identity to the place in a world of increasing new buildings which are now present everywhere.

While these structures are significant, the spaces around them are also play an important role. Over the years, the identity and character of these spaces has changed drastically. There are many tangible and intangible attributes/aspects which change and enhance the quality of these spaces. Broadly these spaces can be differentiated into two main physical characteristics: positive and negative outdoor space. Positive and Negative spaces are two sides of same coin. Though they have different geometries, these spaces cannot be easily differentiated.

Christopher Alexander, in *A Pattern Language*, describes the following in regard to the shape of spaces: **Outdoor spaces which are merely "left over" between buildings will, in general, not be used.** There are two fundamentally different kinds of outdoor space: **negative space and positive space**. Outdoor space is negative when it is shapeless, the residue left behind when buildings — which are generally viewed as positive — are placed on the land. An outdoor space is positive when it has a distinct and definite shape, as definite as the shape of a room, and when its shape is as important as the shapes of the buildings which surround it. These two kinds of space have entirely different plan geometries, which may be most easily distinguished by their figure-ground reversal.

1.1 POSITIVE SPACES

Positive spaces are spaces which are used to its full potential. These spaces could be; meeting points, buying and selling point, is a major interactive point, wherein most of the community activities are done, one's which can generate economy for people of the locality. These are part of cities where people of the community can feel sense of belonging, which maintains social interaction between them and enhances the character and nature of the place.

Figure 1: indicating the positive spaces on the streets which are used to its full potential.

1.2 NEGATIVE SPACES

Negative spaces are spaces which despite having potential are not being used up to its potential. These spaces are qualified by their own senses of absence and emptiness. These could be spaces which are abandoned by its use completely despite being in the urban context, they could be spaces under low surveillance, dull or maybe hardly used. But these spaces constitute positive potential if activated appropriately with relevant considerations.

2. METHODOLOGY

The conduct of this research is employed by two main methods: unobtrusive and non-participatory observations. The unobtrusive methodincluded data collection and categorizing secondary through content analysis.

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Observations were based on the use of spaces and accordingly data collection was done. The content analysis was used to analyse the character of outdoor positive and negative spaces between urban heritage.

3. A CASE OF PUNE

Pune is a city in Maharashtra. It is considered as cultural capital of Maharashtra. The city has its earliest reference from the Rashtrakutas dynasty. The old city is at confluence of Mula and Mutha rivers. The old city consists of Peths & Wada's and has dense population. The city is also known for the rich heritage it has. The modern city has many distinct neighbourhoods. These old Wada's and Peths are of importance and are in the core of the city. Number of activities takes place alongside these Wada's, which are source of economy generation for the community.

3.1Pataleshwar Cave Temple

The earliest reference of the city is from Rashtrakutas period and the oldest structure existing from this era is the 'Pataleshwar temple'. The temple is alongside Jungli Maharaj road (JM road).

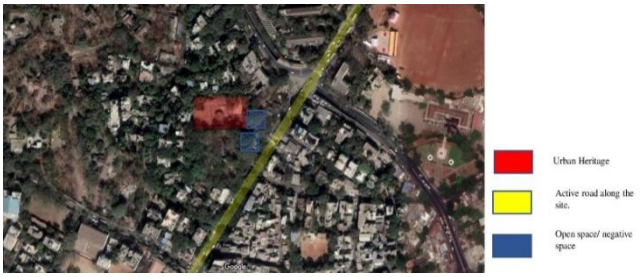

Figure 2: Indicates map of Pataleshwar temple

The **Pataleshwar Cave Temple** (*also called Panchaleshvara or Bamburde*) is a rock-cut cave temple, carved out in the 8th century in the Rashtrakuta period. It was originally situated outside the town, but the city limits have expanded so that it is now located on the downtown Jungali Maharaj Road. The premise of the temple complex consists of an entrance, the open space after entrance with trees, and then the temple. The surrounding spaces around the temple are: food corner at the right;Jungli Maharaj temple at left; housing at the back; and the front had pedestrian path, JM road (which is the most active road), and commercial shops. The open space is actively(positively) used by the students from nearby hostel and college. From 8:00am to 11:30am this space and the space around the JM temple is used by students to study, as it has serene environment, which becomes an ideal place for students to use the space. This space is used constructively in the morning period, but in the evening this space is very dull and dead and no activities take place. The food corner the right is alongside the road junction, which makes it an active space, and has people come in throughout the day. The peak hours are in the morning and evening. The pedestrian path is used by people to reach their desired location; by some people to sleep, even during the day time, it also has some breakfast stalls which are open only in morning. The residences behind the temple do not direct connection with the temple.

The buildings around this temple is oriented away from the temple, because of which it loses its direct connection with space. Thus, the space is only used by students from around the space, and only the temple is visited by some people residences.

3.2 Shaniwarwada

Figure 3: Indicates area of Shaniwarwada and the active circumambulatory road.

Shaniwarwada was a place of historical fortification in the city of Pune, and was built in 1732. Today this space is a historical sightseeing place for tourists and students from different schools and colleges. The site consists of huge entrance, which is the only built form existing and lawns. These lawns are not used for any other function. The road around this heritage is crowded and busiest path. Shaniwarwada has many other small wada and peths around it. The spaces opposite to Shaniwarwada consists of buildings which are multi-purpose use, it has commercial shops and cafés at the ground and residences above the stores. As this heritage is located in the core of the city, the design and the population are dense. The roads around are narrow compared to the spaces around it. Even though its one-way route, the road still faces congestion. There is illegal parking on the roads. The space which is allotted for only cycle and bike parking, car parking is done. The internal roads along the buildings are also narrow, which doesn't leave any scope for more potential use. Further long the road is Lal Mahal, which is also being positively used. It is used as a memorial, which consist of oil paintings depicting life events of Shivaji Maharaj. Beside Lal Mahal is a small garden which is used by children of age 3-7 years.

3.3 TulshiBaug

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Figure 4: Indicates area of tulshibaug, with wada and mandai marked, with its most active road.

Tulshibaug is an area in Pune, which is located in the heart of the city. Its main feature is historic temple precinct, wadas and large market. The prominent Tulshibaug market is located in front of famous Vishrambaug wada. This wada is efficiently used today. It consists of post office on the ground floor and few other small offices of municipal corporation and a small museum above which has Maratha artefacts put together by noted Maratha historian, Babasaheb Purandare. The market sells goods including traditional Maharashtrian cooking item, cosmetics, household goods, as well as puja items. This market is located in between the lanes of residences, which is vehicular-free for free movement of people, which is an efficient way for use of lanes between residences.

The road which leads to Mandai is also an active useable street. It consists commercial shops, and vendors which sell different things. All these activities create an opportunity for an active interaction space, between buyers and sellers. This unique ambience and character of the street and the space, makes the space livelier. The area in front of Mandai is becomes more vibrant and active during Hindu festival 'Ganesh Chaturthi'.

3.4 Aga Khan Palace.

Figure 5: Indicates area in and around Aga Khan Palace.

The Aga Khan Palace was built by Sultan Muhammed Shah Aga Khan III, in Pune. Historically this palace holds great significance, because of which in 2003 it was declared as monument of national importance by ASI. In 1972 this palace was donated to Gandhi Smarak Samittee, and since then the organization is maintaining it. The palace is a memorial for Gandhiji which have portraits depicting glimpses of life events in Gandhiji's life. It is also the headquarters for Gandhi Memorial Society.

The site has large spacious lawns around the palace. Currently this place is used as memorial and for hosting events that are related to khadi and other hand loomed textile. Every morning prayer sessions are held at the samadhi. The prayer draws huge crowd daily.

The spaces around the site is barren land which are not being used potentially. There are no activities that takes place around this heritage. It also consists of residentials, but it has large vacant lands around.

4. INFERENCE

Site	Observation	Inference and potential use.
Pataleshwar cave temple	-The site is used by many students in and around the place for studying purpose. -The site is only used in morning hour, by evening it becomes a dead space. -The orientation of the buildings around the temple is away from the temple, hence itloses its connection from the temple.	-The dead space can be activated by proposing various activities, which would make the space lively at the evening too.
ShaniwarWada	-The space inside the Wada has potential, but is not used for anything except sightseeing. -The roads around the site is very congested, even though it's a one-way route.	-As there is no huge space for community gathering and activities, the space inside the Wada could be used for such purpose. Currently the space which is negative can be strategically used.
TulshiBaug	-The space in and around the site are very active and used very potentially.	-The site invites lots of opportunities for local vendors and people of the locality to have great interaction space.
Aga Khan Palace	-The site is very potentially used for workshops, prayer sessions, etc. -There are a lot of vacant land (negative spaces) around the site.	-The vacant land can be well developed, in a way which could increase the significance of the heritage space and the place could be livelier.

5. CONCLUSION

Thus, positive outdoor spaces are the ones which are supportive places for these prominent buildings. The Negative spaces are thus the spaces which have the potential, but due to non-activeness of these spaces, they are not used to its full potential. The negative spaces in

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turn could be developed in a way which could be the source of economy generation for the public realm.

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Dis-Assembly: Ship Breaking Activities Affecting the Built and Unbuilt at Alang, Gujarat, India

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Abstract: The world has witnessed a tremendous increase of industries post World War I. This has given rise to a newer 21st century phenomenon of Industrial waste. Waste is nothing but matter at the wrong place. Handling industrial waste involves a large amount of space, time and labor. All of them being available at the Gulf of Kambhat in India. These favorable geographical conditions made Alang, Gujarat, India the world's largest dump yard of Industrial waste. Alang is a home to some large and old ships which are on their deathbeds. To suffice these needs almost 50,000 workers are estimated to be working and living in the Shantytowns of Alang under unfavorable and foul conditions. This paper emphasizes on not only the tangible but also the intangible aspects, of the effect, that this industry has on the built and unbolt of Alang. The built consisting of the living, working and commercial spaces and the intangibles being psychology, health and safety of the humans of Alang,

Key words – Labor, Waste, Ship Breaking, Settlement, Shanty-towns

INTRODUCTION

The post-Independence era and after the economic liberalization of 1991, India has nurtured and nourished some notable businesses and industries. Till the beginning of 1980s, ship-breaking was mainly concentrated in Mumbai, Kolkata and Cochin. Gujarat has natural advantage of the longest coastal lines of about 1600 Km. and port facilities for international trade at Jamnagar, Porbandar and Kandla. Having foreseen the potential, Government of India planned the development of new locations at Gujarat, Andhra Pradesh, Kerala and Karnataka. In Gujarat, Alang was identified as the most suitable site for ship-breaking activity. The Alang ship-breaking yard came into existence in February 1983. The first ship named 'Kota-Ionjong' beached for breaking at 9.30 PM with the help of a signal of a simple torch light on 13th February 1983. This was done by small Industries Service Institute, Ahmedabad. This incident proved that all parameters are suitable for promoting ship-breaking activities on a larger scale at Alang. The ship-breaking activity at Alang and 50siya directly generated 1.25 lakh employment. (Mehta, 2012) Out of this 25,000 are the self-employment generation. Other than this employment is generated in the relative activities too. The above parameters led to a condition where supply could not meet the demand. Around 50,000 workers migrate to Alang every year from different parts of the country majorly from the states of Uttar Pradesh, Bihar, and West Bengal. (International Federation for Human Rights (FIDH, 2002) and work in various industries. The industries include re-rolling mills, oxygen bottling plants, transportation companies, local scrap dealers and storage agents. Upstream activity includes the brokers, insurance and banking sector, communication industry. They migrate to Alang on their own, taking a train ride of over 3 days. They send money to their families back home every month which constitutes on an average 50% of their total earnings. They return to their homes once a year during the monsoons (Gujarat Ecological Society et al., 1998). Often the migration dynamics comes into play with the cast system in India. Though officially banned it still remains present deep in the conscience. Most of the workers hail from lower classes of the society where as the owners are from higher. This sometimes results into paternalistic approach towards the workers but often it ends up being discriminatory.

Figure – 1 Shanty Towns of Alang. (Source: Author)

Other basic amenities like hospitals, recreational spaces, and transport facilities are on the downside as well. The working conditions are far from ideal, though there have

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been some improvements, the entire operation remains under total power of the employer. He has the power to hire and fire any worker at any time. Employers, not long ago, saw formation of labor unions completely unwelcome; A change that will end the industry. Likewise working hours, wages and benefits are controlled by employers without workers having much of a say in these matters. This situation prevails due to the abundance of unskilled workforce. The totalitarian control of operation by the owners, abundance of cheap labor and no job security generates a feeling of helplessness among the workers which was evident from the interviews conducted on site.

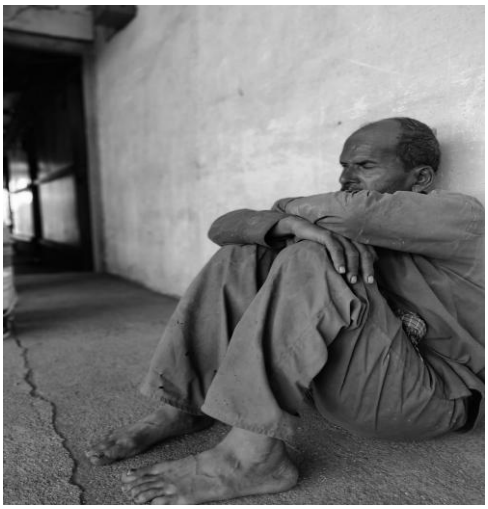

Figure – 2 Shadows of Oppression (Source: Author)

The villages in and around 10Km of radius from the port of Alang, have experienced a paradigm shift since 1983. The community which was primarily agrarian had to leave the occupation in search of other means on livelihood. This was majorly due to scarcity of water caused by the increased pressure on ground water (the only water source) due to migration and the rise of the industry, many villages got involved into trade, transport and other industrial jobs. From the villager's perspective, the industry has only brought in more problems to them namely pollution, diseases and mental health degradation. On a long enough timeline Alang is now and alienated place which has absolutely no connection with its cultural or social history and roots.

Figure – 3 Alang 2002 to 2018 (Source: Google Earth)

LITERATURE REVIEW

Safety

Workers at Alang face a direct health threat due to inadequate safety facilities while working and dealing with hazardous waste. There are many recorded instances of explosions on site. In this connection, it is important to mention that the Final Report of the Supreme Court-ap pointed Technical Experts Committee has revealed the pathetic situation faced by these workers. With regard to accidents, the Final Report notes: [T]he average annual incidence of fatal accidents in the ship breaking industry is 2.0 per 1,000 workers while the all India incidence of fatal accidents during the same period in the mining industry, which is considered to be the most accident-prone industry, is 0.34 per 1,000 workers. These facts provide the first official confirmation of Alang's long-standing notoriety as a hazardous and unsafe place to work in. Likewise, the National Institute of Occupational Health (NIOH), Gujarat, carried out X-rays of 94 workers, and found that 15 of them could be suffering from very early stages of asbestos poisoning (NIOH 2006-07). According to an interview conducted, the workers reported that it takes around 1.5 hours for an Ambulance to reach Alang through a narrow two lane Highway which connects Alang to Bhavnagar (Nearest city). Until 2003, there was no formal setup of a hospital, It was in 2003 when Red Cross Hospital was set up. (Sahu, 2013)

Sanitation

As there is no organization of workers in terms of their livelihood, workers suffer from a major sanitation issue. Many workers reported that outside the yard there are 13 toilet blocks each with 6 toilets are built by a private agency and a social institute named National Sanitation Improvement Foundation (NASA). Out of 13 toilet blocks, 5 are built by private agency which charges Rs. 1 for using toilet whereas other two toilets are run by social institute providing service free of charge. Therefore, workers prefer to use the facilities provided to them free of charge rather than those that charge. Many workers are forced to defecate on open grounds as well. (Sahu, 2013)

It is also important to mention here that the ESI Act, 1948, provides for the provision of benefits to employees in case of sickness, maternity, and employment injury. To implement this scheme in the ship-breaking industries at Alang-Sosiya, the Labor and Employment Department of Gujarat issued a notification in its official gazette on 1 October 2009. As per the ESI scheme norms for constructing a hospital with 100 beds at Alang-Sosiya, the notification issued by the Labor and Employment Department requires that at least 25,000 employees be registered under this scheme. However, in the case of Alang- -Sosiya, a total of 16,067 workers have registered.

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The ship-breaking association has been demanding a relaxation in this norm (as Alang-Sosiya seems to be an exceptional case), so that the Employee's State Insurance Corporation (ESIC) can construct a hospital here.

Housing

In Alang ship breaking yard neither Gujarat Maritime Board (GMB) nor employers provide residential accommodation to labors. To provide suitable accommodation with proper infrastructure facilities to labours, GMB has acquired land of 242813 Sq.m (GMB, 2002). But till date GMB not started construction of the housing colony for labours. On the other hand, employer provides residential accommodation to labor contractors and managers but not to labours. Therefore, labours have to make their own arrangements for accommodation. In the present study, out of 300 respondents, 103 (34.3 percent) are living in rent free accommodation (table 6.2). They are living in the spontaneous houses which are built in the Government/private land. It appears that more migrants are on the look for rent free accommodation to minimize their living expenses. A considerable proportion of respondents live in rented private houses in nearby village. 39 percent of respondents live in rented houses belonging to private landlords. Further 26 percent of the respondents live in collective dormitories in which they are paying rent for living as well as for minimal facilities. In some dormitories there is a facility of common mess. These dormitories are owned by the people from different states. For instance, numbers of dormitories in existence are owned by the non Gujarati personnel. The average expenditure on water by respondents is RS. 132.95 Per month. The study found that migrants have close contact with their family members in the native place. It is found that 93 percent of respondents regularly visit their place of origin and most of migrants visit half-yearly (42.3 percent) or annually (50 percent). The frequency of visit is once in a year or twice in a year due to low wages and high traveling cost associated with visit. On average respondents stayed for 32 days at their place of origin to attend ceremonies, marriages and in harvesting period. The study found that migrants in Alang maintain close contact with their native place.

METHODOLOGY

Sampling strategy

Group of people surveyed for information gathering.

A. Local residents.
- Residents of Alang
- Residents of Sosiya
- Residents of Manar
- Residents of Bhavnagar

B. Migrant Residents.
- Non-Localities from the above towns.
- Non-residents non-workers
- Non-resident workers

C. Local Workers.

D. Migrant Workers

E. Workers from other occupations near the coast.
- Local Agrarian community
- Local Fishing community
- Local retailers and sellers

F. Local Governing Authority members.
- GMB: Gujarat Maritime Board

Interview questions Questions to Migrant Residents + Local Workers + Migrant Workers related to:

A. Quality of Life
- How difficult is it to cope up with the day to day needs given the salary you earn?
- Are sufficient facilities been provided by either the Government bodies or the plot owners?
- Are the basic sanitary facilities in place?
- Do you have access to clean potable water?
- Do you aspire for recreational spaces in the town of Alang? ● Do you have enough mental satisfaction working at Alang?

B. Health of Workers
- Are there enough safety precautions while working at the Scrapyard?
- Are there enough hospitals to suffice the medical needs?
- In case of an emergency, how long does the ambulance take to reach on site?
- Do you feel personally safe working on site? C. Worker Exploitation
- Are you being given the adequate salary as per the laws?
- Are the situations on site such that the owners manipulate you?
- Is there an authoritarian environment on site? D. Worker Housing
- Do you have enough space to accommodate you and your furniture?
- Are the spaces you live in well ventilated and lit?
- Do you feel any sense of ownership in the spaces you live in?
- Are these structure stable enough to resist weather conditions at Alang?

E. Worker Issues

F. Worker Aspirations

G. Environmental Changes

Expert Bodies

1. GMB: Gujarat Maritime Board Engineers
2. Ship Breaking Managers
3. Hasmukh C Patel and Associates
4. GTPA: Gujarat Town Planning Authority

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Archival records/ Drawings/ Base material

A. Map representing the changes in the coast line from 1980 to 2018
B. History of flora and fauna
C. Population Growth
D. Development Control Rules
E. Land use history

Tools for Data Collection
A. Movie Making
B. Sketching / Measured Drawing
C. Interviews
D. Photographs
E. Data Mapping by Observation
F. Data Mapping/Obtainment by Collection
G. Firsthand experience

Mapping Alang

The town of Alang comprises of 4 major parts namely

1. The port The port comprises of around 170+ plots where ship breaking is carried out individually on contract basis. These plots are well defined with compound walls on the side of the road guarded by watchmen/guardsmen. The entry to these plots is restricted unless you have a valid ID or contact.
2. Labour Shanty Towns On the other side of the roads, opposing the port lie the labour shanty towns.
3. Shops Materials extracted from the ships as well as other raw materials likes electronics, plastic wares, household materials, furniture etc.
4. Asbestos Dump yard
5. 50 Bed Hospital

DISCUSSION

Strategies need to. There cannot be any further delays in ensuring basic working and living conditions for workers, and the responsibilities of each implementing agency need to be fixed. (Sahu, 2013) Efforts must be made to involve people from all across south Asia namely Pakistan, Sri Lanka, Bangladesh, Singapore, Vietnam etc so that pressure can be relieved from the workers working at Alang and this industry will no more be a burden on a few. Attempts need to be made for International laws to be standard and monitored stringently all across, particularly in India, it is generally the larger political economy and interests of the market that determine the operation of these industries, at the cost of the environment and workers' health (Kumar 2011)

CONCLUSION

The government should provide adequate space for workers' representatives to articulate their concerns in policy formulation and the implementation of labour laws. This can be made possible by allowing workers' participation in safety committees. Workers should have the right to seek remedies and, in the case of occupational diseases, identification procedures should be strengthened by putting in place special departments in hospitals. Finally, there is no comprehensive occupational health and safety law in the country. As the Government of India is planning amendments to labor laws with a view to providing a safe working environment for workers, every attempt must be made to protect and respect workers' rights. (Sahu, 2013) Attempts need to be made in the housing sector as well. Adequate and sufficient ancillary facilities need to be provided to workers in the departments of water, health, sanitation and safety. Regulations need to be made on worker wages.

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I would like to take this opportunity to thank Ar. Vijaya Srinivasan for guiding me and giving me her valuable inputs on this topics. I would also like to express my empathy towards the labors working relentlessly at Alang away from their homes and under a constant cloud of threat. Trapped by the dark whose name is exploitation?

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Potential of Rooftop Farming for Micro Climate Control in Urban Areas : case study of Pune

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Abstract : In dense urban infrastructure developments, most of the walls and roofs face the direct sunlight which gain a lot of heat and result in increased heat loads on structures. The rooftops are beneficial to individual as well as environment to reduce urban heat island effect. There are examples where these exposed rooftops are seen to be used for farming, considering the potential energy benefitsto buildings and their surroundings in ways such as; passive cooling, less energy consumption, water management, water runoff quality, air purification, use of unused rooftops, reductionin urban pollution, and other productive benefits. The paper concludes by highlighting certain techniques, potentials and benefits of rooftop farming with the help of case examples and by highlighting the role of rooftop farming in creating sustainable environment besides its other productivebenefits.

Keywords: *Urban Rooftops, Rooftop Farms, Techniques, Sustainable Environment, Potential.*

INTRODUCTION:

Urbanization is one of the main factors which is linked with the decreasing green spaces. The city development results in increasing migration. Urbanization results in changing the demographic and landscape patterns which are usually asymmetric and random. Apart from urbanization, other factors also affect the ecosystem of the city. The rooftops cover most of the cityfootprint area which represents potential of current unused rooftops. City infrastructure with a lot of surfaces exposed to direct sun, result in heat gain and release further leading to the heat island effect.

There are modern buildings which use reflective materials, the walls are exposed to direct sun which gain two-third of solar radiation (Poptani, 2014,). Because of exposed roof, structures gain more heat load which indirectly tends to use electrical energy to maintain temperature. The electronic devices like air conditioner releases chlorofluorocarbon which resultsin decreased ozone layer. The roof surfaces can be used as the green covers for urban areas, they have potential to minimize and control the climatic conditions. The rooftops areof two types; extensive rooftop and intensive. Extensive type of rooftop has thin layer of soil substrate layer around 50-150 mm. has minimal maintenance and can be very lightweight in structure. Intensive rooftop system has deeper soil substrate around 150-600 mm to allow deeper rooting plants. It needs preplanned structural system which includes dead loads ofgreen rooftop (Proksch, 2011). It has more capacity to reduce heat loads in building than extensive type.

Green rooftops reduce the solar radiation falling on rooftops because of the soil substrate, green cover, moisture contain in soil, foliage shade.

Establishment of Pune city goes back to 18th century when the Pune was the tiny agricultural city and under British rules.Pune increased from 7.74 sq.km to 243.84 sq.km from 1857 to 1999 with addition of 23 villages surrounding to Pune. As per the 2011 data Pune is the 9th city in population of 3,115,300, Which show high rate of development and sprawl is taking place along the national highway at the cost of adjacent agricultural, forestlands. Pune city has lost 37% of its cultivable land between period of 1980 to 2001 (Census, 2011).

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This paper presents the findings of a research to investigate the micro climatic condition withing the build form after application of green roof. It is hoped that the research information will be useful to promoting sustainable building and environment in urban areas.

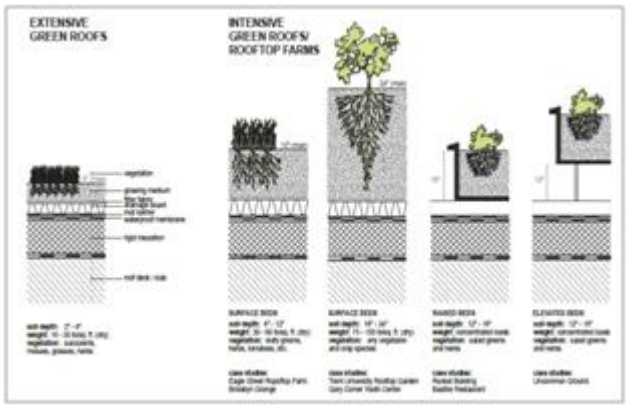

Figure i. Green roof and rooftop farm construction types.

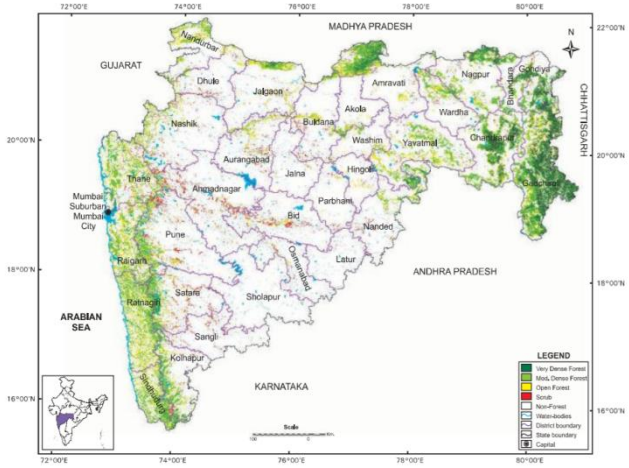

Figure ii . India state of forest report 2011.

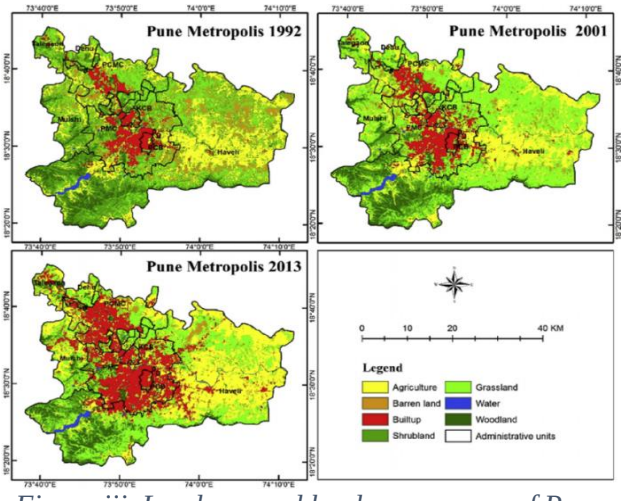

Figure iii. Land-use and land-cover maps of Pune

SCOPE AND LIMITATIONS:

The limitation of research includes the time spent. The scope of study was limited to two number of case examples. since the study is restricted to pune city therefore the results could be applicable in the same.

RESEARCH BACKROUND:

Earlier studies show that the conventional hard, nonporous surfaces do not absorb the precipitation which contribute to heavy runoff in city. “on the yearly basis retention capacity range from 75% for intensive green roofs to 45% for extensive green roofs with a median substrate depth of 4” said by Getter and Rowe.

Study shows that the intensive rooftop has higher potential to reduce pollution in city while extensive green roofs with lesser depth has lower potential. The intensive roof top has planters with maximum foliage and shaded space and Because of the substate depth it adds insulation and thermal mass to the roof. The total solar radiation absorbed by the planted roof: 27% is reflected, 60% is absorbed by the plants and the soil and only13% is transmitted into the soil (Eumorfopoulou 1998). Green roofs reduce the wind speed surrounding to it which cause reduces in surrounding temperature.

The green roofs are also energy saving for the building, which reduce electricity use for cooling. on a summer building consumes 65% of energy (Proksch, 2011). The Yi-Hsuan Hsieh concludes that the city rooftops can produce their own food required and can be self-dependent(Hsieh, 2017).

The research gap was found to analyse the potential of green rooftop within pune and its micro climatic aspect with respect to surrounding.

MATERIAL AND METHODOLOGY:

the basis for the argument of this study is derived from various case studies of urban roof top farming, which shows difference between the conventional and productive green rooftop.

Population of the research includes the structures with rooftop farming and conventional bare roof

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structures in pune. Random sampling of two green rooftops and two conventional rooftops was done. Analysis was done base on comparative study between the green and conventional bare rooftops.

Comparative study includes the actual measurement of temperatures at these respective rooftops.

DISCUSSION:

The research was conducted in two adjacent places, which were, thegreen rooftop of PMC ward terracealong with a conventional bare rooftop of IDBI bank and the other one was, the green rooftop at Mrs. Priya Bhide residencealong with M.M.C.O.A. conventional rooftop.

Table 1

Site	Name of structure	Noted Temperature	Time and date
1	IDBI bank	27.5	7/02/2020, 02:00
	PMC ward terrace	26	7/02/2020, 02:00
2	Mrs. Priya Bhide residence.	25.5	8/02/2020, 02:00
	M.M.C.O.A. College	28	8/02/2020, 02:00

as shown in table 1; the site 1 shows up to 1.5^0C reduction which was covered with shrubs and site 2 shows 2.5^0C reduction which was covered with plants and climbers, in given location and environmental condition as compared to that of bare conventional roof.

CONCLUSION:

Review of various scientific research works and case studies shows the potential and importance of green roof tops. There green rooftop meets the environmental benefits such as aesthetical value to the structure, summer cooling, improved building performance and contribution to water management. In urban areas lot of energy is spent in conditioning the spaces. Exploiting fossil fuels and emission by AC, generator systems further adds to the increment in urban heat. Thereby the controlling the temperature of surrounding and individuals by making use of unused roof tops will reduce the external and internal temperatures.

By using rooftops for farming which can contribute in expanding urban agricultural food production and make individuals self-reliance. However, the green roofs are not supposed to provide food security to cities, but they should be considered as contribution to other sources of food production, as well as they can play a role in planning future agricultural systems.

The comparison of green rooftop and conventional bare rooftop shows that room temperature of green rooftop structure is lower than that of that of conventional bare roof with respect to external ambient temperature. It concludes that the green roof reduces heat gain capacity according to external ambient temperature. increases and decreases on the basis of external climatic condition. In winter days the substrate maintains the inside heat within the structure while in summer it reduces the heat gain through exposed surface to solar radiation.

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This study would not have been possible without the essential support of the RIA faculty and I would to gratitude **to Ar. Ravi Patwardhan, Dr. Supriya Nene, Ar. Jyoti Jain** Tholiafor their extra ordinary coordination and invaluable guidance and supervision. I sincerely acknowledge the efforts of all these who have helped direct or indirectly in completing my research successfully.

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Of Lights and Mass: The Role of Artificial Light in Experience of Architecture

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Abstract: The artificial lighting has become a significant consideration while experiencing a building. Gradually architects have incorporated artificial lights in the design to provide a new spatial experience. The research aims to investigate the role of artificial light in creating different architectural experiences. The scope of this paper has been limited to the contemporary institutions of Ahmadabad constructed in the past two decades. The research has been conducted by visiting the case studies multiple times and representing the experiences in forms of sketches. Thus, the research will conclude on a distinct experience of a building in artificial light as compared to the day.

Keywords: Spatial Experience, Architecture at Night, Artificial Lighting in Architecture, Institutional Buildings of Ahmadabad.

INTRODUCTION

"*Light is of decisive importance in experiencing architecture.*" (Rasmussen, 1959). The primary experience of a space is the visual perception which occurs when the light falling on objects defines the physical attributes of the space like shape, mass, material, texture, transparency, colours. The surfaces that receive the light are the most important surfaces. Traditionally these surfaces were found in elements like *Jaalis*, *Jharokhas*, niches, alcoves. Architects have articulated these surfaces using various architectural elements like sun-breakers, louvers, fins, diffusers, water bodies.

An architect intricately curates a unique experience for the spectators and users of the buildings by manipulating the quality of light in the space. The light entering a space may have different purposes like Volumetric light may simply be used to illuminate the room and widely used to make the spaces visible, whereas the scattered light, light that keeps changing, is used as a guiding element, creating drama, invoke a sense of symbolism, hold a spiritual value.

Traditionally, post-sundown the spaces would be lit with some or other form of fire. In colder climates, the fireplace served the purpose of keeping the spaces warm while providing the light for the activities to be carried out around them. Whereas, in hotter regions, smaller and less intense oil lamps or candles would be lit and placed in an array to provide enough light to space. The necessity of artificial light moulded the architectural elements to create a space for the sources of light to evenly distribute the lights. In traditional buildings, the niches were carved out in thick masonry walls to put *'diyas'* or oil lamps. The use of *diyas* would create a warm glow in the space that did not exist during the daytime and the flickering of the lamp would create its drama of light intensity. Due to the evolution of technology, the lamps were replaced with electrical lights, but their architectural counterparts' traces are still found in some form or the other.

Although technological evolution allowed us to have different types of light intensity, direction, and colours, the spatial experience was not so enhanced as found in traditional architecture. Gradually, architects have tried to reinvent the importance of the spatial experiences of buildings at night and it is now being reinstated. Architects instead of leaving artificial light just as an afterthought, have incorporated it in their design process and provide the users with a completely new spatial experience of the same building at night.

AIM

The aim of the research is to investigate the role of artificial lighting in rendering an enhanced experience of contemporary architecture.

OBJECTIVES

- To identify contemporary approaches in designing spatial experience with the help of artificial.
- To analyse the experience of movement of a building under two different lighting conditions.
- To represent the findings of the study in form of architectural diagrams.

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METHODOLOGY

The research has majorly conducted through the first-hand experiences along with the help of literature review and available resources. The following steps have been undertaken as a part of the research:

- Literature review.
- First-hand experience of the case studies during different times of the day and note down the observations in forms of sketches and photographs.
- Analysing the change in experiences of different lighting condition and representing it with the help of architectural diagramming.

CRITERIA FOR SELECTION OF CASE STUDIES

- The case studies selected are contemporary institutional buildings that are built in the past two decades.
- The architects that have designed the buildings must have put a conscious forethought of experience of artificial light in the spaces.
- The nature of research demands multiple visits to the case studies, hence the case studies selected are such which have little to no permissions for accessing the buildings. The case studies have been selected in and around Ahmadabad for the same reason.

ARTIFICIAL LIGHT IN CONTEMPORARY ARCHITECTURE

Contemporary architects have various interpretations of the artificial lights in space and its use in the building. Some architects have used a combination of the natural light along with the artificial light to accentuate the meaning of the spaces, whereas some rely on natural light to illuminate the spaces in the daylight and create a completely different environment during the night. The role of artificial light doesn't simply end with providing enough lux levels, it has been thought in a way to bring a spatial order to spaces. Architects have viewed light as a guiding element, divisor of spaces, creating a hierarchy of spaces, invoking emotions with the help of intensity, colours, and direction of light.

Alvaro Siza has aptly manipulated the use of artificial lighting in a combination with the natural light to accentuate the experience of the spaces. In his works, he has used different spatial techniques to form architectural spaces with the means of light. When viewing the curvilinear ramps of Museum of Imbe Camargo, they seem as if the white curved walls are revolving around the triple-height void. When the sunlight is not directly penetrating through the opening on the side of the ramp, the diffused light harmonizes with the artificial light making the ramps seem edgeless and the entire experience is focussed around the void, slowly revealing the path to the user. Similarly, in Mimesis Museum, the natural light is welcomed through the clearstory such that the ground plane is uniformly illuminated by the indirect light. This makes the forms of Siza seem even more 'fluid' and spaces become free flowing.

"*The use of electrical lighting alters the perception of forms and volumes in a way no environment aid ever could.*" (Banham, 1969). Banham elaborates that Le Corbusier's 'Forms Assembled in Light' turns his shapes inside-out as the light is emerging from within without the shadows. He further adds that the true nature of building comes out at night when the building is viewed in artificial lighting; the light blazes out through the transparent and translucent surfaces, revealing its true nature. When an architect conceptualizes the building, right from the first sketch to the visualizations of spaces, and talking about the intricate play of light, the architect seldom refers to the spaces and their relationship with natural light.

While visiting the Mill Owner's Association building in the day, the first glance of the building is that of the concrete fins and ramps in the foreground, and the shadows of the foyer and fins creating the background. As one moves from forecourt onto the ramp, the shadow of the ramp rises gradually with the visitor and eventually, when one reaches the foyer, visitors are greeted by soft shadows of the cylindrical columns over the floor, a floating white washroom in front of the curved auditorium wall and fins overlooking the landscape on the East. Whereas at night, the concrete fins on the East let out a gentle glow over the garden while the angled fins on the West let out very scattered light. The cylindrical columns cast an unidirectional shadow and are read individually. As one descends from the dimly lit foyer space to the dark forecourt, the 'missing edge' of the ramp makes the journey of the ramp even more prolonged and stretched.

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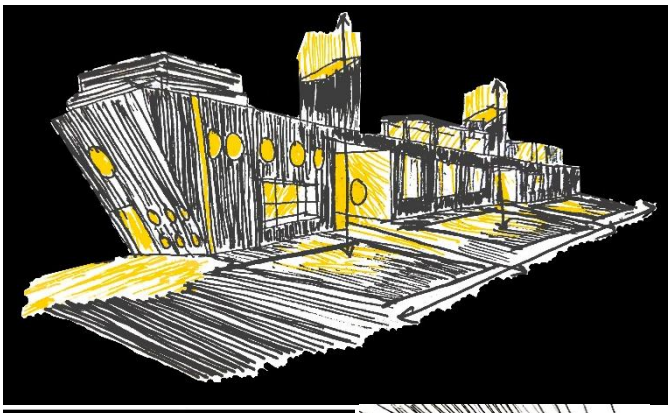
TRANSMUTING THE SPIRIT OF THE BUILDINGS

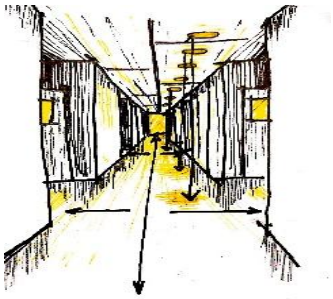
Ahmadabad Management Association (HCP, 1997-2010)

AMA having a linear mass of concrete, sits prominently on the main road, opposite to the old IIM campus. The public institution is hidden behind a promenade of trees and isn't very evidently visible while moving through the traffic. During the day, the entrance of the building is highlighted by the double-height volume of the shadows, creating a thoroughfare between the landscapes on either side of the built form. The vast mass of concrete almost looks like a ship of concrete floating on the soft sea of grass sailing in the rustling melody of leaves (fig. 1.3). While entering through the hull, one almost feels compelled to walk onto the gracious ramp connecting the reception, jutting outwards to the backyard and



moving up to the upper level (fig. 1.4).

The lengthy linear corridors (fig. 1.5) are provided with subtle reliefs of classrooms with full height glazing, overlooking the landscape. This adds to the transparency of the building, allows a deeper penetration of sunlight and provide a contrast to a monolithic structure of concrete. The classrooms have a strong presence of twinkling light through the foliage of neem trees creating a mellow indoors environment (fig. 1.6). On the upper level, the sense of being one with nature is further strengthened in the library when one is reading in the ample amount of natural light, strongly diffused by the adjacent foliage.



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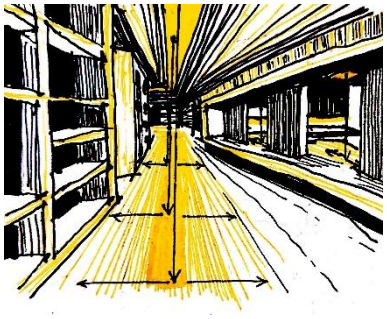
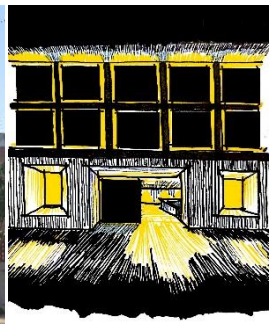


During night, the entrance foyer becomes the kernel of the institution with the illuminated double-height space (fig. 1.7) looking at the trees and gently lit corridor spilling into the classrooms and connects to the auditorium. The journey down the corridor feels stretched due to the uniformly lighting as opposed to the day. The glass panes reflecting the light blocks the view of the landscape giving the feeling of a stretched passage rather than a spillover of classrooms. The upper-level corridor has a sense of relief while viewing the moving traffic and the city lights in an airy balcony under the night sky. The hanging lights in the classrooms and library make the volume of the classroom seem taller as the user is unable to see the ceiling very clearly against the suspended lights (fig.1.8). The ship is anchored in the monochromatic aberrations of night light sets the tone of the spaces to come to a still.



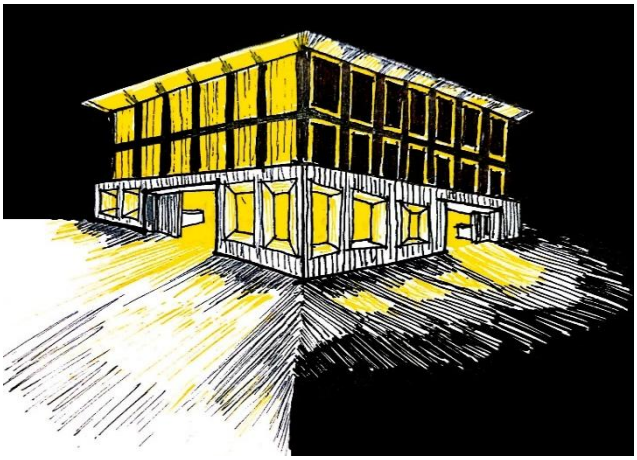
Lilavati Lalbhai Library (RMA, 2017)

Located in the heart ofCEPT campus, the library building is a cuboidal mass which sinks into the Earth, providing pavilion-like structures for public interaction. During the day, cubical volume with entrance from all the cardinal directions is seen floating in the middle of CEPT campus, contrasting in terms of material and language. The thin attenuated slab covers the light steel frame with timber fins diffusers. This light-weight structure sits atop a heavy concrete pedestal with intermediate sittings carved out. The depth of the transparent building is not very clear because of the limited direct light allowed in the building (fig. 2.3). While entering through the bridges, overlooking the exhibition space in the basement, one feels relief from the sun.

As one passes through the exhibition space on the ground and overlooking the one in the basement, one catches a glimpse of a series of vertical skies amidst the timber fins. As users proceed to move towards the basement, they are constantly isolated from the surrounding environment which provides them with the calmness for reading. In the upper basement, the user is greeted with a split volume of two mezzanine levels hovering over the lower basement. The lacquered book racks going from the floor to the ceiling act as a partition between spaces and naturally guide your movement in the space. The polished Kota stone corridors have a sitting space on one side which juts out

of the glass partition to draw in as much diffused light as possible, whereas the book racks on the other side. Separating these two is a continuous band of artificial light which segregates the functions of the spaces (fig. 2.5).

A tubular strip light over the reading tables on the mezzanines, creates an emphasis on reading while marking its boundary on the reading zone and book selection zone. In the lower basement, the volume suddenly feels huge as the mezzanines descend into a uniformly lit foyer. The provision of strip lights in the table controlled individually by the person sitting on the table makes the space dynamic in its terms (fig. 2.6).



During the night, when viewing the building from outside, the upper volume of fins radiates ample light from within and it makes the entire building act as a lampshade (fig. 2.7). The gradient of light falling on the underside of the delicate paper-thin slab and gently fading away before reaching the edge of the slab makes the building blend into the darkness of the night sky and completes the analogy of object floating in space (fig. 2.8).

OBSERVATIONS

The two types of institutional buildings have a very different requirement in terms of lighting and the way they have addressed the use of it. The role of artificial light has been guided by the functional use of the spaces of the library and management association. The reading spaces were required to have enough lux levels for providing comfort to the eye, while both provide a different connection with the outside. Artificial lights have been looked at as a division of spaces and demarcating the movement in the library, whereas the management institute has treated artificial light to diverge from the monolithic feel concrete.

The first glance of the library hides the fact that it is a large volume of concrete and is well hidden in plain sight. Only by moving around the building, one realizes the scale of its mass. The interrelation of using fins to diffuse the light in space during the day and the light that leaks out through them at night creates a frame of the lampshade which blends the roof into the night sky. Perceiving the silhouette of the buildings at night becomes a tad bit difficult which further brings down the vertical volume of the buildings.

While the large mass of concrete stays very well hidden behind the foliage of trees, the focal point of the institution remains in the foyer space whereas the ramp has been given the utmost importance for moving between levels. The boring nature of linearity has been broken with an interplay of transparent connections with the landscape and providing a various amount of changing light conditions in the corridor with activities occurring right beside it.

CONCLUSIONS

These two institutes have provided us with contemporary attitudes towards the integration of artificial light in the building and experiences created by them. The movement throughout the buildings have been enhanced while imparting a new experience to the building, while creating a functional hierarchy and a division of spaces.

ACKNOWLEDGEMENTS

I would sincerely like to thank my guide and co-author Prof. Naresh Chhatwani for constantly helping me with this research, providing me with his invaluable insights and keen indulgence with the topic. I would also like to thank Indus University to provide a precious academic platform for me.

LIST OF ILLUSTRATIONS

Fig. 1.1https://www.hcp.co.in/project/ahmedabad-management-association

Fig. 1.2 https://scontent.famd5-1.fna.fbcdn.net/

Fig. 2.2 https://www.archdaily.com/911812/lilavati-lalbhai-library-rma-architects/5c6c5a0c284dd1af740008e3-lilavati-lalbhai-library-rma-architects-photo

All the illustrations and images are by author unless mentioned

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Street Art as Modern Cityscape

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ABSTRACT: Urban street art is a powerful tool in reflecting the experience of the urban, provoking an engagement of urbanites with their environment, and in re-socialising public spaces. The concept of the city has come to play a central role in the practices of a new generation of artists for whom the city is their canvas. Street art is a complex social issue. For decades, its presence has fueled intense debate among residents of modern cities. Street art is considered by some to be a natural expression that exercises a collective right to the city, and by others, it is seen as a destructive attack upon an otherwise clean and orderly society. This research focuses on various forms of street art from the perspective of the urban cityscape. The general aim is to further an understanding of how people interact with and respond to street art. Qualitative and quantitative data were gathered via direct participant observations of street art installations in pune city. The collective data and analysis will help to know various typologies favoured by public interest, their impact on surrounding, issues related to various aspects. Emerging the need in future city scape enhancement by promoting art to develop sense of responsibility in urban context by authorities and public participation.

KEYWORDS: Enhancement, Urban, Social, Environment, Public, Artist, Artistic, Graffiti.

INTRODUCTION

Street art refers to a practice of unsanctioned artistic expression found in urban public spaces and thus openly accessible for anyone to execute and observe (Jakob, 2008). Many different directions and subcultures come together to form what we think of as street art and graffiti today.

Street art, was originally coined by **Allan Schwartzman** in 1985(fig.1 New York) (Lewisohn, 2008), is an all-encompassing varied artistic expression against an urban backdrop, deriving directly from the graffiti revolution, in a two-dimensional or three-dimensional state. Often referred to as post-graffiti (Bou, 2005, p.7), it carries a new set of aesthetic ideals, media, and techniques that were not witnessed in the 1970s and 1980s graffiti art movement in New York City. Allan Schwartzman is a Founder and Principal of Art Agency, Partners and Chairman, Co-Leader of the Fine Art Division of Sotheby's. This research focuses on human-environment relationships by examining unauthorized artistic interventions in the city, otherwise known as street art. Street art has found its way into museums, but it started out as illegal protest in large cities - from Mexico to Paris and New York. Hip hop culture made it popular in the 1980s.

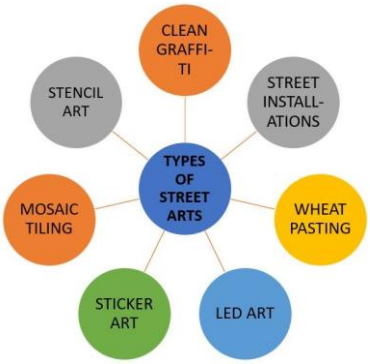

Diagram.1 Types of Street Arts

Fig.1 Street Art Spread in World

Literature Review

It has been said that "street art is a ―window into a city's soul" (Kendall, 2011). Street art can serve as a conceptual frame through which observations and interpretations of the urban cultural landscape may be developed and explored.

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This research is important for two reasons. First, the way people think about the use of space matters because the characteristics of places (e.g., design, accessibility, attractiveness, etc.) influence our understandings of the world, our identities, our attitudes toward others, and our politics (Massey, 2005). In other words, what people make of the places around them is closely connected to what they make of themselves as members of a society and inhabitants of the earth (Basso, 1996). Knowledge and perceptions of places are therefore closely linked to knowledge of self, to grasping one ‘s position in the larger scheme of things, including one ‘s community, and to securing a confident sense of who one is a person. Our sense of place, our sense of the past, and our sense of being are inseparably intertwined (Basso, 1996). In today ‘s globalized world, we must strive towards a forward-looking _progressive sense of place ‘that is open to difference, change, and global connectivity (Massey, 1994, 2005; Cresswell, 2004). Secondly, this research is important because no other studies have gathered the general public ‘s thoughts on street art in a systematic manner. Most accounts are anecdotal. It is essential to understand what people think about street art in order to evaluate if current policies reflect what people actually desire.

EFFECTS OF STREET ART

Street art is not just a spatial phenomenon; it is a complex social phenomenon that produces intense emotions for different people at different times and contexts. It plays a fluctuating in modern consciousness. Regarding the paradox of street art, the author says that it is considered by some to be a in the public realm that exercises our right to the city, and others see it as.

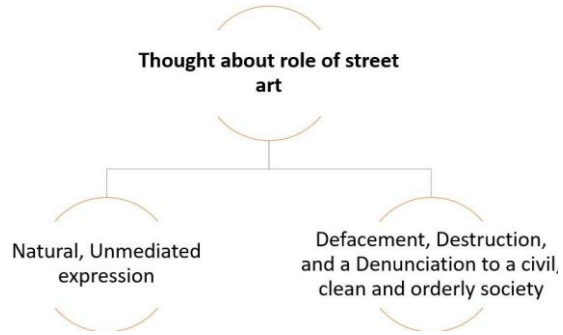

Diagram.2

Those who see it and react to it, acting either individually or as a community, judge the meaning of street art. The audience should not be viewed as a passive receptacle for these aesthetic stimuli. The perceiver, whether reading or looking or listening, should make an active contribution to the total communicative process (Wilson, 1986). This system of signs and symbols, taken together, are narratives that reflect, inform, and construct our collective identities and the places we inhabit. The general aim is to further an understanding of the relationships between people and the places they live by gathering information on what people think and feel about different forms of street art.

Graffiti vs. Street art: what is the difference?

STREET ART	GRAFFITI
Street art is seen in a more positive light.	Graffiti is still considered to be a negative term.
Street art is usually considered more cultured and a good form of expressionism.	Graffiti is associated with the vandalism that the government desperately wanted to erase.
Easy to understand.	Quiet difficult to understand.
Legally commissioned artistic expression.	A not legal art form.
Different mediums of paints are used.	Aerosol sprays are mostly used for creating art.
Street artists are known artists commissioned to design and produce something the public will appreciate.	Graffiti has a culture and language which is known by the artist and its followers.

Table:1 Difference between street art and graffiti (As per literature review)

Fig.2 Graffiti v/s Street Art

STREET ART IN INDIA

Urban street art is a powerful tool in reflecting the experience of the urban, provoking an engagement of urbanites with their environment, and in re-socialising public spaces.

Fig.3 Street arts in India

Street art has become a relatively inexpensive way for municipalities and developers to invigorate the built environment, says Lee Bofkin, the co-founder and CEO of London-based street art agency Global Street Art. “The modern street art movement has collided with, integrated and assimilated the local cultures of painting and muralism

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around the world," he says. It is a new way of urbanization through art and culture. It is helping in exploring new ways of showing creativity as well as enhancing the surroundings and preserving culture as well as spreading awareness.

METHODOLOGY

Collection of primary data is carried out. After the collection of primary data and literature review, visit to the places where street art can be seen is carried out. Data collected by observations, interactions and surveys conducted on the basis of questionnaire. How people interact with, experience, and are affected by, their environment can be explored by studying street art. The purpose of this descriptive research study is two-fold. Firstly, I will do the observation-based study and secondly, I plan to investigate the contexts of street art as a part of the visual culture found in urban areas, aiding in the identification of street art and how it differs from graffiti art. As street art gains popularity worldwide, it continues to borrow influences from the graffiti art revolution, but is also increasingly recognized as a distinct art form. While the general acceptance and understanding of street art is in an indeterminate state, this study intends to describe the position of street art by investigating their varying status in the art world, both problematic and successful. I will collect data through face-to-face dialogue. Each participant will be asked a series of questions that attempt to locate commonalities. After the survey the analysis on the basis of questionnaire is done and the outcome will be obtained on the basis of the observations as well as surveys. This methodology will help in gaining the required outcome and results with a proper data.

STREET ART IN PUNE CITY

The Oxford city of India never fails to leave us awe-struck, either by its food, its gallantry heritage or its beaming art. The street walls of Pune are magnetizing with a spectrum of artwork ranging from city stories to abstract ideas. This is an initiative taken collectively by PMC, Pune Biennale Foundation and a pool of national and international artists students and citizens of Pune. Many other artists as well as NGO's are formed in the city for promoting the street art and enhancing the cityscape. We travelled across the city to capture such gems. Let's walk through the colours, shall we?

Fig.4 Street arts in pune city (Source: google)

CASE 1: BAL BHARTI WALL (INSTITUTIONAL)

Photograph.1 Courtesy: Self

Located on Senapati Bapat Marg, Pune, Maharashtra 411004. The wall is a collaboration of Pune Speaking Walls and Balbharti. Balbharti, with its vast experience and constant efforts in betterment of education, served as a platform for Pune Speaking Walls to work with children and create a beautiful artwork which signifies both of the institutions vision. The wall is painted by artist Abha Bhagwat who has a vast experience of working with children, she believes that hidden talent in children is yet unexplored. Over the years, Balbharti has created a culture of reading among the children. The ease of language used, the colourful, happy children depicting various cultures, tradition and situations make the learning experience a happy one! It helps children to think intensively and to think critically, creating a lasting impact in the lives. Through this artwork, Abha tries to catch this essence that Balbharti is! She has tried to imbibe the various books, art and stories in her work to create a sense of wonder. It would definitely make one nostalgic! The wall is painted upto a length of 370 feet. The height of the wall is 7.5 feet and the total area covered under the street art is 2775 sq. ft.

According to the survey conducted this street art is playing a major role in the enhancement of the entire street as well as the institute. It is depicting the different aspects of school as well as promoting education. It is also helping in

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changing the walking experience for people from that street. It is also making it easy to identify for people that the building typology is educational.

CASE 2: SHINDE SCHOOL (INSTITUTIONAL)

Photograph.2 Courtesy: Self

Located in Sahakar Nagar, Pune, Maharashtra, 411009. Ganesh specializes in city scapes in Oil colours and prefers large canvases. His keen observations on how the city has changed is represented in the art work he is currently doing on the wall of the Shinde School, Taljai, Pune. Along with the stark comparison of heritage Pune and contemporary Pune, the wall will highlight few prominent structures e.g. Mandai, University, Lal baug etc. which has also witnessed these changes through time. Through this artwork, he wants to explore the deeply ingrained images, feelings and thoughts that everyone feels with the old and the ever-changing architecture around them.

According to the survey conducted and the analysis, it is a type of street art which is depicting the culture of the city and cityscape. This street art is complimenting the footpaths and the streets. It is not making it easy to identify for people that the building typology is educational but its is certainly enhancing the walking experience and is depicting modernisation of pune city with a touch of culture of the city.

CASE 3: KASBA PETH, PUNE (RESIDENTIAL)

Photograph.3 Courtesy: Self

Located in the locality of kasba peth, the idea of street art project in pune was initiated by Harshvardhan Kadam (aka inkbrushnme). "In ancient times, Kasba Peth was the point from where the city of Pune started," he said. The street art starts from tilak statue towards the temple and following the lane of the temple we come across certain murals and paintings. The paintings were done by different artists from pune city as well as around the world. The people living in the area also shared their experiences about the art done on the walls and how they are feeling about it.

According to the survey conducted it is observed that the art's have given the space a new view it transformed the dull surroundings as well as lanes into new interactive spaces creating a healthy environment to stay. The origin point of street art is kasba peth and here the people supported the street art with full enthusiasm. It changed the aesthetical perspective of the locality. It adds a value to the place and improves the living by creating a healthy and interactive environment.

According to the case study analysis and the survey conducted the following observations are taken:

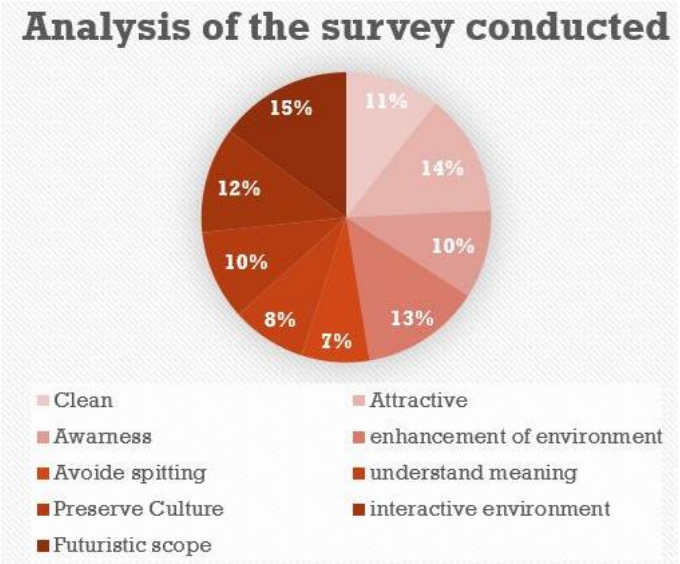

Table.2 Analysis of the survey

CONCLUSION

According to the interpretation from the conducted assessment, street art is viewed as physical, economic and social driver to successfully implement and transform changes to underprivileged places and communities. These being the part of urban enhancement art the cityscape looks more beautiful and add aesthetic appeal to the dull lanes. In order to reinvent, rejuvenate, occupy the city, building, urban space and community via adopting and improving quality of life, urban beautification, community participation, pedestrian networks, economic advancement and a cultural and lively community/city. Street art is a low-cost tool for urban regeneration/redevelopment inclusive of all stakeholders of a community or city as it can alter public perceptions and is a separation of art form and crime. Since urban regeneration is a process and an

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outcome, street art can be a key driver in urban regeneration/redevelopment. Therefore, I believe street art can successfully assist and encourage urban regeneration of cities, places and communities by socio-cultural development and adding value to the artists in the city.

ACKNOWLEDGEMENT

Many thanks to the multitude of the teachers that helped me throughout the research. I am deeply indebted to **Ar. Shilpa Ingawale** for her sound advice and endless feedback, as well as **Ar. Shailaja Bhagwat** and **Dr. Rajendra Koli** for guiding me through this process with composure and insight. A big thanks to **Ar. Ashwini Pethe** helping me know about the foundation conducting the street art in pune. Finally, I would like to thank the Pune Biennale Foundation for taking initiatives for starting street art in pune.

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Mental mending and Mindfulness through Architecture

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Abstract: ***Growing technological developments have harbored the mental growth of human beings. Societal pressures to acquire a particular status in terms of materialistic ambition is seen as success, leading towards a downfall of physical and mental health. In this fast-going and digital age where there is a pressure of reaching somewhere, the meaningful and crucial information is being ignored.***

Increasingly an individual's inability to step away from technology can have serious consequences, one major effect being anxiety. Recent surveys have shown increasing cases of anxiety and stress with the growing and developing world. Along with the fast age, there is an increasing ignorance of self-awareness, human connections and personal well-being.

Here in the paper we will understand what the problem is, in the context of psychological conditions. What are the causes and consequences of the current situation of the society? What actually mental well-being and mindfulness is? Role of architecture in mental wellness and how it can act as a solution and therapy along with psychology and act of senses. Studying and analyzing case studies of such spaces will help understand the solutions to social and self well-being. Concluding factors and sense of designing for human well-being on a deeper level using Architecture and Psychology as tools for a better society.

Keywords- Technology, Social media, Anxiety, Mental well-being, Mindfulness, Mindful Architecture

1. INTRODUCTION

The evolution of social media has come to shape the technology sector as well as real-world social interactions. Social media platforms are some dominating fields today. Along with the birth of "Smartphone", social media seems almost unavoidable as it gets easy to connect to the internet anywhere. It is becoming difficult to separate men from their machine. As society's attention is focused on online praise or impending tragedy through a screen, the connection to the present moment and casual personal encounters are lost. Thus, the technology being so beneficial on one side, and on the other side, it is also deteriorating the mental health of today's society. People want online validation and to match the world they try to be updated as much as possible. And the inability to step away from the technology causes anxiety. In the fast pace and over-stimulation of our digital age, it has become increasingly difficult to focus on meaningful and relevant information. As we live life through a screen and more isolated from our peers and ourselves, adverse effects on our physical and mental health emerge. Human connections and self-awareness is important for maintaining interpersonal well-being and psychological balance where the community is grounded in meaningful experiences within the public and private domains.

Considering the current status of societal stress, the return on investment in mental health, and different practices that address these issues, there appears a marked lack of architecture designed to address society's changing needs. Architecture has the power to promote a sense of presence, forcing users to pay attention to the immediate environment or simply fading into the background to allow users to think on their own. Place influences emotions, which control our lives and could also impact behavior. By crafting mindful architecture, the need to constantly be connected to outside factors can be reduced. Through design, mental state and behavior can be influenced in a way that promotes wellness and therefore potentially reduces the anxiety the user feels towards things beyond his or her control. Mindful architecture is a method and practice of architectural discovery. It seeks to reverse this trend and redirect our focus back to the duality of the mind and body by focusing on the tangible and intuitive qualities of the physical world. Architecture can contribute to well-being as a

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form of therapy by evoking thoughtful states and heightened internal and external awareness through mindfulness.

The study can be further continued by considering a deeper understanding of human behavior and senses in different spaces designed considering various parameters in terms of physical, mental and emotional context. Here, in this research, I've limited the study analyzing some physical parameters for a sense of designing a space to achieve mindfulness. To understand the parameters of designing, Literature study, journals, books andcase studies of some spaces depicting the sense of design.

2. METHODOLOGY

The approach of the paper is to understand the role of architecture in improving the current scenario of the society facing mental illness because of the technological advancements. To better understand the sense of designing any space, the parameters of the study is limited to Materiality + Weathering and Light + Shadow.

The data for the study includes articles/journals, books, literature case study which is majorly collected and referred throughout the process of personal reading and understanding.

Other methods to approach the study can include live case study and interviews based on the parameters for designing the space for mindfulness.

3. LITERATURE REVIEW

The following research material has been structured in a certain way that allows for a better understanding of the different factors affecting the study. The scope of the study will be narrowed down to specific field of study. The literature review will be focused on theoretical study, the theoretical and philosophical bases from researchers that have been analyzed to build up this study.

3.1 THEORETICAL STUDY

3.1.1 SOCIETY INFLUENCED BY TECHNOLOGY AND SOCIAL MEDIA

The constant encounter of social media and technology makes a serious impact on one's mental health. Technology can be incredibly beneficial for connections to a sense of community, both local and global, and benefits users. But as the use of technology and social media is increasing at a fast pace, today's generation is getting more and more depended on it. As the lines between necessity and excess blur out, the connection to technology becomes similar to an addiction. People nowadays spend much less time connecting with their peers in person and more time connecting electronically, especially through social media. The rise in depression is evidence that the connections social media users form electronically are less emotionally satisfying, leaving them feeling socially isolated. The less you are connected with human beings in a deep, empathic way, the less you're really getting the benefits of social interaction. The intense social media use is correlated with anincrease in anxiety and depression as people compare themselves negatively to their peers and worry about missing out.

3.1.2 WHAT IS MINDFULNESS?

Mindfulness is cultivated by paying close attention to your moment-to experience while, as best you can, not getting caught up in your ideas and opinions, likes and dislikes. Mindfulness-Based Cognitive Therapy was used to help patients suffering from anxiety, this form of therapy uses mindfulness as a way to connect to greater awareness. Using aspects of mindfulness is proven to reduce anxiety and mood symptoms as it increases awareness of everyday experiences. Practicing mindfulness is beneficial to mental health and is used more often as a therapeutic means to help those suffering from anxiety disorders. In an effort to adopt alternative methods to mental well-being, the practice of mindfulness has become a popular way to meditate. Meditation is not about doing, but rather being. Mindfulness is about being fully present, on purpose and without judgment. By observing the moment as it exists, personal stress is reduced. Through awareness, mindfulness helps one shift from a doing mode to a being mode, changing one's understanding of self and well-being.

3.1.3 ARCHITECTURE AND MINDFULNESS

The way we look at our surroundings is influenced by the setting of those surroundings, as architecture fulfils the psychological needs of the user. And the diversity of users will impact the success of the design in influencing emotional response. An

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architecture of mindfulness would not only fulfil the needs of mindfulness meditation but also go further in establishing physical attributes that can then form an ideal environment to be present in. Different spatial qualities such as natural light, fresh air, circulation, privacy, scale and even the time of day can all contribute to the users' desire to spend time within the space in a mindful way.
For the purposes of establishing a baseline for a space to be considered mindful, certain physical and abstract qualities of the space must be achieved. There are essentially three different levels of a space that should be considered in designing a mindful space; the context of mindful space, with connection to nature, the architectural environment of mindfulness, including both natural and designed factors, and the humanity of mindful spaces, such as interpersonal relations and the individual's experience within the space.

4. CASE STUDY

4.1 MATERIALITY + WEATHERING/ SPACE + TIME

-The Pierre, San Juan Islands, Washington
Design principal-Tom Kundig

Fig.1 Weathering of stone with season

The rock projects into the space carved out of existing stone, left raw material, natural sinks in the existing stone.
A powder room is carved out of the rock; a mirror set within a sky tube reflects natural light into the space.
The architects were conscious to reveal the means of construction as the boreholes, used for dynamite blasting, create the texture of the walls and ceiling. Architectural materials go beyond their tangible forms and into the atmospheric realm to include sensual generators such as light and wind. Architecture should remain silent and let nature in the form of sunlight and wind speak. They can be chilling or gentle and pleasant. They activate space, make us aware of the season, and nurture within us a finer sensitivity. Material weathering gives architecture an authentic expression, marks the passage of time, the temporality of nature and the process of life and death. Weathering marks the life of a building and signifies human use. Time's passage in architecture includes a building's conception, construction and inhabitation. The project, too, endures through these phases. The building's regeneration and degeneration emphasize the temporality of nature as an order of beginning and ending or, more broadly, life and death.

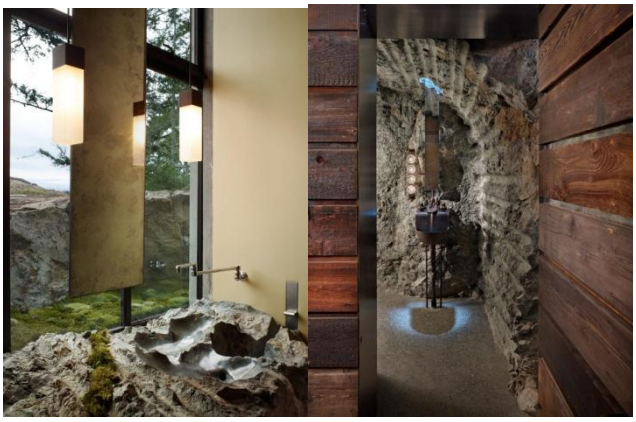

Fig.2 Natural sinks in the existing stone Fig.3 The texture of the walls and ceiling

Natural materials express their age, as well as the story of their origins and their history of human use. Furthermore, these processes allow experiences that surpass any individual life.Time and space are eternally locked into each other. Matter, space and time fuse into one singular elemental experience, the sense of being. It reminds us of nature's temporal power through material weathering and the fusion of time and space with the present. Weathering brings the virtual future of a building into dialogue with its actual present, as both are entangled in its past.

4.2 THE PLAY OF LIGHT + SHADOW

-Colline Notre Dame du Haut, Ronchamp, France
Design principal- Le Corbusier

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Fig.4 Selective opening in the form wall

Fig.5Light entering through thick

Le Corbusier's chapel at Ronchamp, the darkness and weight of the space under the hanging curved roof of concrete is heightened by the rich illumination through the punctured south wall. Mindful architecture intends to harness light and shadow for the entire body. We feel the warmth of the sun on a cold winter day or the relief of shade in the desert. Light and shadow include bodily sensation that influences the spiritual strength of architecture, driven by the quality of light and shadow.Light reveals architecture and architecture reveals light. The integration of light within the built environment has the potential to change the way we perceive and experience space. Using highly textured surfaces, colors and filtration of light provide never-ending stimulation. Roofs, walls, openings and materials are expressed as optical instruments, providing a variety of different lighting effects that change in relation to solar orientation.

The three design treatments that help support the expression of light and shadow within Ron champ are: increasing the wall depth to allow light to mediate through;

the filtration or screening of light; and the use of selective openings throughout the architectural form.

With light comes shadow and together they create a play through which we experience time and space. All life on earth revolves around access to light and shadow. Light and shadow place us in the daily and seasonal transitions of the earth and connect us with the universe. Natural light connects us with cosmic dimensions and brings life into architecture. This connection gives light both permanent and temporal qualities. We experience light at the present moment or light exists eternally as it may have travelled for millions of years to reach our perception. The dynamics of light and shadow allow the senses to experience atmospheric qualities. Space can be manipulated by the architect through the control of light and shadow to achieve spiritual awareness and perceived weightlessness.

5. CONCLUSION

The present scenario and working of the society where media and technology is adversely affecting people's mental health. Architecture can play a crucial role in bettering the quality of emotions and thoughts making the generation mindful mentally healthy.

The study unveiled the possibilities of utilizing architecture as a major tool in improving public health on a large scale. Further for deeper research, this study can be continued by understanding human senses reflex in different spaces with different factors affecting mindfulness.

6. ACKNOWLEDGEMENT

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To my studio director **Ar. Yogesh Kawade**, my research guide **Ar. Kanchan Yadav**, subject professor **Ar. Aparajita Kaushik** and my mentor **Ar. Shruti Hippalgaonkar**.

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Location of Market Places with Respect To Accessibility

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"People make places, as well as places shape people. The way people adopt shape, use and manage the spaces around city will determine the meanings of space".

-Journal of Urban Design, 2018 Vol.23

Abstract : Locations of the marketplaces are affected by accessibility and number of users. The farmers travel from different villages to the city market which solely depends on the road networks and nodes from which people enter in relation with human settlements. The market access environment keeps on constantly developing and changing, a focus on actively changing means of entries along the market should be taken into account. Roads are the crux of the human civilization and social interaction along with activities. Improved accessibility would save on time but unplanned roads lead to sprawl of human settlement which impedes traffic flow and connectivity. Hence, having a resolved access is an important aspect of the markets.

INTRODUCTION- Markets are an important aspect of our lives, in urban, semi urban and rural settings. Most people regularly visit markets as buyers and sellers. It is important for an architectural student to understand how a market functions to be able to design them well. This research explores what aspects affect efficiency of markets.

HYPOTHESIS- The usability and functioning depends on the number of openings for the place which is decided by the means of accessibility.

SUBJECT- To study and analyze the effect of accessibility on the location and efficiency of market places and how does the pattern o of human movement affect the design of market place. The study aims to examine individual accessibility experiences in space, through developing a new accessibility measure using spatial and journey data.

CONTEXT- Research will be in the context of rural area like Baramati where in all the nearby villages depend upon, and people travel from and outside the town to the market on weekly or daily basis. Accessibility to markets, services and infrastructure is a major determinant of economic status. However, some accessibility measures do not have a clear dimension and must use indexing for the purpose of comparing nodes.

Markets link local activities to larger regions through trade. For farmers, markets are the means to sell their goods while at the same time they provide incentives for investments and production choices and hence Accessibility plays an important role in functioning all these activities. Transportation facilities largely determines the access people have to the markets and its maximum utilization. The quality of transport infrastructure in terms of connectivity, capacity and travel distance along with speed affect the market's accessibility which will determine its location.

AIM- To explore the importance of location of Marketplace in the city and understand the importance of location with respect to accessibility of Markets for local communities as well as people visiting the place from other towns.

OBJECTIVE

- To study the location of the local market.
- To study the parameters on which the location of the marketplace is decided.
- To study and analyse the flow of humans into the market including the local as well as people visiting from nearby towns and villages.
- To analyse the problems of accessibility of the market and its causes to increase the potential of the place.

SCOPE

- To analyse the various parameters which play an important role on deciding upon the accessibility of the marketplace.
- To understand the circulation pattern of the market place.
- To analyse the direction of human movement in the market.

LIMITATION

- The study is limited to Baramati Local Market.
- The study will be conducted only on Thursdays which is a market day of Baramati.

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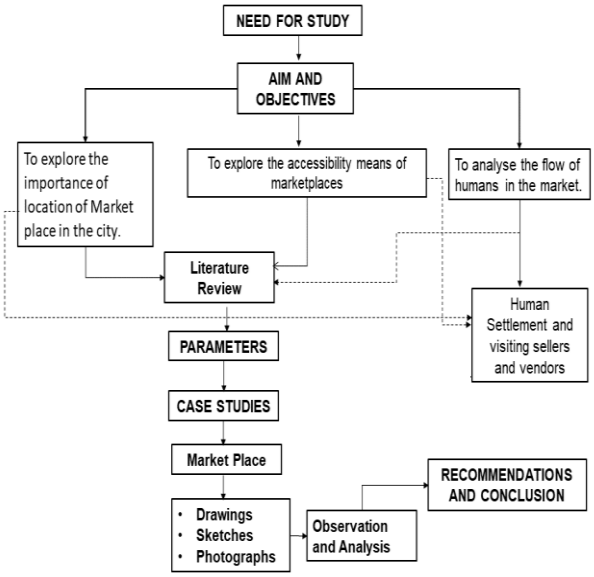

- The study is limited to only temporary Sellers, vendors and visitors and will not include the people visiting the permanent shops.
- The data collected and analysed may not apply to other local markets other than the Baramati local market.

RESEARCH QUESTION

The location of the market has a huge correspondence with human settlements and flow of humans along with the users into the market and, all these factors depend upon the accessibility means, and vice versa. As market influence grows, the paths and journey and circulation pattern changes or we could simply say that shifting of location of the market. So the major aspect considered is the accessibility of the markets.

RELEVANCE OF TOPIC

Markets influence the worldwide patterns of Urbanization, deforestation, agriculture and other allied activities. Yet market influence is rarely incorporated into spatially explicit global studies of change largely and thanks to lack of consideration of accessibility. The market access environment keeps on constantly developing and changing, attention on actively changing means of entries and roads along the market should be taken into consideration. Roads are the crux of the human civilization and social interaction along with activities. Human settlements are though heterogeneous but involve interactions among themselves. It is observed that availability of a suitable location for market places serves or activities like buying and selling which are the major traffic attractors and circulators that tend to concentrate more along road corridors for easy access. Improved accessibility would save on time but if the roads and pathways are unplanned it leads to sprawl of human settlement which impedes traffic flow and connectivity. Hence, emphasis is to be laid on the pattern of structures and accesses to promote ease of access and convenience and maximum utilization of the space. Improved accesses lead to economically viable and attractive place and economics is the major aspect of the market. The complete functioning of the market is based on the circulation pattern inside as well as outside the space and in the Baramati market there are too narrow entries at the front side which do not allow the vehicles to enter and people need to take a long route to enter the market else the only option is walking too long. Hence having a resolved access is an important aspect of the markets.

RESEARCH METHODOLOGY

Table 1

The data for this research was obtained from both primary and secondary sources. Literature Review was the method used for collecting the primary data like parameters which were then used to collect the secondary data from the case studies. Listing down the parameters of the market place gave the parameters like **Location, Accessibility, Human Settlements**, Traffic Congestion, Range of Goods and Socio-Economic Character. Taking into account the Accessibility as the main parameter and listing down the sub parameters of Accessibility **like Number of Openings**, Services and Goods, **Human Settlements**, **Flow of Humans** (Circulation Pattern/ Journey). The data collected would in form of photographs, sketches and drawings which would show the footfall and the journey/circulation pattern of the users as well as the sellers. Questionnaire and physical surveys were used to collect the secondary data. The data was collected between 9am to 1pm on Thursdays and 7am to 12pm on Sundays. The interview was conducted with the sellers and vendors and the visitors as well.

15 respondents were interviewed for the study. They consisted of two groups. The first group: market stakeholders, who were the main research respondents,

a) 5 selected vendors from the market

b) 10 selected buyers

For vendors and buyers, the selection process began with collecting information on what types of goods people normally want to buy when they visit the local market. For this, I asked seven friends of mine, and most of them said that they usually buy vegetables and fruits when they go to a local market. The data collected would be in form of sketches, drawings, images and the observations together with the answers received from the users.

DATA COLLECTION

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To begin with the foremost data to be collected was different typologies of buildings, complexes or public spaces where the culture of the place is defined. A mind map was generated which listed down the various parameters and typologies of the buildings from which some parameters were chosen for my study.

1. Market Places-

Market Places have a spread of activities occurring with different categories of individuals with different age groups and different standards of living which decides upon the place's culture and decides the overall look of the place and these places not necessarily have the built structure rather it is an area where the huge public space junk is converted into the space which sustains the culture of people.

2. Coffee Shops/Hotels/Plazas-

It has been observed that people love to have the coffee, dinner, snacks seating comfortably in the presence of nature rather that an enclosed AC space and watching the dead walls. The culture of people is to sit on a couch or a platform and enjoy the food having a pleasant scenario of the nature.

3. Streets

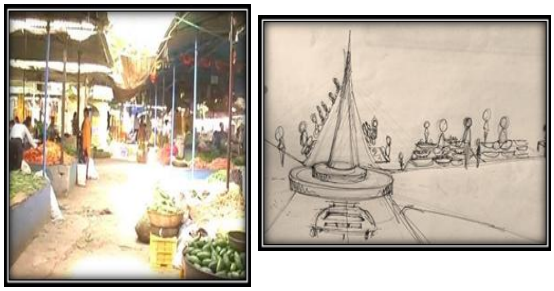

Figure 1(i), 1(ii), 1(iii), 1(iv)

For example, In Mumbai the fashion street is not just the street, but they are being used for having a ramp walk and other such activities which the culture of people residing over there. They need not have a built structure but have converted the public space to sustain their culture.

4. Theatres

Having vendors outside the theatres where people wander around and enjoy the crowd and where the children have a horse ride or so is the lifestyle and culture of the place where in the structure plays a very minimal role and the heart is the streets and the public space outside the theatre which is the attraction point for the visitors and it is that space which sustains the culture of the place and not the built structure.

Case Study at Baramati local Market (refer figures 1(i), 1(ii), 1(iii), 1(iv)) was done on Thursday and journey of visitors was marked wherein it has been observed that people enter from all the 6 gates randomly but the front two gates are used maximum by the local people residing in the main core of the town whereas the rear gates are used by the people residing at the outskirts of Baramati.

Farmers, sellers and all the goods and services were accessed by the 2 side gates. Though there are 4 gates for service entry and farmer's entry only 2 gates were used and useful and many people entered through these gates and no protocol has been followed where the visitors were restricted.

Questionnaire- The answers mentioned below are the average answers received.

For sellers and vendors-

1. Where do you come from? Local or other Villages
- Other villages like Bhigwan, Nira, Malegaon, Limtek etc.

2. What goods do you sell?
- Vegetables and fruits

3. Is it feasible for you to travel to the market and whether the roads are useful or not?
- Not really but do not have an option as selling of goods in hometown is uneconomical and Baramati bears a good amount.

4. Do you find the pathways and roads useful? If not, what inconvenience do you suffer?
- Yes. They are useful as they connect to the main road connecting are hometown and carrying the goods is easy due to segregated openings for the market and no hindrance is created by the public due to different service entries and public entries.

5. Which gate do you prefer to enter from and why?
- The side gates are preferred as carrying the tempo and making it stand is convenient and do not create traffic issues.

6. Does the location of the market have potential and bear you enough earnings?
- Yes, the location of the market is very convenient as it is the centre of the city and all the residents visit in large number being near and accessible and being near the bus stand attracts the travellers too which adds on to the potential.

7. If the market is shifted to some other place would it cause any effect on your economy and trade?
- No, the market was shifted once but created problems for parking the tempo, even the users reduced due to long distance and served to be uneconomical.

For buyers-

1. When do you mostly visit the market?
- Thursday and Sundays

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2. Are you local or visited the place from some other place?

- Local as well as visitors at the bus stand.

3. What type of goods do you purchase most of the times?

- Vegetables and Fruits

4. How long is the market from you home?

- At a distance of 2 km and I can come walking too and need not have a vehicle necessarily to visit the place. Even if I need something other than the market day I can walk and get the goods from the local sellers in the market.

5. Which gate you prefer to enter the market? Why?

- The front two gates as they are near the main road which is connected to the home.
- The rear gate as we live outskirts of the city and coming to the market from the front gates is really inconvenient though.

6. Is the market accessible?

- Yes, very well.

7. Do you face any inconvenience in reaching the market? If yes, what and why?

- No we do not face any inconvenience as such the only issue is the traffic congestion, being located near the bus stand and the node.

8. Will the Shifting of market cause any trouble or inconvenience to you?

- No, the market was shifted once but created problems in reaching the market as it had only one gate and we needed to visit through the lane and no main road connected the market.

9. What location would you prefer over the current location of the market?

- We prefer the current location itself and if the market needs to be shifted we would prefer it near the Panchayat Samiti, Ashok Nagar as the city is developing Ashok Nagar is becoming the center of the city.

DATA ANALYSIS

Transformation of urban spaces, their active and creative use-

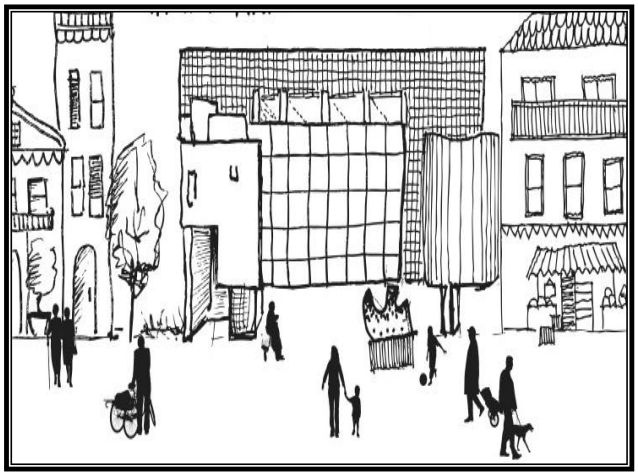

Figure 2

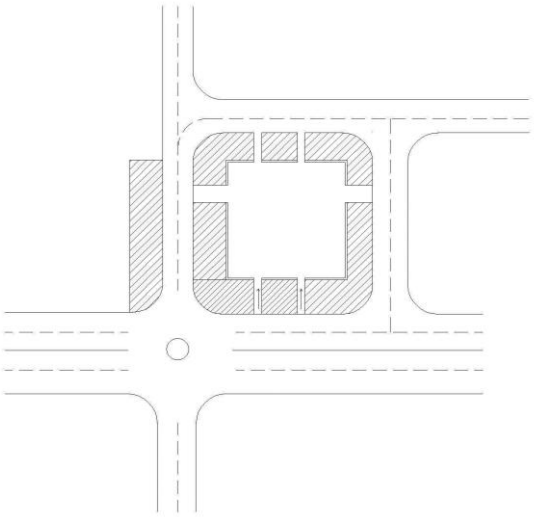

Figure 3

Spontaneous transformation of place and its active and creative use is influence on factors that are close to the terms of the creative city.

Open social climate, Informal social groupings-

1. People of different categories according to their economic status, age groups and occupation settle in to the market and accordingly are their goods and ultimately it decides upon the buyers and the visitors and their flow and their journey in the market and all this is dependent on the number of openings for the market and indirectly the road networks. The maximum vendors sit along the main road connected to the city and connecting villages from where the farmers travel for selling their products and they do not have a permanent place in the market and most of the customers prefer buying goods from these vendors and hence the main access for is the Indapur road.

2. The redesigned market had only one entrance and which created a huge accessibility issues for the visitors as well as the sellers to get their goods all the way through the small streets and then take them into the market and hence created a big issue of accessibility for the users and visitors as well and hence the market was re-shifted to the original place.

Effect of market on the traffic has been depicted in the graph below on Thursdays, the market day. From the graph obtained it can be observed that the market's location and accessibility highly affects the other places. Having openings located on the sides where there is maximum probability of people to enter from is must and to have these opening along those sides need a road or street to make them accessible and having roads and streets depends on the location of the market itself, if the market is located between the congested area it is not

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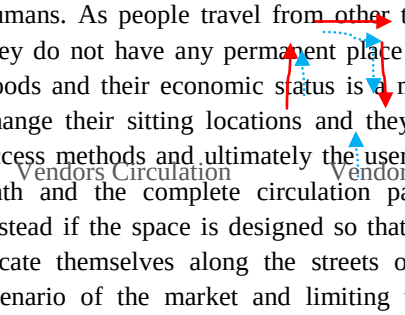
possible to have roads on the periphery of the market and it disturbs the accessibility for the market.

The data from the field observations (refer figure 2) conducted, showed that most vendors and buyers went to the street markets compared to the other market which is outskirts of the city being inconvenient and long for them.

The circulation diagram (refer figure 3), represents the journey pattern of the sellers and vendors and how the number of openings to the market change the circulation pattern. It also represents the journey pattern and footfall of the users of how the number of openings to the market change the circulation pattern and how people enter the market and human settlements around the market and this diagram represents the effect of human settlement on the location of the market and effect of openings on flow of humans.

RESULTS

Though, the entries get restricted or changes people do not follow them and find their own paths into the space so there could be no specific path created to resolve the accessibility issues. But at the other hand if we limit the number of openings it is possible to direct the flow of humans. As people travel from other towns and villages they do not have any permanent place to sit and sell the goods and their economic status is a major factor which change their sitting locations and they create their own access methods and ultimately the users create their own path and the complete circulation pattern is sprawled instead if the space is designed so that no vendors could locate themselves along the streets or just change the scenario of the market and limiting the entries to 2-3 would resolve the accessibility issues. The human settlement being slum on one of the sides changes the means of access, due to location being at the centre surrounded by the slum, residences, main road and bus stand and commercial complex people tend to enter from all the sides without following a specific path. The age factor also plays an important role in defining the path followed by the users and even this parameter needs special attention which has to be considered.

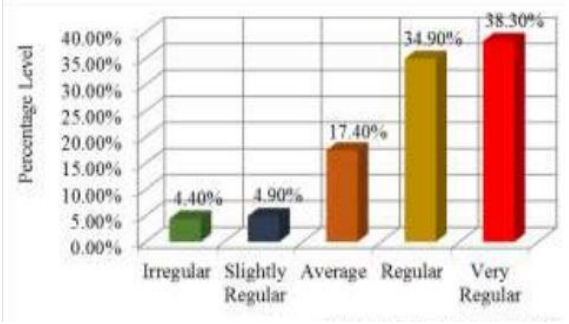


The zoning plays vital role in the functioning of the market as well as it helps in deciding upon the users and their circulation pattern as people with higher economic status would not go and buy things from the vendor and their circulation pattern and journey would be completely being different from the poor people. Not only this the human settlements around the market would decide upon the positions of openings and not only the position but the number of openings as well.

The accessibility integrates three components:

- The transportation component, which deals with mobility
- The spatial component that deals with activity location
- The temporal component, which deals with the timing of activities

From the study it has been observed that market place which is located near residential or business centers, facilitate both vendors and buyers, specially the lower-income group to participate. Due to centralized location of the market, vendors know where they are going to sell their products while, buyers do not have to wander in search of the goods. The poor would find it difficult to spend any transport fee, and hence location of the market should be such that it is centrally located and accessible by



all the people of different age groups as well as different income groups.

CONCLUSION

Accessibility is important for market development since location with better access gets more response of buyers and sellers. The location of the market should be such that the villages and cities from where all the products are sourced are easily connected to the market.

ACKNOWLEDGEMENT

I would like to sincerely thank my guide Ar. Sanjeevani Veer and Research Head Ar. Seemantini Chaphalkar for their great support and guidance in carrying out my research and writing this research paper. I cordially thank Ar. Rajashree Patil for her immense support throughout the research process.

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Status of Universal Access in Shopping Malls in Pune

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Research Guide: Ar. Shilpa Ingawale, Ar. Shailaja Bhagwat

Abstract: India is an inclusive country where people with different religion, caste, race, economy reside together; but are distinguished by physical barriers. Many people are deprived of using public buildings like malls, theatres, commercial buildings, etc. only because of physical inaccessibility and space design. The research paper aims at identifying the status of universal access to Shopping malls in Pune through case studies; to create an inclusive environment through ease of accessibility. The case study was conducted for malls as mall is a place that has activities like shopping, movie theatres and food court, games, café, etc. all under the same roof.

Keywords: inclusive, differently abled, barrier free, access with dignity, wheelchair, universal access, shopping mall.

Introduction: The universe is a home for a diverse population. There are people of different age groups, gender, functional abilities etc. Universal design is the design of buildings, products or environment to make them accessible to all people regardless of age, disability or other factors. The term "universal design" was coined by the architect Ronald Mace to describe the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life(ii, 2013).

Census 2001 has revealed that over 21 million people in India as suffering from one or the other kind of disability. This is equivalent to 2.1% of the population. Among the total disabled in the country, 12.6 million are males and 9.3 million are females. Although the number of disabled is more in rural and urban areas. Such proportion of the disabled by sex in rural and urban areas. Such proportion has been reported between 57-58 per cent (iv) for males and 42-43 per cent females. The disability rate (number of disabled per 100,000 populations) for the country as whole works out to 2130. This is 2,369in the case of males and 1,874 in the case of females.

Among the five types of disabilities on which data has been collected, disability In seeing at 48.5% emerges as the top category. Others in sequence are: In movement (27.9%), Mental (10.3%), in speech (7.5%), and In hearing (5.8%). The disabled by sex follow a similar pattern except for that the proportion of disabled females is higher in the category in seeing and in hearing (iv)

The Universal Accessibility Act "(EqualOpportunities, Protection of Rights and Full Participation) Act, 1995 under Sections 44, 45 and 46 categorically provides for non-discrimination in transport, non-discrimination on the road and non-discrimination in built environment respectively. As per Section 46 of the PWD Act, the States are required to provide for –

1. Ramps in public buildings;
2. Adaptation of toilets for wheel chair users;
3. Braille symbols and auditory signals in elevators or lifts;
4. Ramps in hospitals, primary health centres and other medical care and rehabilitation institutions (i)

The Centre for Universal Design at North Carolina State University expounds the following principles:

1. Equitable use
2. Flexibility in use
3. Simple and intuitive
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use (iii, 2014)

Each principle above is succinctly defined and contains a few brief guidelines that can be applied to design processes in any realm: physical or digital.

These principles are broader than those of accessible design and barrier-free design.(iii, 2014)

Many buildings are constructed by taking these norms into consideration, but the real question is that are these buildings really accessible. A comparative study is conducted at 2 malls in Pune city, viz. Kumar Pacific Mall, Shankarsheth road and SGSMall, camp.

Material and Methodology:

Data Collection and Analysis:

Primary Data Collection: Primary data is collected through interviews and questionnaires of visitors in mall and observing the scenario.

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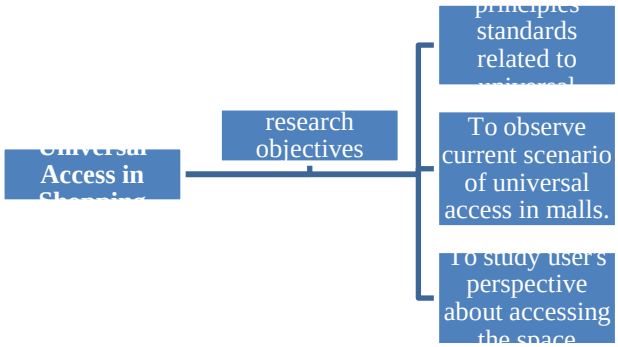
Secondary Data Collection: It is made by studying articles, research papers, journals, other sources related to the topic.



Data Collection and Analysis:

A comparative analysis is made on basis of 7 principles of universal design. The table shows whether the design principles were followed or not in the mall design. It is marked 'yes' if they were followed and 'no' if they weren't.

Design Principle	Kumar Pacific Mall	SGS Mall
Equitable use	**yes**	**yes**
Flexibility in use	**yes**	**yes**
Simple and intuitive	**yes**	**no**
Perceptible information	**yes**	**no**
Tolerance for error	**yes**	**no**
Low physical effort	**yes**	**no**
Size and space for approach	**yes**	**no**

Apart from this, observations were made on basis of accessibility with dignity, accessibility to the toilets and personal assistance services.

	Kumar Pacific mall	SGS Mall
Accessibility with dignity	yes	no
Accessibility to toilets	yes	no
Personal assistance	yes	no

People's perspective:

Kumar Pacific Mall: It was found that the mall was accessible with ease and dignity to babies, adults, youngsters, senior citizens and wheelchair users from road side through ramps as well as basement from lifts.

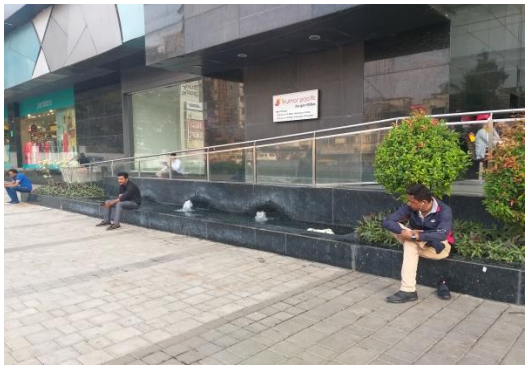


Figure 1: separate toilets for wheelchair users on every floor

Figure 2: ramp at front/roadside entrance.

Figure 3: wheelchair and baby strollers' service provided by the mall.

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SGS Mall: The mall was not accessible to wheelchair users and baby strollers from road side as there is no ramp provided for the same though they are accessible from basements via lifts.

Figure 4: no ramp provided at the entrance

Limitations: Only physically variable people are considered for the study and emotional or mental well-being of the user is not taken into account.

Results: Kumar Pacific Mall created an inclusive environment for all kinds of people. SGS mall had barriers for accessing the mall.

Figure 5: a scene from Kumar pacific mall of a wheelchair user

Conclusion: It was found that it is very necessary to provide barrier free access to all kinds of people. It is very important that these accesses should be with dignity and ease. The design should be in a way that makes sure that no user is hurt physically or emotionally due to inaccessibility.

Acknowledgement: The research is guided by respected Principal, Dr. Rajendra Koli, APCOA, Pune and Faculty guides are Ar.ShilpaIngawale and Ar. Shailaja Bhagwat, APCOA, Pune.

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Enhancement of Roundabouts in Nashik city

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Abstract: The research paper focuses on enhancement and design strategies of roundabouts in Nashi City. Nashik has number of circles to which three to five lanes are connected. They are designed to reduce the vehicular conflict points. This paper also includes evolution of roundabouts and impact to the city. Also planning and design strategies of roundabouts are studied in this research paper. Planning of roundabouts, location, size and shape, and landscaping these factors are studied w.r.t the city. The primary data is collected on the basis of case studies done in Nashik city. Planning of the city is studied to see the location of intersection points where roundabouts are planned. These in intersection and circulation are analyzed w.r.t flow of vehicles during afternoon and evening. Secondary data collected was from literature and books. At each point of roundabout observation and analysis is done and proposal of enhancing the poorly performing roundabouts is given.

Keywords: **roundabout, vehicular flow, lanes, Nashik city, enhancement, circulation, etc.**

Introduction: A road junction at which traffic moves in one direction round a central island to reach one of the roads converging on it is called Roundabout. Now-a-days roundabouts have been an important aspect of cities as the number of vehicles has boosted and at the same time raised to conflict at intersection points. These roundabouts are spreading all over to reduce the conflicts at intersection points. It also gives beautification to the city with minimum maintenance cost. There are numerous roundabouts in Nashik city, which connects three to five lanes at a point, creating a smooth and zero conflict points at a junction. Generally roundabouts are classified in three basic categories according to the size and number of lanes: traffic roundabout, single lane roundabouts and multilane roundabouts (3 to 8 lanes). Nashik has three to five connected to a single roundabout as shown in figure below (fig 1.1) .

Author 'Mo Zhou, Lili Yang, Hoong Chor Chin in article- The Evaluation an Improvement of roundabouts in Changchun' has defined that roundabouts are often designed to connect the main road because of their ability to reduce conflict points and making them safer than other intersections. The author in this article has shown the process to evaluate and improve roundabouts using microscopic simulations to model roundabout. After studying the above mentioned article and the roundabouts in Nashik city , poorly performing roundabouts are proposed for enhancement. This article evaluates all roundabouts in Nashik with the aim to understand its enhancement and performance.

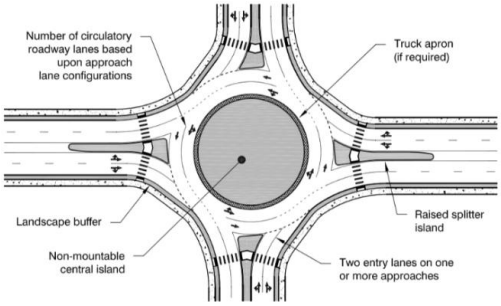

Fig 1.1 Features of two lane roundabouts

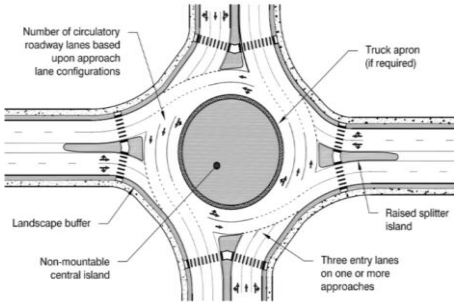

Fig 1.2 Terminologies of Roundabout

Background: Roundabouts were mainly rooted from United States. The basic shape was done all the way back from 1790s, when architect and engineer Pierre L'Enfant proposed a number of circular intersections in Washington, D.C. Columbus Circle, was widely considered to be to country's first circular intersection designed for automobile era. It was revived by American businessman William Eno from 1905 for New York city. Before the roundabout circular junctions already existed including the Circus in the city of Bath, Somerset, England, completed in 1768, part of a world heritage site. Like modern roundabouts, these junctures feature one-way traffic moving around a central hub and connecting roads branching out like spokes on a wagon wheel. But the central circle is much larger, and connecting roads enter at abrupt right angles, requiring drivers to significantly slow or stop before entering the intersection. They're what engineers call traffic circles. In the 1930s American road departments began

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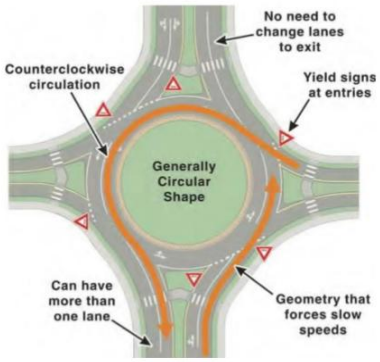
building rotaries, the next step in roundabout evolution. In the United States modern roundabouts emerged in the 1990s. Municipalities introducing new roundabouts often are met with some degree of public resistance, just as in the United Kingdom in the 1960s. As of December 2015 there are about 4800 of these modern roundabouts in the United States. As an example, Washington State contains about 120 roundabouts as of October 2016, all having been built since 1997 with more planned. In beginning of 21st century roundabouts were in widespread use in Europe, France had more than 30,000 roundabouts where as there are more than 10, 000 roundabouts in



United Kingdom.

Planning and design strategies of roundabouts: A roundabout or a rotary junction consist of a central island surrounded by the roads forming a junction as shown in figure below. The shape of central traffic island is elliptical. But it can also be made circular or rhombus diamond shape. The provision of a roundabout junction introduce uni-directional (clockwise direction) circular movement at the intersection. Some planned and classified roundabouts example are taken from a "roundabouts and informational guide" are as follows -

Wisconsin Rapid, Wisconsin

Bend, Oregon

Material and Methodology: The study done for this research is a qualitative and case study based. In which Primay data collection of 13 roundabouts in Nashik City is done. Depending on factors of planning of roundabout, its location, size and shape, Landscaping and planning of city w.r.t roads and lanes observation and analysis are noted. Traffic survey were conducted at intersection points by manual methods. Secondary data is collected to study Panning and design stratergies of roundabouts.With the help of analytical drawings and photographs analysis and conclusion are noted.

Literature: Due to increase in population and number of vehicles major conflicts are seen at the intersection points of lanes. To reduce these conflicts many cities have aopted planing of roundabouts and now needed to be enhancd because of the vehicular flow and increase in conflicts.Rounadbouts in Nashik city are planned but they need to get more enhanced as number of vehicles are increasing day by day. To explore more and clarify the topic 3 relevant other research papers were studied.

1. Evaluation and improvement of roundabout in changchun – This research paper gives a detailed information about the roundabouts in changchun, china. Literature says, that roundabouts are often designed to connect the main road because of their ability to reduce conflict points in making them safer than other intersections. This article

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also satates that roundabouts can also beautify the city whn central island are landscaped. In this researchh paper author has studied typical roundabouts in Changchun, china and their performance and based on this enhancement is proposed. This areticle uses V/C ratio and microstimulatio of roundabout is studied. At last Author ahs concluded the paper showing the process to evaluate and improve roundabouts. The use of microscopic stimulations to model roundabout ia an efficient way to experiment with different improvement strategies.

2. Performance evaluation of roundabout considering traffic conflicts – This research paper talks about the performance evaluation of roundabouts considering Traffic conflicts. A methodology for the performance evaluation of at- grade junctions is proposed. Paper also states the reasons why roundabouts have been positively implemented in several developed countries recently.The study focuses on the gap acceptance maneuver at at-grade junctions, assuming delay and conflict as disutilities. Author concluded the research paper by saying it is necessary to examine the pedestrian volumes to which the introduction of roundabouts is appropriate. Moreover, the influence of the geometric structure of roundabouts to capacity and safety should also be investigated.

From the above research paper studies, importance of roundabouts its need its impact on surrounding area is seen. Also while studing these papers how roundabouts decreases the rush of vehicular flow is seen.

Case Studies and its Observations: There are many roundabouts in Nashik city amongst which 13 roundabouts are been studied as live case study. Amongst these 13 cases there are some roundabouts to which enhancement is needed. To study these first Nashik city planning was studied, where intersection points are seen. And impact of roundabout is studied at the particular intersetion point. 3 roundabouts in Nashik are larger in diameter having multi lanes connected – Maylan Circle , Sarada Circle and Dwarka Circle. These roundabouts are well enhanced and maintained. Other small roundabouts seen in the city are not so enhance aesthetically and are quit poor performing – Vidya vikas circle, Jehan circle, Prasad circle, R.K. circle, Shahid Chowk.

1 Shahid Chowk Circle – Well beautified circle is about 6 m diameter, which is connected with 6 lanes having heavy vehicular flow during evening. This circle has some conflict points at point of intersection which should be enhanced.

Mahatma Nagar Circle – This circle is connecting roads from college road, Mahatma Nagar and Gangapur road. The circle is about 8m diameter, around which heavy vehicular flow is seen during 12:00 pm. As this circle has a lots of space around there was no conflict points were seen. Each turn had a footpath for pedestrians which reduces conflicts of vehicle and a walking person. This circle became a center area for all three lanes connected to it and a landmark too. It should be beautified for better impact on surrounding.

2 Prasad Circle – This circle is also well beautified with diameter of 6 m again. This circle is also connected to total 6 lanes 2 of 12 m wide two ways service road and other two are 6 m wide two ways lanes. The intersection points are to be enhanced same as Shahid Chowk Circle.

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Shahid Chowk circle, Prasad Circle, Sakal circle, Vidya vikas Circle are all in a single stretch which has similar issues and same vehicular flow along the road. Oher roundabouts Maylan circle, Sarad Circle, Dwarka circle are very well beautified and maintained cicles in Nashik having traffic signals for control of vehicular flow and zero conflict with smooth movement of vehicles seen there.

Analysis and conclusion – According to the above study, ita is seen that some roundabouts in Nashik are well developed in aesthetic as well as in planning fcator. Some roundabouts are to be improved as the vehicular flow has increased and conlficts can be seen around roundabouts aswell. Two three person around were questioned- what issues they face while driving around (poorly performing roundabouts) ? solution got was to place tarffic signals at each lane connecting to the roundabout so that the vehicular

3 Sakal Circle – This is a circle with 4 m diameter which is connected with 6 lanes same as prasad circle.

4 Vidya Vikas Circle – 6m diameter circle with 8 lanes intersecting at a point. They are two way lanes, double lane roundabout, with 6 m wide roads.

5 Ravivar Karanja – this roundabout is beautiful landmark of Ravivar Karanja area. It goes through many different type if vehicles heavy vehicles, buses, two wheelers, auto, 4 wheelers, cycles etc. this area is jammed with traffic as many hawkers sit around the roundabout which leads to less space for vehicular moment and raise to conflicts.

flow from each lane becomes smooth and zero conflict is seen. Also the roundabouts must be aesthetically enhanced and beautify the surrounded area.

Acknowledgement-The author wishes to thank to subject faculty Ar. Pranoti Lad, Ar. Shreyas Paranjape and Ar. Lily Roy for giving this opportunity and their valuable

guidance, inspiration and encouragement throughout the semester.

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Temporary Structures creating Permanent Bonds : Architectural Impermanence in the City of Pune

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Abstract: This is a new interpretation of spaces which are temporary in nature among a dense urban fabric. Khadda vegetable market-Camp and Sawai Gandharv Utsav-Mukundnagar, are captured in terms of their processes, routines and unique features of operations. The process shows that the establishments, though they are ephemeral; have a relationship with the locality, the physical elements and the people. They touch the ground lightly, are economical and also sustainable in terms of its methods of construction and materiality. The study throws light on the importance and need of such open spaces and encouragement of temporary structures in cities.

Key words – temporary structures, open spaces, temporal changes, space optimization, reusing materials

INTRODUCTION

Cities are growing faster than ever today. Each new day land is taken up, utilized for some or another need and is filled up with the heavy built masses. In India, considering the population, land is used for kinds of activities ranging from the very basic needs of food and shelter to the spaces of leisure. But there is this one peculiar aspect also present in the Indian Culture. It is the art of building temporary structures for a specific need or a social gathering in a community. It is the art of using and reusing something to its fullest potential. Throughout time it is been associated to the less fortunate people but maybe they can be looked now as the future of construction technology.

In cities such as Pune, there is always a need for spaces to cater a certain gathering /function/ritual etc. During this process permanent solutions are made without giving a thought whether if the need for which something is being built may still prevail in the future? Shopping malls, stadiums are some of the examples which come up in a city infrastructure citing need of the society. But once the purpose is served or if something new comes up in the vicinity this infrastructure is left defunct and becomes just a dead load on the society with no fruitful returns.This provokes a thought whether if these solutions should have a certain amount of resilience to them? Cities should optimize each and every space and rather spaces should be used which may in turn could be given back to the city after its use.

Temporary structures may be the answer to this problem. They touch the ground lightly, cater to the everchanging needs and vanish once the purpose is served. This form of structures, formally or informally, have been a part of our traditions for a long time and it is rooted within our people; the idea of using something for/on multiple occasions. They may not come under the architectural terms but rather in terms of spaces and patterns of occupation. Thus, there is a dialogue formed between the temporary establishments and the people. E.g.: A mother goes to the same vegetable vendor every day in her vicinity. The vendor may not have particularly a shop, but operates through a temporary setup. This setup serves to both the stakeholders and just vanishes at the end of the day. The wedding pandols, festival decorations, hawkers sand street vendors, all create a dynamic streetscape which in turn starts giving a character to the city. Hence the question arises if whether permanent solutions are necessary for temporary problems?

LITERATURE REVIEW

The figure 1 below represents the transformation of Manek Chowk in Ahmedabad, India on a single day from the morning till evening. Manek Chowk is one of prime examples of a dynamic public space at a heart of the city. Manek Chowk transforms from a parking lot in the wee hours of the day with some street hawkers to a hustling bustling *'khau-galli'* or food street by the night. The cycle lasts for a day and thus this repeats itself every day. This is being done for over many years and even if it is seen as a very informal type of a setting; it is seen that a very complex level of planning and handling of situations is done to create a conducive setting for people to reside and eat. It is seen that people have attached to this locale and it is not just a commercial space but an entity with many different relationships.

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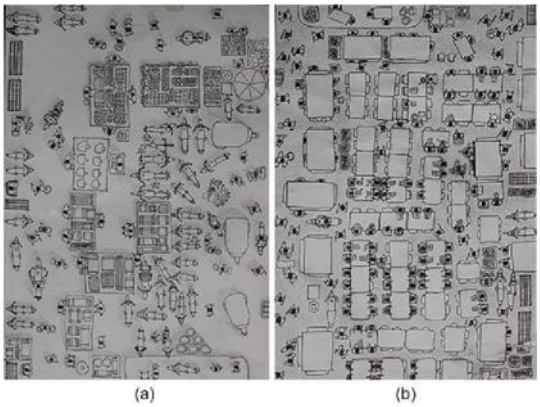

Figure 1: Drawings showing two setups of the Manek Chowk (i)

This one single piece of land acts as a parking space for the customers in the morning when the markets are open. During the night-time, when the shops are closed, hawkers literally set-up a hotel for the people.Thus 'Multi-use' is seen at a very direct level in terms of place-making and social engagement. Though this space vanishes by the end of the day, the identity or the image it has is so strong that it is the major attractions for the people in the city of Ahmedabad even in front of the other built compatriots Ahmedabad has to offer.

Something similar also takes place at the Goa 'tiatr' performances(Vaz, 2013). These are basically a traditional way of performance dramas to give a strong social and political message. It doesn't happen at the urban level anymore but it is still active at the rural level. An open ground is chosen in the village either near a chapel or a landmark and according to the availability either a stage only or a whole semi-open structure is set-up. A temporary auditorium to put it in perspective. As the main motive is to create a politically/socially connected environment, the space is built in a very simplified and a humane way so that the informality stays and there is a dialogue between the community due to this gathering. Thus, there is a bond which is there and also the function of a performance space is also catered with the help of a temporary structure. A formal auditorium, with heavy volumes and a strong built character, may provide amenities and comfort but this study shows that the informality and lightness of the structure helps to bring the people together unlike the formal divide which happens in a auditorium; a spectator and an entertainer. The two cases which we have seen right now are almost for a scale for 500-2500 people. But temporary structures cater to a lot more.

Figure 2: Satellite images showing the Ganges plains before and during Kumbh Mela setup

Kumbha-mela, it is the largest public congregation in the world. It is an event that is celebrated every 3 years and 4 different locations and every 12 years in Allahabad (Purna Kumbh Mela). The 2019 edition happened in Allahabad. This happens over six months of time (3 months for setting up the makeshift city and 3 months of the actual festival) and on an expanse of over 32 sq.km. Refer to the aerial image above to understand the scale of this mega-event. It is been termed as the *ephemeral megacity* by Rahul Mehrotra(Rahul Mehrotra, 2019)
. This example celebrates expansion and reversibility in the most pragmatic and sustainable manner in a dense urban situation. The whole city is set-up only for this one purpose when the Ganges river recedes after monsoon and after the Mela (festival) is completed each and every thing is easily dismantled; most of the material is recycled or either reintroduce them into the regional economy. The materials used are bamboo, jute, steel columns, aluminium sheets for roof covering and a skin to enclose the structure. All other infra-structure is shifted and put to use somewhere in the state. The purpose is served and also no harm done to the environment, no wastage of resources too. The river bank is offered back the same way it was. This isthe beauty of this temporary mega city and its characteristics. The cycle of materials and the way the land is, as if it is untouched; it is so important for us to look at this example and imply those similar principles to our cities all over the country.

A city consists of 2 parts; the Static City and the Kinetic City(Mehrotra, Kinetic City, 2019). A static is everything that is the built. The permanent and formal parts of a city regulated by the governments etc. On the other hand, the kinetic city is the temporary city. The one which reinvents and modifies itself and it is always in motion. The Kinetic city, *bazaar* like in form, can be seen as the symbolic image emerging from the Indian urban conditions. It can rather help in understanding spatial limits and how to optimize built form in the dense urban fabrics. Mumbai is

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a Kinetic City. It is a fast-moving city and the spaces there too, shift their uses at a higher rate. It doesn't have to be a specific location or a demarcated boundary but it rather transcends to the idea of space-making, to the idea of one's needs, one's requirements for a particular time being or maybe a certain community's aspirations which in turn lead up to an occasion which makes the City a Kinetic city.

RESEARCH METHOD AND METHODOLOGY

The study investigates the idea of temporariness of a structure in terms of its materiality and spatial organization. It also studies the impact of the structure on the land it is been situated. The relationship between the space and the public engagement is also looked upon and commented. 2 live case studies are done in detail; an informal and a formal type of setting is chosen to understand various aspects w.r.t to scale, public engagement, function, economy, etc. The temporal changes here are studied for a course of one whole day and one month respectively. These findings are viewed through a critical lens w.r.t its impact on the land and the people. These are documented majorly as visual components with the help of photographs. Also, quantifiable data is presented with the help of infographics.

Figure 3: Use of the space during different timings (Courtesy: Author)

DOCUMENTATION AND DISCUSSION

The first example looked upon here is the Khadda vegetable Market in Camp, Pune. As the name suggests this market is setup in in a Khadda i.e. a depression along the main road. Around 75-90 vendors setup their stores every morning in this place and stay there till the evening.

The first half here shows the condition at 12:00pm on a regular day and the second half is that of at 6:00pm in the evening. It can be clearly seen that the dense market which was setup is dismantled and vanished once the day's business is over. Each hawker only 2 materials to

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setup his stall, sometimes 3; uses 'vasa' or a bamboo support, a 'tadpatri' or the skin acting as the roof and 'dori' or jute strings to tie up the structure. The same material and same setup are done the following day. Hence no new need of resources, one-time investment and reusing it for a number of times. There is no harm done here to the land, no carbon footprint generated, no wastage, in its own sense it is an economic and a sustainable model. The space in the evening gets back to the community where children play, women gather around and also acts as some amount of parking. People in the vicinity by their groceries from here itself on a daily basis. And that level of engagement is also there even if there may be a point where the shops doesn't even exist. This the permanent bond with the temporary structure of a place. And even though the whole system is light weight it runs all year round and in all seasons. Certain additions maybe done during severe conditions but the level of engagement it has is always maintained in the community.

The second study taken here is of the Sawai Gandharv Music Festival which happens in December every year at the Maharashtra Mandal Ground, Pune. It is one of a kind classical music festival with aficionados coming from all across the country. This a very formal structure and is a state sponsored enterprise. It spreads on about 75000 sq. Ft. or a whole football pitch for comparison. It is a one whole performance area which is setup and can cater to almost 15000 people seating at a time.

Figure 4: Timeline showing Construction of the Pandol (Courtesy: Author)

Predominantly, the whole structure is setup using only 6 of the materials;

1)Bamboo 'Vasa'- The supports
2) Steel stanchions
3) Trusses for spanning members
4)Aluminium sheet for roof
5) Cloth- as a skin covering

Jute 'Dori' is used to tie the members to each other. This the basic palette used by the contractor for erecting this megastructure. Skilled labour is not required and hence daily wage labours also contribute to this. The cost of setting the structure up is around 35-45 Rs. Sq. ft. which is way less compared to the general 1200 Rs. Sq. ft of a RCC structure.

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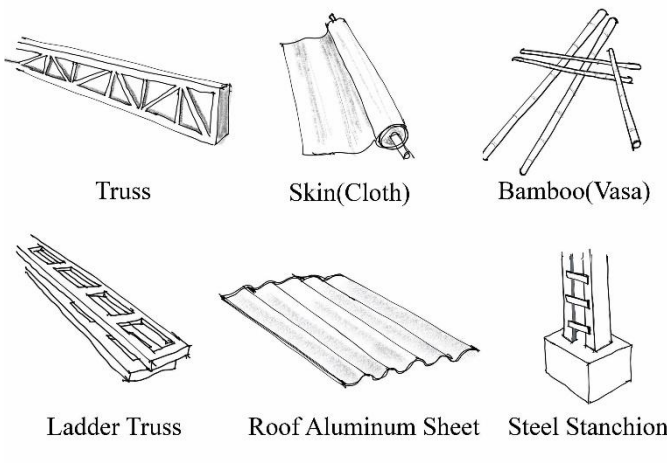

Figure 5: Basic set of materials used for construction

It is the same technique used for so many years, assembling and dismantling. A months' time is taken to setup the pandol, after which the festival happens over a week and then the dismantling process takes a week. All of the material used is stored in a shed or taken to different site to be used for a different function. Though design parameters wise it may not be the best-in-class in terms of its services or aesthetics; but rather this quality of informality helps the user engage more with the performer and in the end gives them a better experience. The ground is given back as the football field it originally is for the community to use. No wastage of materials as well as land resources happens. No embodied energy whatsoever as there is no need of building anything new. All the stakeholders are satisfied as well as the Nature itself.

CONCLUSION

Temporary structures are need of the hour and so are the open spaces in a dense urban city. The above examples have shown that these traditional systems are in fact more sustainable, economical and also do not harm the environment. These methods can be adopted by us for future needs as well as the technological advancement today can further strengthen this idea of temporary construction.

ACKNOWLEDGEMENTS

I would like to express my deep sense of gratitude to Ankush Navre (Contractor for Sawai Gandharv Festival) for giving me information about the whole process of construction. I would also like to thank my guide Ar. Aarthi Chandrasekar for her valuable guidance, inspiration and encouragement throughout.

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Analysis of Fractal Geometry in Dravidian Temples

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ABSTRACT : Architectural composition is progression from large spaces to intimate details. Fractal geometry is the formal study of such progression of self-similar detail and serves as framework to broaden the perspective and understanding of art and architecture. The case in study for this research is Indian Dravidian temples. Dravidian style temples originated in the Pallava Dynasty who ruled the present-day Tamil Nadu. In Dravidian temple architecture the existence of self-similarity has been observed and fractal geometry is seen to play an important part in understanding the structure and composition of these temples. Fractal analysis of these temples will help understand the deep relation between geometry and the temple architecture. This research paper aims to study Dravidian temples and the significance of fractals in the field of architecture. It also corelates and analyzes the Dravidian temple architecture through fractal geometry with respect to the fractal sets it is composed of. It aims to understand the benefits of using fractals and draw inferences based on the comparative analysis. In conclusion the paper also suggests some design implementations of fractal geometry in present day life which incorporate the environmental and aesthetical aspects in the design.

Keywords: Fractal geometry, Dravidian temples, Fractal design, Design principles, Fractal analysis, Design architecture

1.0 INTRODUCTION

1.1ORIGIN

The presence of fractal principles in nature, art and architecture has been a phenomenon in all times and it is not restricted to the period after the mathematical understanding and analysis of fractals.

The term 'fractal' was created by Benoit Mandelbrot in 1975 to describe the geometry of fragmented forms of nature that were perceived as amorphous such as clouds, trees, etc and were not easily represented in Euclidean geometry. He coined the term fractal set to collect together examples of mathematical ideas and apply it to natural phenomena like clouds, coastline, branching of blood vessels, etc.

The origin of the word is from the Latin term 'fractus' which means broken or fractured. Fractals are self-similar patterns composed of the same sets in different scales. Fragmentation of these sets tends to recur identically at different scales.

Fractals can be found everywhere from natural rough lines to clouds, plants, art forms and also in architecture. There are many types of fractals like natural fractals, abstract fractals and geometric fractals based on their formation and shapes (as shown in figures a).

Figure a. Nature Fractals, Abstract Fractals, Geometric Fractals

Fractal geometry has been applied in architecture widely in ancient times**.** Fractal principles are also observed in the traditional arts and crafts, in the ancient civilizations, gothic structures and temple architecture of India.

1.2 HISTORY

Construction of temple architecture started in Southern India in the early 2nd A.D. century during the Pallava rule. The architecture of these temples was inspired from the Buddhist architecture. This type of temple architecture was named the Dravidian architecture and originally took root in Tamil Nadu. The state was subject to rule of four great dynasties: Cholas, Cheras, Pandyas and Pallavas and all these dynasties greatly influenced the temple architecture of the state. These evolved from simple rock cut temples to complex townships and temple cities.

The Pallava dynasty was an Indian dynasty that existed from 275 CE to 897 CE, ruling a portion of southern India. The first stone and mortar Dravidian temples were constructed during this period and were based on the brick and timber prototypes. Some of the best examples of architecture are: Kailasanathar Temple, The Shore Temple and the PanchaRathas of Mammalapuram present day Mahabalipuram.

The Pandya Dynasty, also known as the Pandyas of Madurai, was a dynasty of south India. They contributed immensely in the field of architecture. Gopuras, Prakaras, Vimanas, Garbagrahas (as shown in figure) are the special features of the Pandya temple architecture. Some examples of Pandyan architecture: Madurai Temple, Srirangam.

The Cholas were another dynasty of South India. They were prolific temple builders. They built the largest and tallest of all the Indian temples of their time. They promoted construction of a large number of temples that were spread over most of Chola Empire. Brihadisvara temple located in Thanjavur is one of the greatest architectural marvels in this era.

Analysis of Dravidian temples elaborates on the uses of fractals in the following ways:

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- Repetition of shapes in the planning of temples.
- Repetition of geometrical towers
- Mirror images of similar geometrical towers at various levels and different scales.

Repeating these distinct elements in different scales gives a sense of infinity and an illusion of an object as a whole. Fractals give a sense of universal appeal and a virtually satisfying sense of scale. This research aims at studying fractals and Dravidian temples individually and analyzing the relation between them and understanding the advantages of fractals and using the principles of fractals in present day scenarios to increase high performing structures which incorporate psychological environmental as well as aesthetical aspects in the design of a structure.

2.0 Methodology

This research paper aims to understand about concept about fractals and their usage in the architecture. Also aims in using quantitative and qualitative methods to analyze the fractal geometry in Dravidian temples. Fractal analysis of Dravidian temples helps in finding out the techniques and methods which were used for implementing fractals in these temples. And also understanding the benefits of fractals and how it can be implemented in present day structures to gain the utmost advantages of the fractals.

3.0 Relation between Dravidian Temples and Fractal Geometry

Ancient Indian architects were very skillful in geometry and they used this knowledge to derive many conclusions. It was realized that the concept of progression could be applied in real life and the outcome of this progression was aesthetically beautiful structures. This progression later came to be known as the fractal geometry. Fractals when used in architecture acts as mode of expression to reveal the beauty in complexity. Early Indian architects followed these principles in their temples and the results can be seen in the case studies discussed below.

3.1 Case studies:

3.1.1. Pallava dynasty:

Pallava architecture represented an early stage of Dravidian architecture. The first stone and mortar temples were constructed during this period and based on brick and timber prototypes. The Pallava architecture shows the transition from the rock cut temples to the stone built temples. The monolithic temples gave way to structural temples like the Shore temple in Mammalapuram. Shore Temple is granite made temple at Mahabalipuram built during this period. This group of temples is a UNESCO World Heritage Site and is one of oldest structural temple in India.

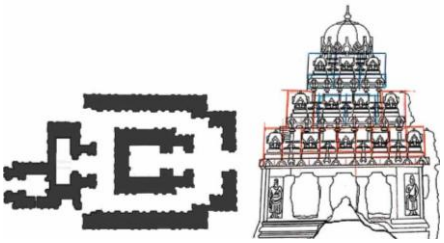

Figure b. Plan and Elevation of the Shore

3.1.2. Pandya dynasty:

The period of the Pandya rulers saw the development of elegant Vimanas, Gopurams and Shikharas in the temples. Pallavas used bricks as the main material for their construction of temples.

Meenakshi Amman Temple, also known as Minakshi-Sundareshwara Temple, is one of the oldest and most important temples in India. Located in the city of Madurai, the temple has a great mythological and historical significance.

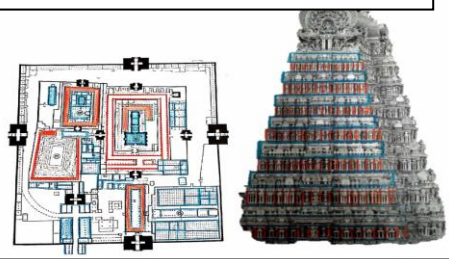

Figure c. Plan and Elevation of the Madurai Temple

3.1.3. Chola dynasty:

The Chola kings built many temples throughout their kingdoms. These Chola temples reveal the gradual evolution of the Chola art and architecture. They earlier built brick temples and later moved on to build stone temples.

The greatest landmark in the history of South Indian architecture is Brihadeshwara temple at Thanjore. It has a great architectural significance. This is the largest and tallest temple in Tamil Nadu.

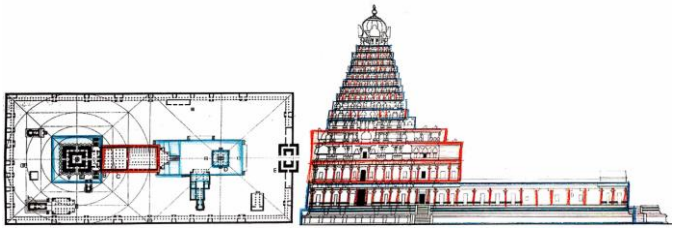

Figure d. Plan and Elevation of the

3.2 Analysis:

The geometry of the plan starts with a line forming an angle and then evolving into a triangle. Then triangles then combine to a form a square and distinctly into a circle thus deriving the complex forms (as shown in figure e). This

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results in self-similarity and further leads to the occurrence of fractal geometry. The fractal geometry gives a feeling of spaciousness because it helps optimizes space without increasing the dimensions.

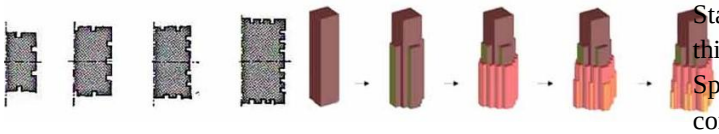

Figure e. Progression of the shapes, forms in the Plan and Elevation

Considering the visual language of the elevation of the temple, the gradual progression starting from the base to the top of the temple is seen prominently. The elements have been repeated in different scales forming a pyramid like structure (as shown in figure m). The elevations of these temples give off a character of harmony and rhythm leading to the aesthetical beauty which is due to the proportional relationship of the geometry of the elements and forms.

Fractal geometry was so vastly used in the temples as they brought a sense of completeness to the structure. It generates an identity of elements and forms and brings strength structurally and visually. It brings modularity in the structure which saves time and resources and offers ease of construction. The geometries used help create aesthetically enthralling elevations and build timeless structures.

4.0 Implementations of Fractal Geometry

Fractal geometry is a design process which can be used in different ways to build aesthetically beautiful structures which give a sense of completeness and adopts most of the design principles like harmony, rhythm, balance and shows movement in these structures (as shown in figure f,g).

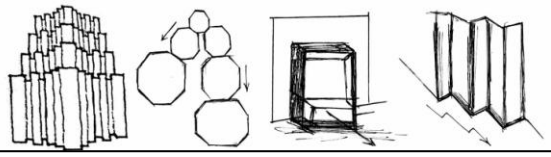

Figure f. Progressive Multiplication, Expanding Repetition, Projection, Staggering

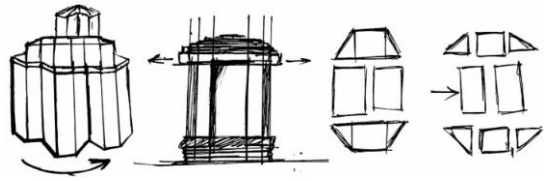

Figure g. Gyration, Bursting of boundaries, Splitting

Progressive Multiplication: The elements or forms are multiplied in progression in either in the vertical direction or the horizontal direction.

Expanding Repetition: Using the same element, shape or form and repeating it in different scales.

Projection: Projecting out the elements or forms from the surface of the structure typically above ground level.

Staggering: The elements and forms are staggered; usually this helps in showing movement.

Splitting: Splitting up of elements and forms into smaller components and repeating them.

Bursting of boundaries: The elements are projecting out of the outer boundaries of the structure.

Gyration: Rotating the forms and elements in different directions and repeating them.

These are some ways in which fractal geometry can be implemented in the structures. One important aspect of fractal geometry is the use of hierarchical scales, without the use of scales it will create a disconnection from the environment. Balance and harmony can be achieved through proper composition of the elements. There are certain rules of proportion and geometry which helps the structures look as one with the environment. The basic concept of fractal geometry is to create complex structures using simple forms and shapes.

5.0 Examples:

A) Palmer House, F L Wright

Palmer House is designed by Architect F L Wright. In fractal architecture, usually one module is considered as the main element. In this house, equilateral triangle is considered as the main conceptual building block and the whole planning and elevations are based on this block.

In the planning of the house, the equilateral triangle is repeated in the floor plan in at least 7 different scales. Progressive multiplication and staggering of triangles can be seen in the planning.

The elevations and the roofs of the house have interesting use of triangular forms. The triangular building block is rotated, expanded and projected out.

Palmer House is a very great example of using fractals in architecture. The house is very aesthetically beautiful and very unique due the use of triangular blocks and fractals (as shown in figure h).

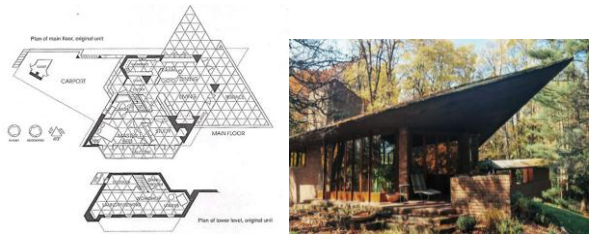

Figure h. Plan and Elevation of Palmer House

B) Habitat 67, Moshe Safdie

Habitat 67 is designed by Architect Moshe Safdie. In this residential complex, the building block is a simple square

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block where two building blocks are combined to build an L-shaped blocks. The L-shaped building blocks are a module and then the modules are placed one above the other. The modules are rotated and progressively multiplied to give the whole residential complex a unique balanced composition and in sync with the environment. This can be seen in the elevations and as well as in the plans of the complex (as shown in figure i). The modules when used here give ease of construction and saving of the resources.

Figure i. Elevation of Habitat 67

The above studies show that fractal geometry can be implemented in the present day strutures too using the fractal techniques and principles.

6.0 Conclusion

Fractals have always present in the nature and the surroundings. Fractal geometry when used in architecture can help the architects build complex structures using simple elements, shapes and forms. From ancient times, fractals were used in various architectural structures and Dravidian temples is one such example.

Various techniques of fractal geometry were used in the Dravidian temples to make the structures more appealing, have a balanced composition and be structurally strong. The use of fractals made the construction of these temples easier and also saved on a lot of resources.

Fractal geometry contributes to a progressive transformation of the building and optimization of spaces. Also using fractals helps avoid monotony and dynamic facades with visual balance can be created. Architects can build organic and complex structures which fit harmoniously in the natural environment and interact with it. This increases the efficiency of the structures built using the fractal principles.

This is seen in the modern day examples which use the fractal geometry and its modularity to build structures which are aesthetically beautiful, very efficient and high optimization of spaces. The fundamental concepts and properties of fractal geometry is very essential to architecture design and its implementations in the structures will strengthen the building visually and structurally.

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v. *ALIK Belma :Fractals and Fractal Design in Architecture pg.no 2-10*

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Safety of Women on Urban Streets: Case Study of Aundh, Pune

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Abstract: Women safety has always been an issue of concern in India. From 2000-2012, the crime against women has gone up by 200% thus making India a global leader in crime against women. The research focuses on making urban streets safer for commute of women and aims at identifying parameters for street design that impact the perception of safety for women on streets of Pune. The research is a comparative study based on observations made on 3 streets emerging from Bremen chouk.i.e. Spicer CLG Road, Aundh Road, New DP Road in Aundh, Pune. These case studies are analyzed on the basis of 4 factors that are light, distance, activity and functional zoning and sets parameters of consideration for future street design to make the city a safer space for all its citizens.

Key words – Women Safety, Safe Street Design, Safe Commute, Smart Urbanization, Safety, Streets in Pune, Eyes on street.

INTRODUCTION

As the cities are growing bigger and undergoing an urban boom, safety and security of its residents needs to be taken care of. With ever growing boundaries and expanses of cities, the residents are exposed to newer, unfamiliar areas and surroundings. This may lead to people being exposed to unsafe circumstances. In the past couple of decades, the issue of women safety has been observed more prominently. This research looks into the design aspects of safety. However, the culture and perception of people play a an equally important role when it comes to safety. While the design parameters will ensure factors of space making, the context may nullify the expected results at times. This research intends to study an urban problem and come up with design strategies to solve this probing issue of women safety.

LITERATURE REVIEW

Women safety has always been an issue of concern in India. From 2000-2012, the crime against women has gone up by 200% thus making India a global leader in crime against women. "*Previous research and literature show that Women particularly feel unsafe in public spaces and single women feel threatened in almost every context* "(Nag, 2016). Stanley (et al. (2012) found that "*The form and function of public space vary based on particular cultural arrangements, but still having similar features. It needs to be inviting, lively, attractive and comfortable*." Bright lighting, presence of police and presence of several shops and establishments along streets would enhance their perception of safety. (Jehangir Bharucha and Rita Khatri, 2018). Streets as public space are populated area; therefore, they should be designed with safety aspect in mind. Findings showed that majority of respondent (70%) agreed that physical elements in the area affect safety perception among women. These elements were visibility, land use mix, lighting, accessibility, orientation, signage and presence of vibrant activities. (Suhaila Abdul Rashid, Mohammad Hussaini Wahab, & Wan Nurul Mardiah Wan Mohd., Rani, 2017). Safety planning and design also involves more than just the concrete, physical features of a space, although interventions at this level may occur first in safe cities for women programmed (Zarabi, 2013, 47). Hence, 'Empowerment' refers to movement where Women's rights to public spaces, as citizens equal to men, must be protected—if India's cities are to truly shine. (Meher Soni, 2016).

All of the above research shows that factor affecting perception of safety have been studied, ways in which these parameters can be integrated into street design principles is missing. The above research brings into picture the 4 affecting parameters of study chosen for this paper.

METHODOLOGY

The cultural context and character of any street cannot be generalized. A detailed study of the city needs to be done to derive the affecting parameters and streets should be designed accordingly. Hence, the question of women safety on streets of Pune is a topic of concern. The question has been further subdivided to understand parameters of design that enforce safety on streets with the following factors: Light, Distance, Activity, Functional zoning. The scope of research has been narrowed down through 3 case studies observed in Aundh, Pune. These case studies emerge from one chouk however have varied characteristics. The research is a comparative study based on observations made on 3 streets emerging from Bremen chouk .i.e. Spicer CLG Road, Aundh Road, New DP Road in Aundh, Pune. It is a qualitative study. The study is justified and analyzed through surveys and interviews that will give quantified terms for analysis. A sample size of 50

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Case Study Understanding

women who use the street has been selected. The age group of the sample size ranges from 20-50 years of age. Economically, the sample size belongs to the middle- or higher-income group.

3 streets originating from Bremen chouk with different characters and typologies have been selected. They are as follows:

STREET 1: NEW DP ROAD- This road falls between Bremen chouk and Parihar Chouk. It is a 1km long stretch. The street has retail shops on structures adjacent to the walkway with housing on top floors.

STREET 2: AUNDH UNIVERSITY ROAD- This 3km long stretch lies between Bremen chouk and university junction. The Adjacent plots belong to various institutions. The structural density is very low and has heavy forestation on both sides the street.

STREET 3: SPICER COLLEGE ROAD- This stretch ranges from Bremen chouk to khadki station road. This is a 3km stretch. The initial part has institutional plots with heavy forestation and the second half has ground floor retail shops with housing on top.

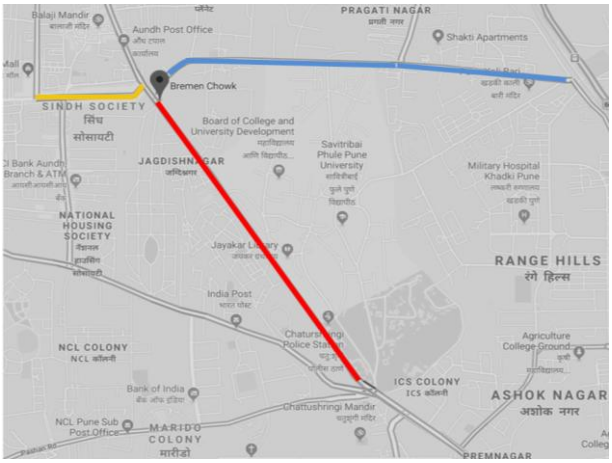

Figure – 1. Three roads originating from Bremen chouk, *Source: Author*

SAMPLE SIZE DESCRIPTION-69.8% are residents of the area. 26.4% use the space as a place of work. 17% use it for recreational purposes and 3.8% use it as place of study. The most commonly used timing is from 10am-4pm used by 62.3% people, followed by timings from 4pm to 8pm with 52.8% of users. Only 30.2% women use the space from 6 am-10am. The least amount of activity is observed from 8pm-6am.

The survey also showed that 60% women prefer to travel on their scooters/bikes, 21% drive and only 22.6% choose to walk. 66% of the sample uses the area daily while the remaining 40% use it from 3 times a week to once a week. The survey showed that 77.8% were faced with road accident/harassment.5.6% cases of sexual harassment were recorded. And almost 22.2% were confronted with crimes of theft. The analysis is done based on their user experience survey.

- LIGHT: Light plays an important role in the perception of safety. Most of the recorded crimes occur in places of poor or no lighting. It contributes in visibility of surroundings which in turn affects the user perception of safety of space. On urban streets, most primary roads are provided with street lights. However, the secondary and tertiary roads are left unlit.
- DISTANCE: Proximity of safe spots on the streets and last mile connectivity are two major aspects of consideration. It specifically talks about distances between assumed shelters in case of an occurrence of crime and include units like ATMs, Medical shops, Police Stations, Chai tapris, Temples, Restaurants and Hospitals or clinics. This parameter is important for users that walk to their destination.
- ACTIVITY: The activity on a street affect the concept of perception of safety. The more the number of people, larger is the on-street activity and points of human interaction. A lot of these activities are brought in due to activity magnets like seating areas, hawkers, jogging tracks, play areas etc. These spaces encourage human interaction and hence contribute to safer neighborhoods.
- FUNCTIONAL ZONING: The building land use of structures adjacent to the street play an equally important role. Mixed use buildings may create a scenario of activity magnets and promote the eyes on street concept. In case of specific use structures, huge compound walls create a scenario of silent walls and blank roads. Furthermore, the proportions of these compound walls may have an effect on the user perception.

Figure – 2. New DP Road for light and activity

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Figure – 3. Aundh Univ. Road for light and activity

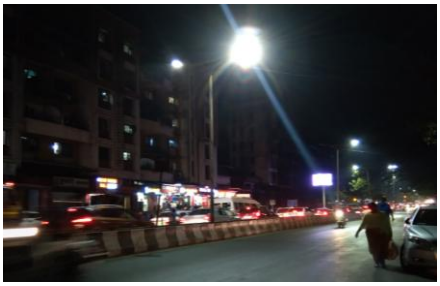

Figure – 4. Spicer Clg. Road for light and activity

Results and Tables

LIGHT:

In this research, light has been studied based on two factors- color of light and presence of light. There are two types of streetlights observed in Pune .ie. bright white and warm yellow. Both lights have a different impact in the user's perception of safety. The survey results showed that 94.2% of the women perceived bright white light safer as compared to warm yellow. The second part surveyed the response of users towards presence of lighting in the following three scenarios- Streetlights + vehicular light, No streetlights + vehicular light, Streetlight + No vehicular light. The response received showed that the first case was preferred by 92.3% of the users. The second case was not perceived as safe by any of the users. The third case was preferred only by 7.7% of the sample. This shows that Streetlights along with a regulated influx of vehicular traffic is perceived as the safest scenario by most women.

- DISTANCE:

This parameter focuses on the concept on safe distances in a user's mind. It was studied for distances that women feel safe using and junctions/places on a street that are 24 hours working that can be possible refuge/rescue areas. The results of the survey conducted showed that 47.2% ,45.3% and 7.5% women felt safe in a 3km, 1km, 0.5km radius from their place of work/residence respectively. 90% of the women that felt safe in a 3km radius had New DP Road belong to the area covered in the radius. The survey also showed that on an average 80% of the women had ATMs and Medical shops in close proximity and they also identified these spaces as safe spots for possible refuge/rescue areas. Other facilities like chai tapris, restaurants and hospitals were also identified, however they weren't as many in number and weren't considered as safe spots.

- ACTIVITY:

The survey conducted showed that 96.2% women identified New DP road as a safe street because of its activity during various times of the day. This activity was mostly pedestrian activity. 13.2% women considered Aundh-university road as a safe street in terms of activity. This activity was majorly vehicular activity. Only 1.9% of the women found Spicer college road as a safe street. This was majorly because of a lack of vehicular as well as pedestrian use.

- FUNCTIONAL ZONING:

New DP Road which has a mixed building use with no compound walls adjacent to the walkway was considered the safest among all three study areas. Spicer college road has institutional buildings and hence the street becomes a ghost street post 6pm. The users hence perceive the street as least safe of the three. Aundh university road again has major institutional buildings with high compound walls on both sides with no activity magnets on either side. In spite of all of these drawbacks, due to the availability of light and fast moving heavy vehicular traffic, this road is perceived as a comparatively safer street.

CONCLUSION

The streetlights used should be bright white in color and should be placed taking into consideration foliage of the surrounding trees to avoid dark patches on the roads. 24-hour open units like ATMs, medical shops, Chai tapris, restaurants, hospitals and police stations should be placed at regular intervals along or near the streets. This would create refuge/rescue areas in case of an incidence crime. The streets should create opportunities and places for activity magnets like hawkers and chai tapris and this should have designated spots along the road. These areas again should be uniformly placed along the stretch to have uniform densification of people. This means that they should have large, well-lit walkways along with road crossings at regular intervals. All major roads should have mixed use at least on the ground floor along the main street and minimal to no compound walls. This would increase the porosity on the street and chances of escape. The streets should also have minimal or no setback policies thus enabling the eyes on street concept. The above considerations during street design will contribute to safety of women on streets and help build safer neighborhoods.

Along with above mentioned factors, traffic plays an equally important role in determining the factor of safety. The speed of traffic and road crossing experience of the

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user can determine safety based on transition and mobility on the street.

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	LIGHT	DISTANCE	ACTIVITY	FUNCTIONAL ZONING	OVERALL ANALYSIS
NEW DP ROAD	• Bright white street lights are used. • Additionally because of the mixed use typology of buildings, the pedestrian walkway is also well lit. • This road is a condition of streetlights + low vehicular traffic and hence, according to the survey, is perceived as a safe option. • The streetlights are positioned in the centre of the road and hence are not covered by any foliage thus preventing any dark spots on the roads.	• This road has mixed use building typology hence creating an opportunity for various activities to take place. • It has 2 medical shops at the two ends, 3 ATMs, 1 24 hour chai tapri, a hospital within 1km radius. • This street also showcases the eyes on street concept, thus making it the safest of all three. • The survey conducted shows that women find this street the most comfortable in terms of distances.	• This street has mixed use buildings and spaces for hawkers and other public magnets. • These facilities generate activities throughout the day thus resulting is safer streets. • The survey shows that women would use this space in spite of no activity just because of quality of lighting and character of the street.	• This road has mixed use buildings that make it a lively and interactive space at all times of the day. • The road does not have any compound walls on any adjacent edges hence making it porous and bringing in the concept of eyes on street. • The entire stretch is functionally uniform and hence has human activity throughout.	• According to the survey, this street was determined as the safest street. • It showcases the concept of eyes on street and is always buzzing with activities. • Post redevelopment of the street, the compound walls were brought down to create an integrated street function. • The light quality on the road is extremely good and hence adds on to the feeling of security.
AUNDH UNIVERSITY ROAD	• This road has bright white street lights. • This is a condition of streetlight + vehicular light. • In terms of lighting, this street is considered safest of all three. • The streetlights are positioned in the centre of the road and hence are not covered by any foliage thus preventing any dark spots on the roads.	• This road has institutional buildings adjacent to the road with single entry points after large distances. • This street lacks any 24 hour units except police station on one extreme end of the 3km stretch. • This street is activity free after 8pm except heavy vehicular traffic. • The survey shows that this is the least safe of all three.	• This street lacks human activity at all times of day. • Its is an extremely fast vehicular traffic heavy road thus leaving no scope for any human activity except occasional fruit vendors. • This road has huge blank walls that overwhelm any pedestrian activity. • Survey shows that women consider this to be unsafe.	• This road has institutional building with huge plots and singular entryways. • It has huge stretches of compound walls with no opportunity for human interaction. • While the stretch is functionally uniform, it doesn't have any human activity throughout the day.	• According to the survey, this street was determined as the most unsafe. • The street lacks any human activity. • Its is an extremely traffic heavy road. • While the road is well lit, the large characterless walls add to the perception of being unsafe. • In case of an occurrence of crime, the street holds no chance for the victim to call for help or take rescue in any 24 hour safe spots.
SPICER COLLEGE ROAD	• This road has bright white streetlights • This is a condition of no streetlights + vehicular traffic and streetlights + vehicular traffic at varying junctures. • In terms of lighting, the survey showed that this road was the least safe. • The streetlights are positioned in the centre of the road however due to dense foliage, this street has a lot of dark patches.	• This road has institutional buildings adjacent to the road with single entry points after large distances and mixed use after a certain point. • This road doesn't have any 24 hour spots except one medical shop at the Khadki end of the road. • This road has porous exits onto secondary roads which are not well lit and lack basic facilities. • The survey showed that this was comparatively safer.	• The initial part of the road lacks any pedestrian activity post 6pm. • The second half of the road has mixed use buildings and hence has huge pedestrian and vehicular traffic at almost all times of day. • This road very occasionally has human activity post midnight and hence the survey shows that this is considered to be unsafe.	• The initial patch has institutional plots and buildings. This road hence becomes free of activity after 7pm. • The second half has mixed use buildings which create opportunity for human interaction. • The stretch doesn't have uniform functionality and hence creates scenarios of major variation in the density of human interaction.	• This road is lively and green during the day, however these same positives create dark patches on the road does creating an opportunity for occurrence of crime. • The ununiform functionality has varied activity distribution not contributing to safety of women. • Due to lack of basic pedestrian walkways, the pedestrian traffic overflows onto the carriage way thus reducing the safety of the users. • The secondary roads are dark and reduce the porosity of the street.
OVERALL ANALYSIS	• Bright white light is perceived as safe. • Streetlights should not be overshadowed by foliage. This creates dark patches on the street making it unsafe. • Streetlight + vehicular traffic is considered the safest.	• Having 24 hour spots at regulated intervals creates an opportunity for refuge/rescue points. • The streets need to be more porous in nature with better designed secondary streets and adjacent structures.	• Activity on street has a direct correlation to the safety of that street. • Any street design should create opportunities for activity magnets to take place.	• The road should have uniform distribution of function to create a safer street. • Having long stretches of blank walls can add to the feeling of not being safe in a surrounding.	CONCLUSION

Table – 1. Analysis of all three streets along with overall study, *Source: Author*

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Designing With Colours for Hospice

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Abstract:Hospice is a special care system designed to give patients and their families security, support and dignity when a life-limiting disease no longer responds to cure oriented therapies.The purpose of a hospice is having a barrier-free environment to inspire the comfort and well-being of the patients, thus creating a house where there are perfect conditions to accomplish life.Among the five human senses, vision is the most powerful in providing information. It also informs us about the environment around us, not just in an objective way by determining things such as room's shape, size and colours but by creating a psychological sensation which can induce feelings of comfort, security, stimulation and much more. Colour has a vital role in enhancing the environment and providing information and spatial orientation, helping occupants of hospice make sense of their surroundings. Most patients in a hospice have stigma about their condition because of the society's negative evaluation. So, it is obligatory for a hospice to build an environment which can help patients cope up with such stigma. The application of colour and design to healing environment should take account of the emotional and psychological factors which can affect patient's well-being. Terminally-ill patients can go through emotional upheavals which are more receptive to emotional stimuli of colour.

Keywords: Hospice, Colour,Barrier-free, Spatial Orientation, Terminally-ill, Healing Environment.

I. INTRODUCTION

Hospice is a setting where the relatives and terminally-ill patients seek refuge from the sickness and anticipation of upcoming feelings of loss and sorrow. Hospice care centres bring together a team of people with special skills - among the nurses, doctors, social workers, spiritual advisors and trainedvolunteers.Unlike other medical care, hospice care focuses not on treating underlying disease.A hospice requires an optimum level of physical and emotional care for patients as well as their relatives. Colours can have an impact on people's perceptions and responses to the environment and also affects the recovery rates of patients.

The use of color and design to suit patients should take into account the emotional and psychological factors affecting their well-being. Colours cannot directly heal, but it abets the healing process and also provide a sense of well-being. There are no specific rules to prepare a colour design manual. In healing environments cost and maintenance are the important issues related to colour design. This led to use of single colour irrespective of the use of spaces. For more stimulating environments that help benefit users can be achieved with the help of creative colour schemes. Colour design is ideally included in all areas starting from materials, colours in building exteriors and also accommodation of patients. Coordinating colours of all finishing materials helps achieve colour harmony. Appropriately used colour schemes create a visual interest and distraction which is essential for terminally-ill patients. Overusing one particular colour can lead to depressing environments.

AIM

- To study the positive impact of colour design and colour therapy on terminally-ill patients.
- To understand the basic colour theory and its psychological bearings on resident patients in a hospice.
- To study the difference in healing environment with the help of patient's experience and interaction with spaces treated with colour therapy.

OBJECTIVE

The present paper constitutes following objectives:

- To prepare a guiding document on the use of colour design as a strategy for a healing environment.
- To study the patient's comfort achieved with the help of colour therapyin terms for environment, the research was restricted to the major areas where patients spend most of their time. These were
- Wards
- Bath and W.C Facilities
- Nurses' Workstation
- Dayroom

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- To use the guiding document for better orientation and wayfinding for patients in a hospice

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II. METHODOLOGY

This paper is perceived by obtaining reliable information of a hospice care centre and colour psychology from literatures related to the topic. The research is based on knowledge of existing works on subject and by formulating a personal understanding on colour therapy. The data analysis is done by referring journals and research papers and the outcome is based upon the literature review.

A) Colour Design for Patients:

Patients require a quality environment. They wish to be easily visible and also see staff and key facilities. Colour and contrast are the most economical and effective tools for designing functional environments that are easy to use. Use color contrast may help patients understand the spatial orientation of surfaces such as staircases, floors or doors. It is a good practice to maintain a sufficient difference in wall, ceiling, floor and door colours. It is necessary to limit the use of reflective surfaces as they not favour easy navigation for elderly people. Reflections of glossy floors creates glare which is disturbing for older patients when they walk around. Use of matt floor finishes aid navigations. Small details like door handles, finger plates should be of significantly different colour. These colours should be such that it contrasts the door itself. Potential obstacles like corridor seating can be threat so they too must be finished in contrasting colours. Young patients also have particular requirements of colour design scheme. Children can find hospice centres stressful. Good color design will make the therapeutic environment look less bureaucratic, and a place to be more fun and relaxing.To understand the designing of environment for children scale and perspective are crucial. Very young children are much more aware of colour and shape than form. Colour design help children by providing visual interest and an emotional outlet thus, helping to overcome the fear of hospital environment. One age group who needs special attention are the adolescent as it is difficult to cater them because neither adult nor child spaces are entirely appropriate.

B) The Colour Schemes:

There cannot be any set rules for colour schemes. The locality, existing materials and context plays a major role in deciding colour scheme. So, it is necessary to build the palette from the analysis of existing colours including building and finishing materials. Colours should be such that use of appropriate lighting can enhance the final appearance of the space. “Pale colours should account for around 80% of the interior colour to reflect the available light.” [i]. These colours could be opposite harmonic colours such as blue and yellow. It can be useful to use a theme for creating a colour palette. White should not be ruled out of colour palette even if a typical problem is that white is seen as hygienic and clinical so,is sometimes desired by users.Evidence suggests, however, that an allwhite environment can cause visual understimulation, and thus create tension.“Neutral environment produces anything but neutral effects” [ii]. Colours like beige, grey and cream can be very functional and useful colours for interiors[v]. Particularly floor and ceilings are important reflectors of light and hence should be finished in light colours over most of the area. Lighting has a considerable bearing on choice of colour. Colours of objects and surfaces behaves differently under light so it is important to view all the material samples underneath the types of light sources that will be used.

C) Colours for Orientation:

Colour is not only an aesthetic component of the environment; it can be a powerful tool for easy navigation around a structure. It can improve the functionality of a space especially a healthcare facility. Patients use cues other than signage to find their way around. Colours can help reinforce the hierarchy of spaces, landmarks and prominent features. Thoughtful implementation of colours in healing environment can aid intuitive way finding and also cognitive mapping. Patients need to find their way in and around the hospice centre that can be complex. Good design of wayfinding components with calming environments will relieve many of the major sources of frustration. To do this, people require well-designed, strategically placed information to assist them during a stressful and difficult time. Colour design can play a big part in helping people to find their desired locations in a hospice centre.

D) Wayfinding

Wayfinding is the best tool for navigation in healing environment. The goal of successful wayfinding is to provide information in the right way for users of a structure. “Vision is typically used to make sense of our surroundings as we seek distinctive forms to create sense of location” [v] In a hospice, patients are prone to develop anxiety if they are disoriented or uncertain of their location. This creates a setback for developing a quality healthcare facility. “People need information to have confidence in making the right decisions about the right routes to take to avoid losing their way to a desired

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destination." [v] Comprehending the way spaces relate to each other and being able to see the underlying organisational principle of the circulation system are vital. Colours are able to simplify the graphical representation of site layouts, plans and charts, emphasising the primary routes.

E) Colour-coding

Colour-coding can be used to make sense of the environment and help simplify the site into wings and blocks. This helps users of building to find their way around and differentiate between areas and departments. Color-
coding can be used in a number of different ways. These c an be included in site maps and guides and repeated in fini shes on the soil. Walls and flooring can be available in var ious departments in different colours."One of the most important aspects of colour-coding is in the design of signage." [i] Colour coding is one of the most difficult applications of colour design in healing environments. It is best if one implements it at planning stage and must be kept very simple. Colour coding is often misunderstood by the people for who it is designed. Hence, it is essential to identify why and for whom the colour-coding is being used. Basic fundamental of colour-coding is that it should be easy to comprehend and should not be more than few colours. "Over enthusiastic colour-coding can dominate the environment." [i] Placement of colour-coding and zoning needs to be well-considered. Being simple and consistent with the convention is also vital so that people expect or anticipate the information they require.

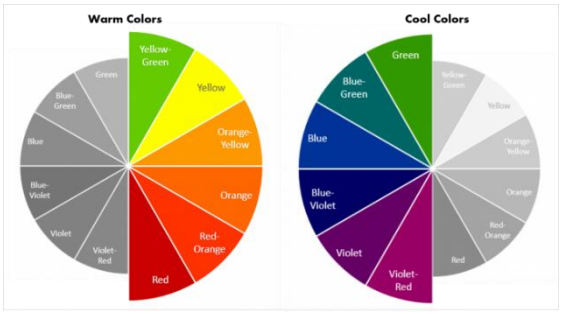

Figure (a) Warm and Cool Colours

RESULT:

COLOUR DESIGN STRATEGIES:

A] WARDS:

Wards are the care areas where patients spend most of their time. Appropriate application of colour and corresponding lighting can contribute to the efficiency of the rooms. "A delicate balance is required; an environment should make the patient feel that they are under modern and highly skilled medical care yet be comfortable and relaxed." [i]Colour schemes could have variations in wards depending upon the type of patients. But the common spaces of ward units like patients' bed bays, toilet facilities, nurses' stations and relaxing areas may help patients to relate with one another in a coordinated way.

Natural light is one of the imperative outlooks in ward designing. Thus, use of brighter colours for these areas can augment the room experience and also it maybe obliging to compensate for any lack of natural light. "Wards should be harmonious with variety of luminaires to give the eyes a chance to rest." [iii] The colours of the wards should be different from the circulation areas to help confirm the arrival at the ward with ease. Appropriate colours can provide intuitive cues for entering the ward and can be a major part of wayfinding.From the workstation of the nurses to the hosp ital, it can be helpful to slowly disperse the pastel version of a stronger shade. "Flooring should be pale and fairly light to reflect and avoid hiding dirt." [i]

B] NURSES' WORKSTATION:

Nurses' station can be a part of ward unit itself. Each ward consists of one nurses' station. This area needs to be visually prominent as the area is one spot which carries more than one activity. It also functions as a reception desk for patients and visitors and also for visiting medical staff. Use of stronger hue is preferable to highlight this area. "Experiments in the USA with the colours in office environment found more mistakes and stress occurred in offices that were totally white without any relief from other colours." [iv] "A nursing station can at the same time be both a happy and a very stressful place. The quality and design of the nurses' workstation can affect the efficiency and morale of both staff and patients. Hence soft and lively colours like greyed blues, greens and yellows should be used" [i](fig. a)

C] DAY ROOMS:

"A dayroom should be an oasis." [i].This needs to be restful, clutterfree zones and should all ow
patients who are outpatient to be involved if necessary.Thi s area must have a homely appearance and can be creatively designed with play of light to make the room visually clutter free. Like all the other major habitable spaces dayroom must also be day-lit. "Visual distractions, art works of some kind make a sensible strategy for these spaces." [ii]

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Colours of dayroom should stimulate the minds of the patients. Use of warm colour scheme can create a sense of activeness. (fig. a) "The hues used should e of high reflectance value but include harmonious combinations followed through with upholstery, textiles or carpets." [i].

D] BATHROOM AND W.C FACILITIES:

These facilities are purely functional spaces and are not given much attention when it comes to aesthetics or colour schemes. But keeping these spaces neat and attractive suggests healthy and lean environment of a healthcare facility.

"The colour scheme should provide adequate colour and hue contrast and bring a varied colour palette to the area." [i] Colours of these area could be of warm colour scheme. (fig. a) Also, the sanitary ware in the bathroom is advantageous if it is in contrast with the rest of walls and flooring. These can assist visually impaired people to use the facility.

III. CONCLUSION

There has been contrasting opinions about colour design impacting the psychology of patients. But it is evident that a properly designed visual environment with appropriate colour schemes will have abiding benefits on patients as well as staff and visitors. Articles and papers on the use of colour in environmental design have shown that: there are some demonstratable, replicable, behavioural and perceptual effects from colour that justified their use in certain ways of design.[iii] Terminally-ill patients or even visitors are most of the times overwhelmed while trying to orient themselves in a new environment like hospice. Hence, colour can act as a powerful mechanism for wayfinding assisting the users of hospice. A warm and restful environment will also help the correlation between patient and staff. A hospice is usually a complex building with lot of functions. So, it is necessary to derive a proper colour scheme with limited colours for easy maintenance of spaces. The appearance of spaces is vital and a good colour scheme in addition with appropriate lighting makes the spaces look lively and hospitable. These benefits of colour design could reflect much more if these decisions are taken at much earlier stage than currently.

IV. ACKNOWLEDGEMENT

I would like to express my gratitude to my primary supervisor Ar. Mukta Latkar Talwalkar, who guided throughout the research.

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Vertical Farming : Implementation And Benefits Of Vertical Farming In Urban Context

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Guide name- Seemantini Nakil

Abstract*: Cities are trying to cope up with rapid population growth adding 2.5 billion dwellers by 2050. Due to this increasing population food is the major problem that can be faced in the future. Planners and architects have become increasingly interested in vertical city. Big vertical structures are generated in the cities due to scarcity of land. As there is increase in population deterioration of quality has been observed, Climate change is also a major aspect in quality production. Vertical farming is the solution for the problem. Vertical farming is the urban farming inside a building where floors are designed to grow crops in a city or urban centre. These heights will act as the future farm land and as architects we can shape these high-rises to sow the seeds for the future. This research is an attempt to implement the techniques in Indian context and study the impacts. This study aims to spread the awareness of importance of this technique which can revolutionize farming in Urban areas.

Keyword: Vertical farming, Farming systems, Issues of farming, Implementation and benefits.

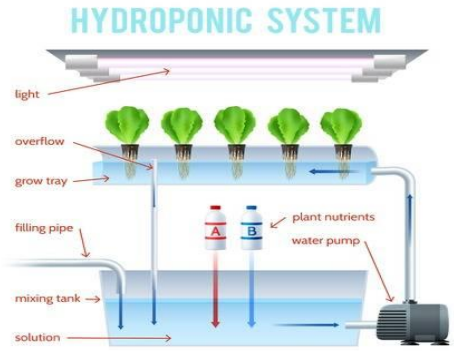
I. Introduction

World population has increased to 7.8 billion in 2020, and adding more 2.5 billion till 2050.Over 3.4 billion population resides in cities and are predicted to increase to 6.6 billion till 2050. Buildings are growing vertically to support this haphazardous growth of population. Due to this increasing rate in the population, requirement of land is increasing and so fertile land which should be used for agriculture is used for urbanization. Food is also a measure aspect necessary for growth. Quality of food is decreasing, as there is increase in production in lesser time. Use of pesticides and other chemicals is increasing which affects the health. Climate change also affect the food industry in many ways. Our traditional methods of farming will not be able to support the demands of this growing population. There are also issues related to traditional farming like irrigation problems, soil degradation, lack of mechanism, improper transportation and storage facility and fluctuating agriculture market. All of this concerns have led to a new approach to farming.

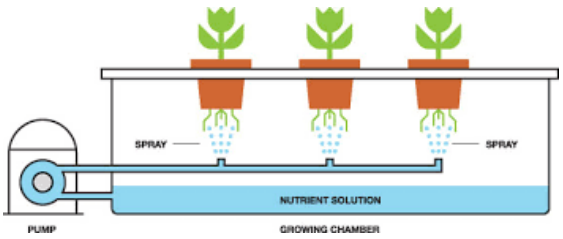
Vertical farming is the solution for all the concerns. This method was developed by Prof. Dickson despommier in 1999. Vertical farming is a methodused to grow crops in city or urban context. In this method where the farm is stacked on a top of one another which reduces space horizontally. One indoor acre of land can be converted into 4-5 outdoor acre or more depending upon the crop which is grown. A building is designed where the floor acts as plates where different crops can be grown at different levels.Modern vertical farms use controlled environment agriculture (CEA)technology where all environmental factors like light, humidity, temperature, and gasescan be controlled as per the requirements. These soilless farms use systems like hydroponics, aeroponics and aquaponics. With help of this techniques it allows the farm to grow fresh and nutrient rich food. It also cut downs the transportation cost andcrops can be grown locally.Using this technique many urban properties can be converted into food growing centers.Therefore, there is a lesser carbon footprint and more efficient use of water and land. It also helps create new urban employment opportunities.

II.Systems of vertical farming

i)Hydroponics: It is a method in which plants are grown in water using minerals and nutrients without use of soil.



ii)Aeroponic: It is a method in which the plants are tied to a support and all the necessary nutrients and minerals are sprayed.



iii)Aquaponic: In this method Aqua culture and Hydrophonic system is fused with each other.Nutrient rich waste from the fish tanks is usedto fertilate the plant beds.

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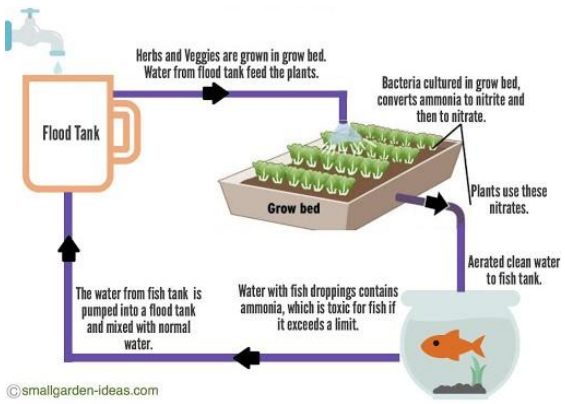
Plants beds functions as the bio filters that removes gases and chemicals from the water.



III. Methodology

Thisresearch has a descriptive study based on primary and secondary data. One Literature case study of a conceptual project showings its implementation on site and its production. Live case study of a farm in Indian context its implementation and parametric analysis. Various research journals, websites & reports were studied related to vertical farming to draw the conclusions.

1) Case study's- literature case study

Introduction

The living towers is conceptionally located in Rennes, France. Designed by Architectural firm SOA Architects. This building was designed as both residential and commercial. It was proposed in year 2005.

The Aim is to serve living spaces and agriculture production in a vertical space. It can grow over 63000 kg of tomatoes, 37,333 feet salads, 9,324 kg of strawberries per year.

It has a Sustainable featurelike wind mill which is located at the top in the direction of wind flow which produces200 to 600 kWh electricity produced per annum. Rain water is collected and stored in the tanks which is filtered and re-used in offices, residence and hydroponic system. Black water produced is recycled and reused in agriculture in the tower. South facing photovoltaic panels of 4500 m^2 are Installed in facade and the roof generate electricityfrom solar energy of 0.7 million to 1 million of Kw/h per year.

Prototype program table:

SPACES		FLOOR	AREA(Sq.m)
Residential	130 apartments	2-15	11045
Offices	-	16-30	8675
Hydroponic Cultivation	-	1-30	7000
Shopping	Shopping center and Hypermarket	-1,0,1	6750
Amenities	Library and Nursery	1	650
Parking	475 parking space	-4, -1, -2	12400

2) Case study – livecase study

Texcellance hydroponic farms. Located in Kandivali, Mumbai. It is a Hydroponic indoor farming.Project started in2019.

TheTechnology used is Hydroponics system. The Total area is 150sqm. And the Productive areais 80 sqm.Its Initial investment for the setup is 40 lacks. Estimated Cost per sq. ft- 560/-(Without LED) and 3500/- (with LED). Setup of 4 AC to maintain 20 to 23-degree Celsius.

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Minerals used is Vertigrow (Combination of Micro-Mcro).Products produced there are 3 types of lettuce which are Oakleaf, Roamine and Lollo green. The process is followed as 3 days for germination 15 days for nursering and 35 days for NET (Nutrient fill tech.). Energy consumption cost is around 35000 per month.

IV. Benefits drawn from the case studies.

Implementation of vertical farming are producing extremely higher quality and quantity per available land. It has year-round production. Transportationcost is reduced as the plants are grown locally and supplied. No soil is used for production. It uses 70 to 80% less water compare totraditional farming method.It also helps reduce rising temperature in urban areas.Is not affected by seasons and any climatic hazards. The yield is 5 to 6 times better than traditional farming. Soil-less cultivation so no use of pesticides, and fertilizer in agriculture which are not good for health. No use of non-renewable energy consumed by the agricultural engines. Creates employment oppocties

V. Feasibility of vertical farming in India

India is known as the largest producer in agriculture sector. Concept of vertical farming is new in India. Many startups have come up over the time period and taking roots all over the country. *Herbivore Farms* in Mumbai Andheri is a project in which the grow over 2500 plants in 1000 sq. ft.*Letcetra Agritech* in Sattari, Goa use only 20% water than the traditional method. Delhi has *Triton foodworks*; Noida has *Natures miracle*; Chennai has Sriram *Gopals Future farms*. Investors are taking huge interest in this concept. ICAR (The Indian Council of Agricultural Research) are working on this concept to implement it multistory buildings in metropolitans like New Delhi, Mumbai, Kolkata, Chennai etc. Reports also show some problems like lack of proper storage, lack of expert's advice on crop management and future planning and also Lack of proper delivery methods.

VI. Conclusion

Agriculture is the main factors which directly link with Economy and Health of India. Considering all the crises in traditional agriculture like lack of produce, overuse of pesticides and fertilizers and also degradation of soil, vertical farming is definitely a solution not only for Indian farmers but also farmers worldwide. It has revolutionized the method of farming which can be beneficial in future for both Agriculture and also Environment.

VII. Acknowledgement

I would like to express m deep sense of gratitude to my Guide Ar. Seemantini Nakil, for her valuable guidance, encouragement, inspiration, and useful critique. In additional I'll also thank my friend Abhilasha Bhavar for her direct and indirect help and assistance during my research.

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Space Impact on Off School Education in Pune

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Abstract:A street child is the child for whom street has become his or her habitual abode and/or source of livelihood; and who is inadequately protected, supervised, or directed by responsible adults". The street children in India choose to leave their families and homes for strategic reasons: urban poverty, aberrant families, and urbanization. Education system in India leads to contributing development of nation through healthy habits , attitude and quality character of a disciplined citizen of the country. Street children education in India constitutes one of the most neglected factor. Deprived of adequate and appropriate protection , education and health care , street children survive in unsafe environment of city streets. The research scope is to identify various causes and conditions of off school education in Pune.

Keywords : Street children, causes , education, deprivation , UNICEF, quality character, right to education , act.

Introduction: The Right to Education Act 2009, also known as the RTE Act 2009, was enacted by the Parliament of India on 4 August 2009. It describes modalities of the importance of free and compulsory education for children aged between 6-14 years in India under Article 21 (A) of the Constitution of India. This act came into effect on 1 April 2010 and made India one of the 135 countries to have made education a fundamental right for every child.

1. The benchmark mandate
2. Special provisions for special cases
3. Quantity and quality of teachers
4. Zero tolerance against discrimination and harassment
5. Ensuring all round development of children
6. Improving learning outcomes to minimise detention
7. Monitoring compliance of RTE norms
8. Right to Education Act is justiciable
9. **Creating inclusive spaces for all.**

The increasing number of street children in Pune , especially around markets or shops in city centre, might have been a concern for many people . These children deserve a decent education to upgrade their knowledge and time to play and gather around with their friends, but due to financial concern, they could not obtain what they are supposed to get. Instead, they are more concerned about . Some street children make a living by working as bearers, parking attendants, street musicians, and even beggars.Beside the above phenomenon, lack of knowledge about a significance of an education in their life is also one of the reasons for the lack of awareness to attain a decent education. One way to resolve this problem is to approach them personally.

Objectives to study :

1) To enumerate the number of children in street situations in Pune city in a reliable manner.

2) To understand the socio economic profile in terms of age, gender, education , occupation.

3) To recommend interventions strategies, policy and program initiatives required for the rehabilitation, care, and reintegration of children in street situations.

Literature review:

Education system in India leads to contributing development of nation through health habits attitude and quality character of a disciplined citizen of the country. The deprived groups of street children education is somehow lagging behind due to which the vulnerability and decreasing the progress rate due to moral values is been losing its essence. Street children education in India constitute one of the most neglected thing. Deprived of adequate and appropriate protection, education and health-care, street children survive in the unsafe environment of city streets. The research scope is to identify various causes and conditions of street education in Pune.

Issues Identification: For economic reasons, children are forced to choose between domestic violence at home and public violence on the street. Children move to and fro between these two worlds.

These children are so mobile and not permanently in the same place: they may also spend time in juvenile homes or in institutions, they may go back to their families for a short time, they may take part in project activities, or they may move from one town to another or be forced to move.

Current scenario in Pune: This presents the findings of the census undertaken in Pune City. The provides estimates of the number of children enumerated in street situations in the city and also provides broad profile based on the information collected by the way of census enumeration. It gives details of information such as, categories of the street children, sex and age distribution, marital status and

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religion/caste, place of origin and mother tongue of the children in street situations.

Challenges and Limitations: Street children have a very high mobility. It was often difficult to keep atrack of their movements to collect the information**.** In some sample locations street children were not found because of this mobile nature of their living and working conditions. In such situations the team moved to other neighboring locations to interview the remaining sample units. Majority streetchildren worked either during the daytime or in the evenings. Due to this, the field surveyors had to revisit every ward at least two to three times to interview the children at their convenient time. On top of that, the survey team had to cover long distances walking within the larger wards to administrate the survey. Similarly, certain areas in the maps did not match with the sample locations selected and hence the survey team had to struggle to reach those places to administrate the survey. These are the factors influential to take a longer time to complete the process

Material and Methodology :

The survey methodology consisted of three stages.

1. Census enumeration according to the area selected.

2. Detailed survey

3. Focus Group Discussion (FGD)

In the first stage, a census enumeration was conducted using a census questionnaire, during which each street child was identified as per UNICEF definition. In addition to enumeration, some basic information and demographic characteristics of the street children was also obtained.

In the second stage, using the census as a listing exercise, a detailed socio economic profiling of a sample of street children who were enumerated in the census was conducted using a detailed questionnaire consisting of closed and open ended questions The detailed questionnaire captured the details of socio economic condition, stay, place of origin and reasons for migration, schooling, water and sanitation, food, illness and disability, earning and spending, abuse and assistance of the children. The questionnaire was administered using one-on one interviews in Marathi or Hindi to the selected street children.

In the third stage, based on the census findings, specific vulnerability mapping was done through FGDs capturing occupational characters and types of migrations of the sample surveyed.

Case Study Analysis: The public areas of Pune like Railway Stations and bus stands were been selected for the case study purpose along with user consideration.

Area 1: Pune railway station:

Fig: 1 Google Location for Pune Junction

Pune Railway station is the main railway station of Pune .This station has three footbridges with a skywalk. Elevator service is available on footbridge.

Accordingly the selected areas are been selected where street children vendor and roam around. A questionnaire was been asked to these children related to his/her name , gender, age, about schooling activity if any, can he / she read or write , family background and reasons and causes for ending up on streets . One of the main reason which came into conclusion is the utility of the spaces. How learning spaces are created and utilised in each of the area. In case of Pune railway station, **few spaces can be utilised as a learning environment** for these street children which can enhance the space quality in and around the area of Pune railway station, also can improve the life quality of these children .

Area 2 : Swargate Bus Stand :

FIG 2: Main porch of Pune junction

Fig 3: swargate location with connecting spaces around

Table 1: Percentage distribution of street children by type of child, classified by sex of child

Swargate is the main bus stand of Pune city. It is one of the busiest place in Pune . The reason selecting this as the case study is Street-centered intervention, refering to the act of personally approaching the street children who was centered in the "street" where they usually work.

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The increasing number of street children in Pune is a social phenomenon that needs serious attention from various parties. Same questionnaire was bee n asked to the working or non working street children . In this case study of swaragte, **the void spaces under the flyover**, many street children are been venturing . Hence there's a scope if we can make these void spaces as an learning environment for these children.

Category of street children	Boys	Girls	Total (Percent)	Total (N)
Street Living Children (Alone)	5%	1%	3%	313
Street Working Children	18%	10%	15%	1564
Children of Street Family	77%	89%	82%	8550
Total (Percent)	100%	100%	100%	...
Total (N)	6053	4347		10427

Table 2: Percentage distribution of street children by sex and age

Category of street children	Boys	Girls	Total (Percent)	Total (N)
Street Living Children (Alone)	5%	1%	3%	313
Street Working Children	18%	10%	15%	1564
Children of Street Family	77%	89%	82%	8550
Total (Percent)	100%	100%	100%	...
Total (N)	6053	4347		10427

Results and tables :

The increasing number of street children in Pune is a social phenomenon that needs serious attention from various parties. This attention is not solely driven by the large number of street children, but also because of the situation in which the right of the poor street children is often violated. Given that "street children" refers to those aged less than 16 years old who spend most of their time on the street by doing particular activities to earn money in order to survive. Based on the general characteristics, it is known that poverty is the main cause of their presence in the street. They come from low level education background and undergo financial problems. Therefore, they prefer to be street children and work to meet their day-to-day needs.Based on the interview result, the street children need affection and are willing to have a decent education parents. Street children hardly receive these kinds of things. They grow up in difficult circumstances and living conditions.

According to the interview result, there are some factors influencing street children to work, including both internal and external ones. Some internal factors are; a) they had low interest in studying at school. They thought that school is such a waste because school did not provide any benefit for them compared to working on the street as the latter allows them to get money to pursue what they want; b) they got neither appreciation nor encouragement from school that they were able to attend other examination to just pass; and c) They have some future ideas such as becoming a doctor, teacher, and civil servant, but they did not get enough support and knowledge for those ideas. Some external factors include (a) socio-economic conditions. Most parents work as construction workers, security guards, motorcycle taxi drivers, cleaning service and some who did not have regular job with low incomes. The figure below indicates the parents' perception then do something negative like smoking or other negative acts. In addition, (c) some parents thought that education is less important because attending school is such a waste of money and energy, and that education is only for those who can afford it. The government seemed not to give a hand to the poor family. Children cannot help their family if they choose to attend the school, and they have low parents' education level. Apart from the factors above, street children who got off working on the streets are willing to go to school to make their ideas come true.

Conclusion and Recommendations :

Based on the above discussion, it can be concluded that:

1. The education problem is still regarded as the responsibility of the government and schools.

2. Cultural factors and lack of parents' attention to the importance of education cause street children to help their parents work for a living, leading them to dropout. **If some areas in public spaces can be utilised as the teaching and learning space for these street children which can empower the children to survive on its own and can also enhance these public spaces with the help government by providing scholarships.**

3. Some street children still want to attend school to get a decent education.

Acknowledgement :

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Also a NGO named Robin Hood Army Pune who works for these street children has been an important source for data collection.

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Landscape As a Part of Sustainable Streetscape

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Abstract - Sustainable streetscape ensures that spaces are long lasting and function as a part of the greater ecosystem implementing technologies that reduce carbon footprint. Sustainable streetscape plays an important role in development of urban areas. The streetscape inurban areas which are built for the public interaction, physical activities, traffic control etc. In this context, the research aims to create sustainable streets with the use of landscape elements to provide an attractive and healthy environment. In Pune, many streets in core of the city are very crowded and have heavy traffic flow, so with the help of landscape, making street more user friendly and sustainable is necessary. The research consists of the study of different streets with different character and the study of landscape elements useful for making streets more sustainable. The research concludes the importance of developing urban environment in Pune by creating sustainable streetscape through landscaping.

Keywords - sustainable – streetscape –landscape - ecosystem- urban development – user friendly.

Introduction - Nowadays, urban development is increasing rapidly. It majorly affect to climaticchanges. Streetscape is an important part of urban development. And by making streets more sustainable with the help of trees, shading devices, planters, water features .etc.one can help reduce pollution and carbon footprint. The research paper focuses on how does landscaping help in making streets more sustainable. As an answer to this question, the case studies have been selected from Pune. Case study includes J.M road and D.P road as sustainable streets.

Sustainability means use of natural or recycled materials, application of energy efficient methods in our design that is beneficial for public and also for future generations to live with healthy environment. Sustainable streetscape means the spaces we are designing are sustained or long lasting, user friendly, functional for all age groups andhelps to reduce carbon footprint.Sustainable streetscapes are beneficial to create better places and environment for present and future development.

Research Objectives –

- To study the advantages and principles of sustainable streetscape.
- To study the different landscape elements and their effects on climate tomake street more sustainable.
- Toidentify design principles for landscaping to make street sustainable.
- Formulate design recommendations for developing street landscaping of one street in Pune.

Research Methodology –

The research based on the study of sustainable streetscape and providing conceptual design for one street in Pune. The details of methodology of this paper given below:-

- Primary data - Collection of all the theoretical data required for the study of landscape elements used in sustainable streetscape.
- Secondary data – Collection of data through live case study and interviews and then list down the observations of case study. Case study of four streets includingtwo streets with landscaping and two streets without landscaping.
- Analysis of collected data –Analysing the data to understand the climatic conditions and design elements used in street design. Which will help to develop the landscaping of street in Pune.
- Design recommendationfor making street sustainable through landscaping.
- Conclusion.

Advantages of sustainable streetscape:

- Sustainable streetscape creates healthy environment for user.
- It helps to create interactive public and gathering spaces.
- It creates a visual image of particular area.
- It helps to reduce heat effect, glare and improve air quality.
- It helps to reduce air and sound pollution.
- Improves stromwaterrunoff by increasing permeable/ porous surfaceand landscaping.

Principles of sustainable streetscape :

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- Liveliness and attractiveness.
- Healthy environment.
- Sustainable materials/ energy efficient materials.
- Reduce heat effect.
- Improves air quality.
- Reduces glare and sound pollution.

Landscape elements and their effect on climate :

- **Trees** – 1.Trees can be used to address the pedestrian and vehicle movement. Trees provide shade and screening. Trees can also be used to modify the microclimate of area and helps to reduce heating.

2. The vertical angle of the sun changes seasonally and hence does the area of building subject to the glare of reflected sunlight. Plants of various heights can screen sun glare from adjacent surfaces. [fig.1]

3. Large masses of plants physically and chemically filter and deodorize the air and reduce air pollution.

4. Evergreen trees are beneficial in both summer and winter. Trees obstruct and filter the radiation from sun, cooling and protecting the surrounding.

5. A combination of deciduous and evergreen trees and shrubs reduces sound more effectively.[fig.2]

- **Landscape strips**– This strip is an effective option between sidewalks and streets to create a buffer from vehicular movement and provides comfortable walking along the street.

- **Rain garden**- It is a bed which is designed to treat stromwater. As water falls onto bed and enters garden it is passed through a filter media which is planted with vegetation. This treated stromwater is then goes into drainage system.

- **Sustainable materials** – Using sustainable materials reduce energy use and conserves natural resources. Sustainable materials are made from natural and renewable resources. Paving material should be porous, durable and locally available.

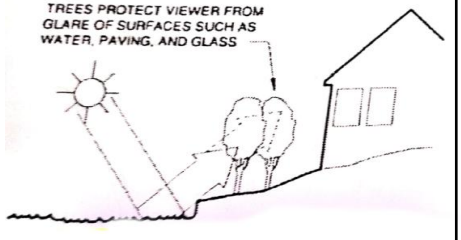

Fig.1 – Glare protection.

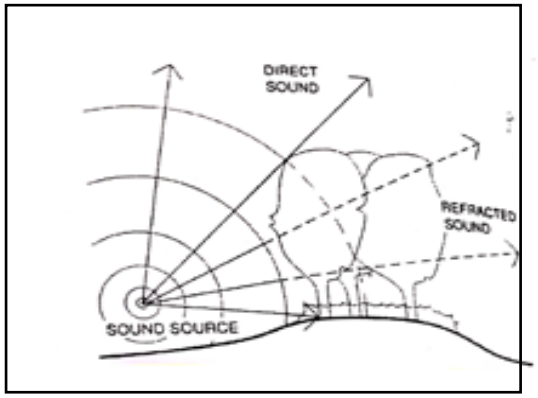

Fig.2 – Sound reduction

Design principles for planting

Scale and Proportion– Tall buildings require large scale trees to provide the necessary relative proportion of mass. With the proper selection of trees, the visual mass of the plants can conjoin with the building mass into harmony and proportion.

Human scale– Trees can function to provide comfortable feeling of human scale. The sequence can be established, starting with shrubs near building entrance, next ornamental trees followed by large shade trees, as a person proportion outward.

Balance – The design components of both the landscape and architecture work together to achieve an equality in design. Large trees will effectuate the necessary visual to coexist with the building's mass.

Mass Planting– Plant groupings in sweeps or masses rather than individual species works more effectively. Placement of trees in groups should respect the importance of safety and signage.

Case studies of streets with landscape and without landscape

Two cases were selected for the comparative analysis between the streets in same climatic condition to prove the sustainability.

The selected case studies were –

1. J.M road, Pune.
2. M.G road, Pune.
3. D.P road, Pune.
4. Vimannagar road, Pune.

Fig.3 – Graph showing Temperature difference on streets caused by landscape.

A research through an interview was carried out where

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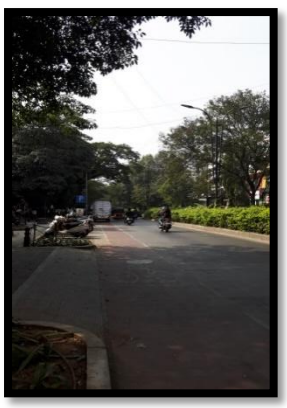
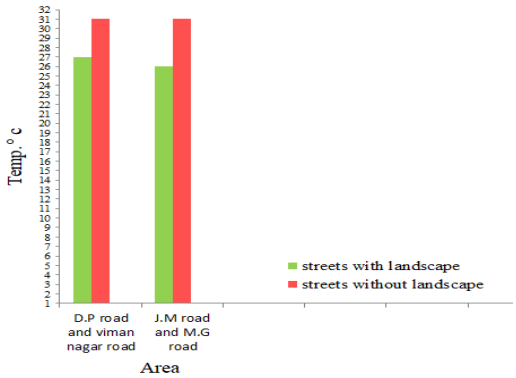


people were asked to give their opinions on the basis of climatic conditions and how they feel about that street. Along with the interviews, observations were made on the basis of materials, plantation, street furniture, light, spaces etc.

Observations of J.M road are compared with M.G road because the density and use of both the street is same, only difference being M.G road does not have proper landscaping. Similarly, D.P road and Vimannagar road have same density and use but Vimannagar road is without landscape.The factors selected for interview questions states the sustainability of street. These factors are as follows -

1. Glare.
2. Shading .
3. Air quality due to landscape.



4. Comfort caused by landscape .
5. Temperature difference.

Glare - Because of planting shrubs on dividers it helps to reduce glare of surfaces such as glass, paving. And also trees along the road reduce direct sunlight coming on street and this is more comfortable in summer while walking on street.

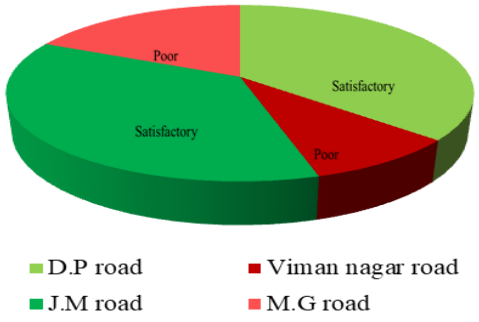


Fig. 4 – Pie chart showing the reactions of people for air quality.

Image 1 and Image 2 shows the street landscape of D.P road and J.M road.

Image 3 and Image 4 shows the very less amount of landscape on Viman nagar road and M.G road.

Table 1 – Comparison of streets based on density, widths, vegetation and climatic effect

Location	DP road , Aundh	JM road , shivajinagar	MG road , camp ,pune	Viman nagar road,pune
Zone	Commercial + residential	commercial	Commercial	Commercial + residential
Traffic flow	Less	More	Heavy	Heavy
Street width	18m	24m	18m	24m
Vegetation	Dense Trees were large enough to provide shade for parking and pedestrians. And helps to reduce glare.	Very Dense Trees were large enough to provide shade for parking and pedestrians. Dense. And helps to reduce glare.	Less	Very less
Effect on climatic condition	Reduces glare and heat. Improves air quality.	Reduces glare and heat. Improves air quality.	There is no landscaping which increases heating and does not help to increase air quality.	There is no landscaping which increases heating and does not help to increase air quality. Negative effect on traffic movement.

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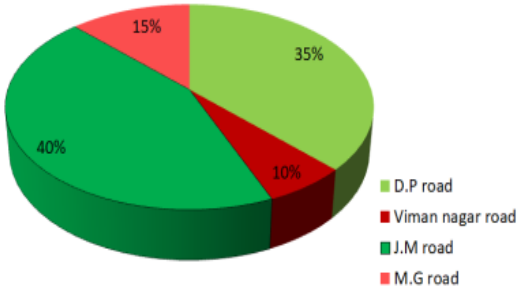

Table 2 – Comparison of streets based on general observations.

Analysis of case studies

From the case studies and interviews the research conclude that the street landscaping is important to reduce heat effect. Streets with landscaping are more user-friendly than streets without landscaping. Due to vegetation along the street it helps to improve air quality and a user walking on street feels fresh and comfortable. Shrubs are planted for street division and it also helps to reduce glare. The street landscaping and spaces like sitting areas, play areas created on the street attracts people to visit again. The streets without landscaping majorly affects climatic conditions like increased heat, pollution.

Recommendations –

1. Selection of street –

From the case studies, it states that the Vimannagar road and M.G road are comparatively less sustainable than J.M road and D.P road in terms of landscape. Therefore for street landscape recommendation Vimannagar road has been selected. The street islocated near Pune Airport. The urban development is rapidly increasing in this area and this area has been formed as a youth hub as various institutions and IT parks are located nearby.

The traffic movement on this street is more and the division for traffic is improper. The widths for pedestrian movement is sufficient i.e 1.5m. There is no vegetation and greenscape on the street this results in increased pollution, glare ,resulting in unpleasant atmosphere. Users do not feel comfortable while walking on the street because of less greenscape on the street. Therefore providing street landscape is necessary in order to provide shade for pedestrians and to ease traffic movement, thus helping reduce carbon footprint. Adequate street landscape would attract people to use the street efficiently and effectively. This street landscape would not only serve the aesthetic purpose but also impact the mind-sets of the users.

Fig. 7 - location map of Vimannagar road.

2. Design Recommendations –

The recommendations are based on the primary data and data collected from case studies in terms of sustainable streetscape. The design aims to make the Vimannagar road sustainable with a landscape.

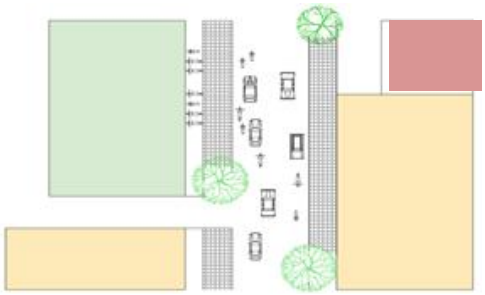

Fig. 8 – Existing plan of Vimannagar street.

Fig.9 – Image shows the landscaping on Vimannagar street.

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Fig.10– Image shows the live depiction of Vimannagar street at 12pm.

Fig. 11 - Image shows the live depiction of Viman Nagar Street at 3pm.

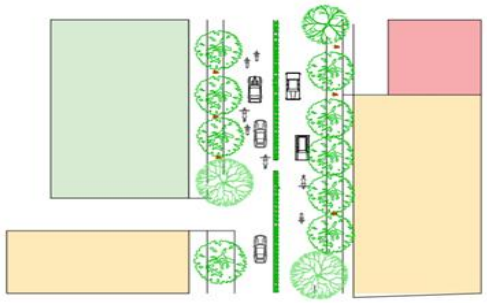

Fig. 12 – Proposal plan of vimannagar street

Conclusion

Sustainable streets are essential in urban context. So to form a sustainable streetscape, principles of sustainable streetscape with respect to landscape should be taken into account. Therefore providing necessary landscaping improves sustainability of street.As shown in the applied study research concludes the recommendations for making street more sustainable with the use of landscape.

Acknowledgement

I would like to thank Ar. Seema Paulzagade who guided for completing the research paper and to achieve the research aim.

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Factors Affecting the Architecture of Hindu Temples in India

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Abstract : Hindu temples are seen as a portrayal of social structure of relevant times in history.They are not only considered as abode of God and places of worships but are alsocentre of knowledge, art and culture.This paper presents the study of several factors which influence the architecture of Hindu temples in India.The data will further be analysed and compared between two styles of Indian temple architecture namely Nagara style and Dravidian style. The objective of this paper is to study the importance of above factors in temple architecture during their evolutionary process. This study will helpful to give detail description and analytical comparison based on principles which will govern the architecture of Hindu temples.

Keywords : Hindu temples,worship, temple architecture, Nagara style, Dravidian style.

Introduction

From ancient times to today's modern era architecture has been playing considerable role in shaping the society. The term temple signifies a place or structure devoted to perform practices of various rituals followed by society also having a role as one of the most sacred buildings. Hindu temples are seen as a portrayal of social structure of relevant time. Hindu temple architecture has played an important role in ancient Indian architecture. Temples were the sign of dominance religion and the culture of the dynasty who ruled their respective time. The organizational structure of Hindu temple is an important part of their design. The philosophy, beliefs, sacred geometry and religious concerns of the people also affected the planning process of temples

The architecture is also influenced by the various stages of temple construction and techniques that have been adopted in temple construction since ancient times. At the ancient times philosophical and geometric aspects govern the planning of a Hindu temple. The role of light and shade is also the most critical factor which affects the temple architecture.

This paper proposes to study how the spatial configuration, organizational principles, philosophy, light and shade, material and construction techniques influenced the architecture of Hindu temples and how they were implemented at that period.The study is mainly focusing the planning rather than form and elevation of the temple.
Early temples were developed from monolithic rock and later on in about 8th century the Dravidian style of temple architecture was emerged and later on the Nagara style. The Nagara style of temple architecture belongs to temples situated in the northern part of the India whereas the Dravidian style belongs to temples situated in the southern part of India. The study is focuses on only Nagara and Dravidian styles of temple architecture.

Objectives

The objective of this research paper is to find out why is that even after centuries Hindu temples in India have retained their energy.To study the factors which have rendered them ageless and also their importance during the evolutionary process of temples. To find out can these factors can interpret in contemporary times.

Methodology

The methodology will include to find out the factors affecting the temple architecture in India. The influential factors have been analysed and compared between Dravidian style and Nagara style of Indian temple architecture. The required data is collected through secondary sources.

Literature Review

Casestudy 1-The Sun Temple at Modhera, Gujrat.

The temple complex built in 1026-27 during the region of Bhima I of the Solanki dynasty and it is dedicated to Lord Surya. The temple is the best example of Nagara style of temple architecture.

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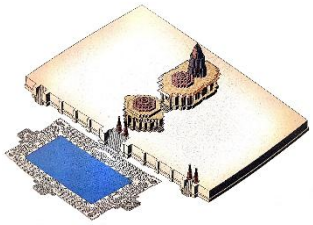
Influential factors

1)Spatial configuration

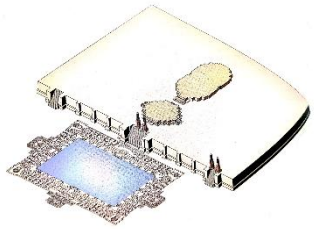
The temple complex comprises of following parts,

A) Kund (ritual water tank) B)Torana (entrance arch)

C) Sabhamandapa(pavilion) D) Goodhamandapa (prayer hall)
E) Garbhagriha (sanctum)



Kund-The kund the large rectangular water tank forms the first part of spatialsequence punctuated by sub shrines of 60 minor deities.



Torana-It is with the trabeated assembly of multifaced sculpted columns, ornate cross beams and flying arches.

Mandapa-The mandapa being perfectly symmetrical on both axes and itself sits on a small plinth. A small open to sky distance separate it from the entrance porch of the temple which creates detachment of two structures not far enough to fell scattered.

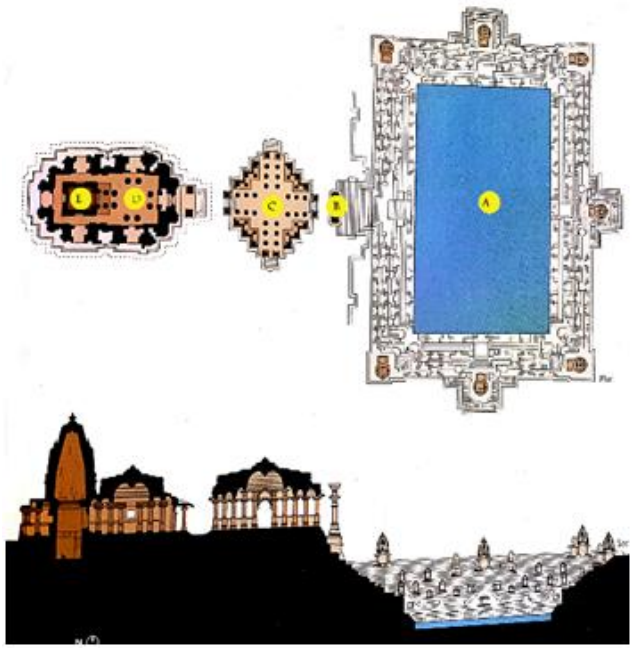


Fig 1-plan and section showing spatial configuration

The Temple-Within the main temple building there a two spaces goodhmandapa and garbhagriha both part of the same mass externally but separated internally by a construction of wall planes

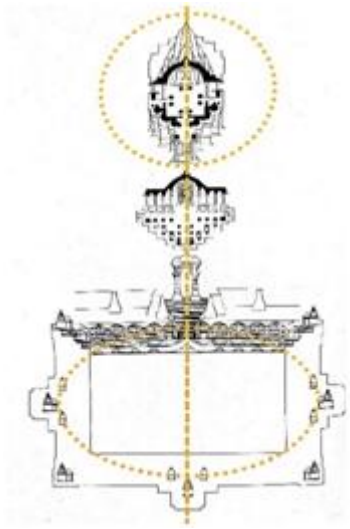


Fig 2-Formations of spatial configuration in roof plane and ground plane

2)Geometry and organizational principles-The temple complex is perceived as a consolidate composition along a single axis. The circulation route which determines the movement through the space guides the experience of the surrounding.The arrival to the complex is along the axis of its orientation, which offers in the visual frame from the distance only the outline of shikhara of the temple, the flat façade of the mandapa and the temple base.

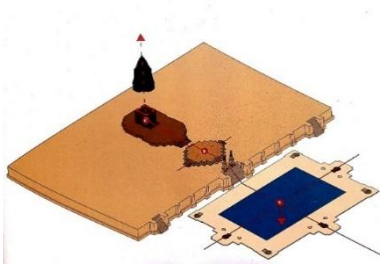


Fig 3-juxtaposing the visual axis with the movement path by miniature study

Each part within the entire complex though seen as acomprehensive composition and as a single integral unit but it is effectively grouping together as anindividual whole. The kund as a purification and domestic centre, the mandapa as a sacred gathering space and temple as an abode of god are themselves,complete architectural entities. They are connected together by visual juxtaposition and adjancy as well as the organizational axis.

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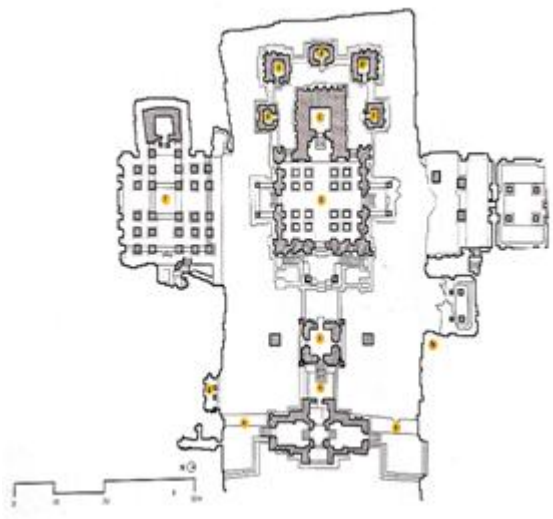

Fig 4-Various individual formations within the same complex

3)Philosophy - The kund becomes an altar to water while the temple is a shrine to the sun an embodiment of fire. This is the personification of Vedic myth that the sun arises from the dark inert of an ancient ocean as well as the concept of duality and contradictory co-existence. The pitha depicts the difference between the sacred domain of the temple and the profane world of human purification. The main route into the temple, as implied by the organization, is down into the kund and after purification, climbing un ascending towards the heaven through the torana, symbolizing the ritual purification of the person before entering the abode.

Fig 5- flight of steps through torana leading towards pitha

Fig 6-view of sabhamandapa from kund.

4)Light and shade - The goodhamandapa (prayer hall) lit by two windows on either side also. The garbhagriha (sanctum) is dark and unlit leaving perception to the imagination. Windows lighting the small passage between the sanctum. The cella is dark and the final point in the movement sequence placed axially to receive the first rays of the rising sun from the east.

Fig7-detached goodhmandapa marks the next transition through light falling on entry porch.

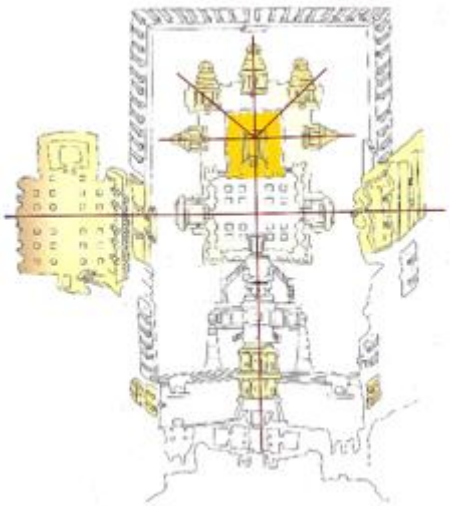

Fig 8-plan showing spatial configuration of the temple complex

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The variations of enclosures arefulfilled by the transition in light intensity, from the totally sunlit and bright kund tothe moderately lit hall leading up to the subtly lit interior hall and absolutely dark sanctum.

5)Materials and Construction techniques - The whole complex is built out of a coarse grained, buff sandstone, in some places changing to red brown. The stone blocks were set layer upon layer according to the dry masonry method that is they were not joined by mortar. Stability was achieved through a careful balancing of weights. The pitha (plinth) is filled by bricks and facing with sandstone. The organization of stone into composition gives shape to the pattern of art.

Case study 2-Kailash Temple, Ellora

The Kailash Temple at Ellora is magnificent example of Dravidian style of architecture consisting of both free standing and hollowed out forms carved out of the living rock of an entire hill side. The temple is dedicated to Lord Shiva and built between A.D. 757 and 773.

Influential factors

1)Spatial Configuration - The temple complex comprises of,

A) Nandi Mandapa B)Maha mandapa C) Garbhagriha

D)Sub shrines E) Bridge F)Lankeshwara cave

G)Shrine of river Goddess H)Yagnashala

Nandi Mandapa-It is the free-standingmass, housing the statue of sacred bull, the deity's vehicle.

Yagnashala-Space for rituals and shrine of the river Goddess.

The temple- The main temple comprises of mahamandapa which is covered by shallow dome and projected balconies and axially placed garbhagriha.

Sub shrines-They are housing varied forms of maindeity each capped with a small shikhara and kept on a smaller plinth.

Comparative Analysis Table

2)Geometry and organizational principles–

The Kailash Temple is organized around the geometry of centre and sub centres.This notation is physically translated through the circulation path where each sub centres become a pause points which helps to orient oneself in the temple complex.Visual frames further guide the circulation. One frame leads on to the other in a smooth transition but with emphasized expression at sub centres. The organization consists of various centres. The entrance portal is the distinct space in itself which acts as a primary transition from outside to inside. The connecting bridge to the plinth acts as veranda or open courtyard to the upper level.The main temple and Nandi shrine being at a higher level take the visitors above the ground plane.The formation of the spaces at the upper level create notes which demarcate and distinguish the main from the sub spaces.

3)Philosophy-Therising plinth detaches the person from the earthly formation and expresses the ascent to the sacred. The Nandi shrine placed up to the temple level to express the transition to the heavens.

4)Light and shade The use of light and shade is another significant aspect in this temple which is used as aperspective tool in the understanding of forms.The freestanding elements awash with light with every detail seen clearly and starkly. The open to sky spaces in between allows light to assists the appreciation of form and proportion.The transparent clarity and brightness of the open peripheral areas transforms gradually into dimmer introverted indoor spaces culminating in the mysterious dark space of sanctum.

5) Material and construction Techniques – The whole structure is cut and cut from one enormous bit of rock. The sanctuary is chopped down fit as a fiddle around 50 meters somewhere down in the back and sliding towards the lower level in favour of passage entryway. Three channels were made at right edges and chop down at right edges to the degree of the base of the slope. Initial a mass of rock 200 feet in length, 100 feet wide, 100 feet in tallness was secluded. At that point the mass was pounded into shape. The construction took 200 years and 10 ages to finish the development work of the sanctuary complex.

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Influential factors	**Case study 1 Nagara style - Sun Temple.Modhera**	**Case study 2 Dravidian style- Kailash Temple, Ellora**
Spatial Configuration	Evolution of main building of temple.	Evolution of temple complex.
Geometry and organizational principles	Organization of spaces based on vertical axis on ground plane.	Organization of spaces based on vertical and horizontal axes in ground plane.
Philosophy	Based on Vedic myths.	Based on Vedic myths.
Light and shade	Partially lit sabhamandapa by using colonnade. The garbhagriha is kept dark as it was related to earth's womb.	Partially lit mandapa by using projected balconies at the upper level. The garbhagriha is kept dark as it was related to earth's womb.
Materials and construction techniques	Sandstone (as it was considered as a sacred) and brick filling used for the plinth Dry masonry construction technique.	The massive basalt rock (as it was considered as a sacred) carved out from top to bottom.

Conclusion

The most prominent factor in temple design is philosophy behind it, followed by geometry and organisational principles which influences the Indian Hindu temple architecture. The light and shade as well as use of construction materials could be seen as secondary factor. The temple of nagara and Dravidian styles are based on a single philosophy and geometry. The special configuration varies by the intended use of structure and ideology of the organisational body.

Acknowledgement

I would like to express my special appreciation and thanks to my guide, Professor Ar.Suraj Kocheta, you have been a tremendous mentor for me. I would like to thank you for encouraging my research and for allowing me to grow as a research student. Your advice on both research as well as on my career have been invaluable. I would also like to special thanksto my other advisors Ar. Sakina Hakim and Ar. SurabhiKanade for guiding me from time to time.

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Architectural Expressions of Different Cultures on Maratha Temple Architecture During Peshwa Period

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Abstract : Maharashtra has been an important centre for the temple architecture activity since the days of early Buddhists rock-cut architecture in Ajanta- Ellora till the well flourished temple architecture till the 19th century. A productive phase of temple began in the 11th century under the Yadavas .This tradition of building temples in basalt flourished until the 13 th century when Muslims invaded from the North India(Sohoni, The Temple architecture of the marathas of Maharashtra, 1998). Many elements from the architectural styles can be seen on the temples during the Maratha period i.e. during the Peshwas from 18th century to the 19th century. A detail analysis based on visual surveys will be obtained in the further study , with the help of live case studies , to study Maratha Architecture and temples during Peshwa period and what were the various styles in India which were mixed with the Maratha temples during the Peshwa period. The paper aims to study the architectural expressions of different cultures on Maratha temple architecture during the Peshwa period .

Key words – Temple traditions, Temple architecture , Maratha temples , Marathas, Peshwas , cultures , etc.

Introduction :

The temple traditional architecture of Maharashtra has a vast history from rock cut architecture in 2nd century BC to late 19th century i.e. Maratha/Peshwa era , in which we can see many changes in architectural styles over the period of time i.e not in the planning of the typical temples but the aesthetical elements added in exteriors and interiors of the temples , different invasions by the rulers of other countries or architectural styles getting influenced by other styles of different states of India. These changes were done were for enhancing the typical temple architecture of Maharashtra since 2nd century , but most of the temples from that period till Maratha period doesn't exists or not well conserved , the temples from Maratha era or Peshwai period can be seen in Maharashtra in large no. . However, in Maharashtra, after initial persistence of Yadava patronage in the 14th century, Islamic rule in the Deccan was challenged by the rising powers of the Marathas. The Marathas ruled over most of Maharashtra from the mid 17th to the early 19th centuries. While focusing on the understanding of the architecture of Maharashtrian temples, the study investigates the impact of the two preceding traditions of architecture in Maharashtra. Maratha temples in Maharashtra are the product of a tradition in which certain forms underwent transformation while some new forms were created, stemming from the earlier traditions in the region. This study is the first to treat Maratha monuments as a part of a tradition(Sohoni, The Temple architecture of the marathas of Maharashtra, 1998).Along with the Islamic elements , Rajput and South Indian Temple Architectural elements can also be seen in the Maratha. The aims of this study are to record the formal characteristics of the temples at the various stages of development, in order to understand the evolution of the temple architecture. This study is to show how other styles of different cultures are mixed up in the indigenous Maratha temples of Maharashtra in Peshwai region.

- **The rise of temple architecture during Maratha period-**

Shivaji Maharaj , who was the founder of Maratha empire himself was deeply religious person. So it is quite likely that he built many temples in Mahrasthra .During the reigns of the Peshwas there was a gradual revival of building temples. The most famous temples builders of this period was the Guru of ShahuRaje and the Peshwas ,Brahmendra Swami and many other temple builders such as third Peshwa Nanashaib , during his reign it gave rise to the temple building activity . The next seventyfive years i.e. 1740-1815 witnessed the construction of large number of temples in Mahrashtra. The Shindes and the Holkars including Ahilyabai Holkar were one the greatest temple builders of the period . Along these people many rulers or important people such as V.M. Gadre ,G.Y.Chandachud , The Puranadares of Saswad, The Patwardhans of Sangli , Nana Phadanviw of Wai buiklt many temples around their towns. These greatest temple builders built temples at places of

their region and choices. The list goes on endlessly Here it would be enoughto consider as the temple building activity raised during the Peshwa period. (Mate, 1959, pp. 72-112).Naturally question appears that what was the style of these temples ? Were the materials and construction techniques used to built these temples same or vary from earlier temples ? What were the reasons for amalgamating the different styles with the Maratha temples ?

The research focuses on the few best examples of the temples around Pune having cultural influences and their architectural styles on the Maratha temples . The temples which reflects prominently Maratha elements as well as Islamic, Rajput and Dravida architectural elements. The study prominently focuses on the architectural elements of a style , but use of these elements can differ the materials and construction techniques for the same.

Methodology :

The study is based on qualitative research and case study based in which the live case studies are done as a primary data having observations , notes , sketches and drawings of the temples are done . Photographs explaining the compositional features of the monuments and the various architectural elements to be made in order to explain the anatomy of the selected temples . With the help of this analytical drawings and photographs analysis to be done. Book case studies to be done for comparison of different styles of the temples.

Following are the literature review on the literature -

The temple tradition in Maharashtra was same , but the architectural elements on the external facades of the temples changed or were mixed according to the rulers or cultures influenced.here are the research papers on the similar topic –

1. The temple architecture of the Marathas of Maharashtra, by Ashutosh Sohoni, 1998 , the thesis states the overall temple architecture of marathas of Maharashtra since Yadava dynasty (9^{th}-13^{th} century), in which he says the Maratha architecture was an addition to the yadava temple architecture , which was discontinuous after the Yadavas but started developing since Shivaji Maharaj in 17^{th} century who was the father of Maratha kingdom wich was flourishesd in many states until late nineteenth century, the architecture was military architecture the indigenous one ,but was enhanced later on because of safety or enhancement purpose was the revivalism in the Maratha architecture. He classifies the temple tradtion in two ways such as indigenous – the original style and the rivavilist architecture that the modifications done according to many other reasons, which was the high peak point of the Maratha Architecture.

2. Post Mughal Maratha architecture , by Sarvesh Kulkarni, the research paper states the changes done in the indigenous Maratha architecture after or during the Mughal invasions for safety of the temples or enhancing the temples . In this he says , any changes in structural planning was not done but architectural ornamental changes were done externally for the same purpose . The author has focused on the evolution of Maratha Architecture during and post Mughal era in Maharashtra. He studied the architectural changes in the structures such as forts , temples and typical housing named as wadas after Mughal era. The questions such as when did the Maratha period start and how their architecture start developing and what changes were done according to other rulers in the architecture lead to the research of this topic

3. MaratheshahiVastushilpa chapter 01 , by M.S.Mate , 1959, The author studies about the typical or Maratha architecture in Maharashtra.the study is done detail to understand the elements and building typology of the Marathas and their and different types of structures like forts, temples and typical houses named as *wadas.* The study focuses on the building style , materials and techniques used in this architecture.

4. Ganesh temple at Tasgaon- Apothesis of Maratha architecture , by Ashutosh Sohoni, 22 March 2011 , The article showcases the detail study of Ganesh Temple at Tasgaon, Sangli, Maharshtra . the research was done to study the building style of the temple which was the amalgamation of Maratha temple and south Indian temple architrecture and how was the planning was affected because of this and what their planning system. To study in which era the temple was built. The temple tradition and its architecture which was at development in Maharashtra during the

Peshwa rule , also evolved by mixing the different styles for enhancing and modifying the temple architecture of Maharashtra , he says.

From the above study we can see that the topic needs more exploration and needs to be put light on it , hence this topic is selected for the research.

Case Studies :

Live Case studies are done in and Around Pune in which features of different cultures can be seen in the Maratha temples –

- **VitthalwadiVitthalmandir , Pune-**

The temple is located on the banks of riverMula-Mutha in Pune. The date of the temple is quite unknown but the

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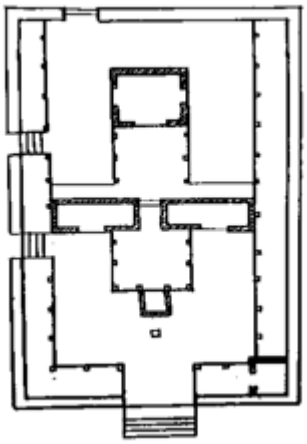
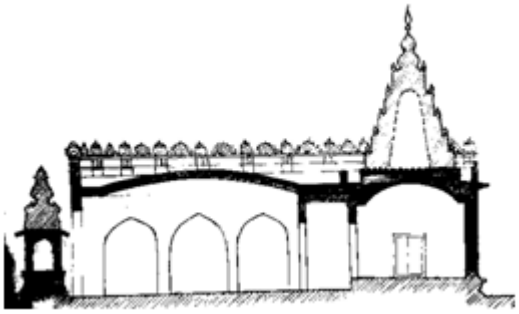
history saysthat the temple belongs to the one of the two temples built byShivaji Mahraj , temple has typical Maratha elements and was renovated in late peshwa period , the temple is dedicated to lord Vitthala and Rukhmini. The shrine is designed in square shape and faces east . The mandapa in front of the shrine is square and made of stone . The pillars in this mandapa are of the Yadava style.the pillars around the aisles around the shrines have same pillars having a flat ceiling. Mirror work similar to the Rajput style mirror can be seen in this mandapa. A small door in the front of this mandapa opens in another mandapa completely made of stone which has arches and vaults.

Typical Maratha shikhara on the top of Garbhabriha and gopuram on the entrance in east can be seen and *kelfulmahirapri*arches in the mandapa . Whereas the Dravidian style elements on the parapets of the terrace and boundary wall of the temple is seen.Types and styles reflected in the temple – Yadavapillars , Maratha structure and arches , Rajput mirror work , Dravidian style motifs





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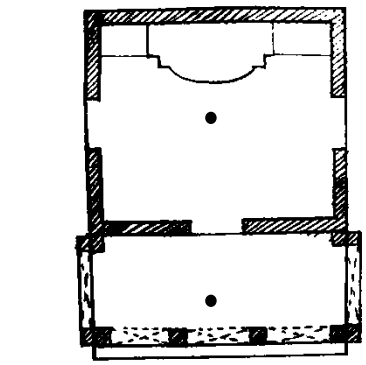
Khandoba Mandir ,Jejuri -

The temple is located in Tehsil Purandar , Pune . the temple is dedicated to Lord Khandoba and built in 1742-1770 by Khandoji and TukdojiHolkars. It is also said that the Bhonsales of Thanajvur renovated the temple in Dravida style. The temple is situated on a hill having a stone wall and a grand entrance , and the temple can be easily divided into two separate sections i.e Mandapa and Garbhagriha. Completely made of stone and have pointed arches of stone . Some of them have stucco canopies over them. The typical*dipmaal*i.e. the special features of the maratha temple architecture can be seen here in large number. The shikhara of the temple has a beautiful amalgamtion of two different styles i.e Dravidian and Islamic . the shikhara of the temple reflects the typical Dravdian style architecture whereas minarets from Islamic structures can be seen on the shikhara .Types and the styles reflected in the temple - Yadava pillars , Maratha structure , Dravidian motifs and Islamic minarets , arches and dome.



The shikhara completely made in Dravidian style and have Islamic minarets on it.

Photo Courtesy- Google **Khandobatemple ,Jejuri**

Khanoda

Tasgaon Ganesh Temple ,Sangli –

The temple is located in Tasgaon in Sanglidistrict . built by ParshurambhauPatwardhan , the king of Sangli.Raje Parashuram had fought more than 100 wars against the Tipu Sultan in South India. At that time he was impressed by the South Indian Temples. These construction was made by Hindu- wadar caste peoples from karnataka. Its architecture resembles South Indian temple construction. The temple as a five storeyed Gopuram at the entrance having typical maratha temple elements and Rajput elements such as umbrella like structure called as *meghdambari*and human sculptures of same styles. . The entrance gateway formed by a masonry arch surmounted by a tower of the form known as the Gopura The Gopur is a large and lofty pinnacle. It is seven-storied, gradually tapering to a ridge at the top. The lowest storeymeasures , the whole is and the kalasha and curved arms. Gopura is carved into images of gods and goddesses. The templeconsists of garbhagriha and a Mandapa of plain but finely worked stone. The garbhagriha has a spire , flanked by our smaller ones ,shorter making a grand composition. Mandapa has a flat roof of carved Stone slabs. The hall consists of a nave with three aisles made by two rows of pillars .At the hall's entrance are two shrines of

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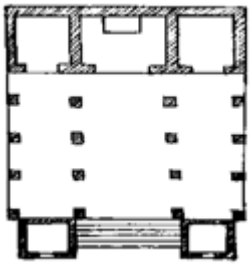
the bull Nandi and the Garuda including the typical maratha style shikhara.



Garbhagriha

Mandapa with Maratha arches

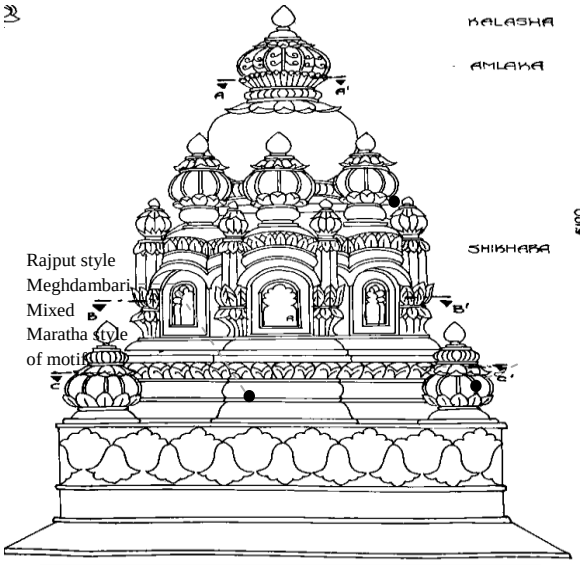
Another shrines

Photo courtesy – Author

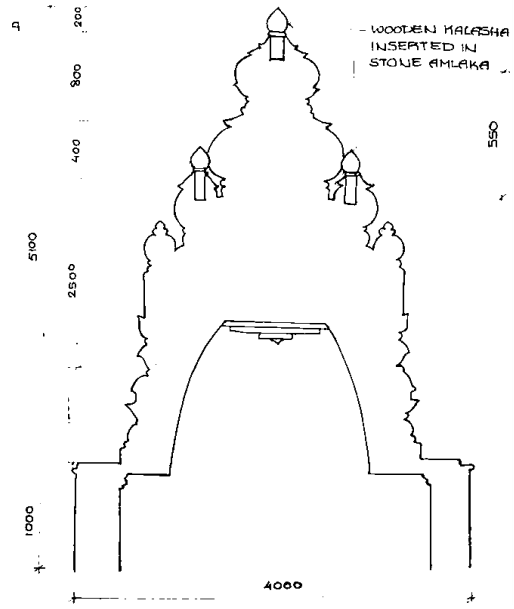
The*Rajputana meghdambari*

Between the Maratha mahirapi Arch.

Tasgaon Ganesh Temple



Rajput style Meghdambari Mixed Maratha style of motif



Elevation of Shikhara

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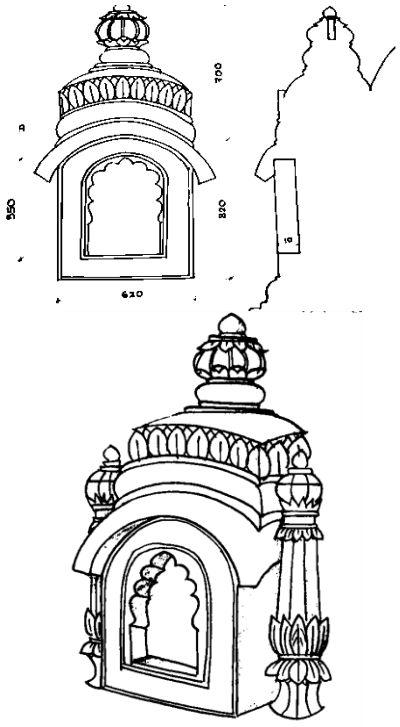

Analysis:

Case study 1 Case study 2 Case Study 3	Case study 2	
Period	Built by Shivaji Maharaj in 17th century and renovated in Late marathapriod.	Built by Khandoji and Tukdoji Holkar in 1742-1770

Section of Shikhara

The transition constitutes an important feature of all buildings both in their structural and ornamental aspects.

Conclusion:

It can be seen easily that by alternating relative proportions of the various features by giving prominance to some and by depriving some of their boldness and by changing the arrangements of the blocks and other motifs , innumerable varieties can be obtained. After studying temple architecture of a particular period , it shows how the temple architecture of a region can flourish gloriously by amalgamation of architectural elements of different cultures and their influences which helped to gave a rise to the temple architecture in Maharashtra during Peshwa especially the late Peshwa period. The study also shows how the evolution not only affected the civil works of the temples but also in the respect of elevations which enhanced the 'Maratha Temple Architecture'

Acknowledgment:

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iv. *Article- **'Post Mughal Maratha Architecture'** by Sarvesh Kulkarni.*

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User Satisfaction in Housing Depending on Outdoor Variables: A Case of Housing in Pune

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Abstract: Housing is one of the primary needs of a human being and largest investment that a person makes in his lifetime therefore satisfaction in this investment is very important. Satisfaction not only comes from the internal space you reside in but also the surroundings variables that affect the space you are living in. A gap was observed, most of them speak on indoor but the outdoor variables are somewhere left out for understanding user satisfaction. The site of study was Hyde park housing society, Market yard, Pune.Interview method has been adopted for getting on to conclusions of the research. The purpose of this research is to understand the factors affecting user satisfaction and strategies for housing design for enriching the satisfaction.

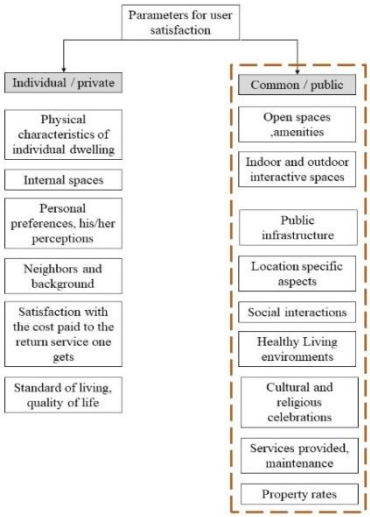
Keywords: Investment, User satisfaction, Housing, Outdoor variables, Pune.

Introduction

Pune has come across rapid increase in population in the last two decadesbeing the "Oxford of East" ("Truly Oxford of the East", 2017)and also cultural capital of Maharashtra since its existence (Joshi, 1996). Pune has its hub for education, manufacturing and information technology due to which a lot of displacement of population taken place. The first need of any individual is a place to live, hence housing development has become important.

Residential satisfaction depends on the difference between the households actual and desired aspired housing and neighborhood situations (Glaster, 1987). A close relationship between outdoor quality and outdoor activities, "Within certain limits - regional, climatic, societal - it is possible to influence how many people, and events use the public spaces, how long the individual activities last and which activity types can develop" (Gehl).The evaluation of performance of residential environment has traditionally been based either on physical monitoring or user satisfaction surveys (chandiwala, 2010)Users give their views and/or feelings about buildings-in-use based on their experience and interactions with buildings (vischer, 2008) as compared to the views of professionals who design and construct buildings and never use them (preiser, 1999) (Nawawi, 2008).

Table 1: Conceptual framework of study for outdoorParameters for user satisfaction
(Source: Author)



In the definitions to which an emotional component is significant, user satisfaction in housing means reflecting the sentiments of satisfaction and happiness to the housing place which also creates these feeling (Gold, 1980) (Weidemann S. &., 1985)Studies of residential satisfaction are basically of two types; those that consider residential satisfaction as a predictor of behavior (intention to stay/move from existing housing), or residential satisfaction as a criterion of housing quality (Weidemann S. &., 1982). Quality isn't expensive it is priceless hence that is what leads too satisfaction of user. (Varady, 2000)stress that housing satisfaction is related to satisfaction with dwelling unit (i.e. physical aspects and personal preferences), satisfaction with services provided, and satisfaction with the neighborhood and area, which also covers the location specific aspects. Satisfaction in the residential environment reflects people's responses to the area they live in. The term 'environment' is related not only to the physical components consisting of the housing

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and neighborhood, but also to social and economic conditions. If appropriate techniques are used in data collection and analyses, it is possible to measure physical, social and administrative factors that determine the level of user satisfaction in the housing area. This information can be used not only for establishing ways in which improvements could be made (Francescato, 1979).

Table 2: Number of families with people of age group of range specified. (Source: Author)

Age group	No. of families with people from age group (n=67)
0-10	16
10-20	55
20-30	52
30-40	35
40-50	55
50-60	40
60& Above	51

Image 1: Hyde park housing society, Pune
(Source: Author)

Looking on this one we can arrive on a point where there are different design dependent and independent variables that can affect the user satisfaction like user type, size of spaces, indoor environment, his or her perceptions; amenities,physical characteristics of the housing, location with respect to city, rate of property, neighborhood, infrastructure connectivity and so on respectively. Most of the times thesedesigndependent
variables are talked upon but the independent variables i.e. the outdoor variables affecting the satisfaction are not looked upon so often.

Methodology

A sample of nearly 67 households (n=67) was selected from a total of 200 housing units(N=200) within the Hyde park housing in Marketyard. The sample represents 34% of the total housing population. The data was collected by having self-administered interviews and discussions with 1-2 individuals from each household.The questionnaire was formulated in a multiple-choice question format so that a person could select the suitable option.The interviewconsistedof the demographic background of the household,frequency of visits to outdoors, play rate of the children in outdoors, environment surrounding the housing, city infrastructure and city amenities around it, location of the housing with respect to city and work place, community and cultural celebrations, maintenance and safety in outdoors satisfaction with the rate of property,preference for suggesting someone for residing in this housing or area surrounding.Within the interviews, individuals were asked to choose adjectives for the outdoor spaces from which surrounding spaces may me better

Setting, sampling and Analysis

All the housing units (N=200) were owner occupied and nearly 25% of the household interviewed (n=67) are residing there for 10-12 years. 5% of the interviewed households were residing for 14-15 years and 10% for 8-9 years. The above statistics states that families are satisfied with the housing environments they are living in. It was observed that out of total sample of households interviewed 75% of them were living in Pune before residing in Hyde park housing society.

The literacy of the households interviewed (n=67) included 79% of ‘n’ have graduate in families ,22% ‘n’ of post graduate in families, 9% of ‘n’ in high school, 3% of ‘n’ in Primary school and 4.5% of ‘n’ in preprimary school in families. It was also noted that maximum number of households had their working place within 5 km area.

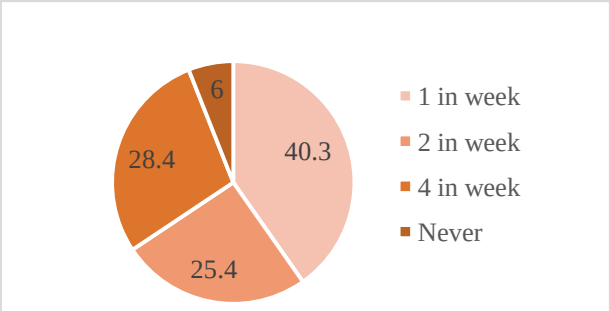

Fig 1: percentage of children playing in outdoors(Source: Author)

Figure 1 shows about frequency of children playing outdoors. It clearly states that 40% households from n=67 said that their child goes out to play once in a week and other times they play indoors and in the lobby in front.

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25.4% of the households stated that he/she goes to play outdoor twice a week and 28.4% households 4 times a week while it was significantly observed that children from 5% households never go outdoors to play. The discussions with households also revealed that there is hygienemaintained in the society. The above study shows a deficiency in children's play area in outdoor even though having a club house in the housing society. Children's like to play garden games usually in their older ages.

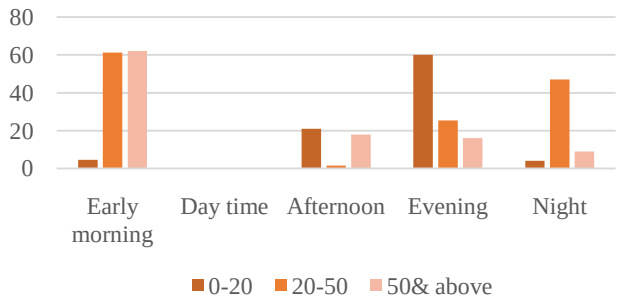

Fig 2: Frequency of different age group of people visiting outdoors(Source: Author)

Figure 2 shows frequency of different age group people visiting outdoors at different times of the day. It showed that people from age group 20-50, 50 & above come in outdoor in early morning hardly children as they are in rush to go to schools and colleges.

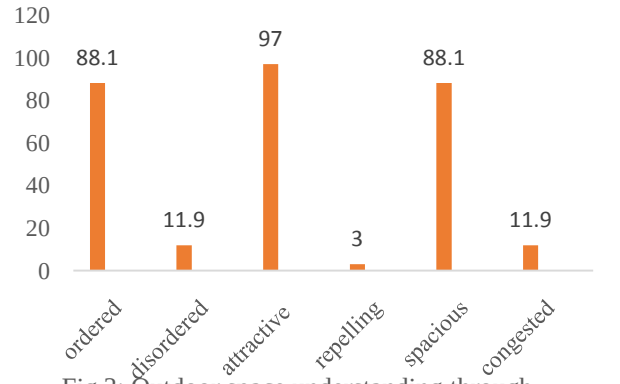

Fig 3: Outdoor space understanding through adjective pairs (Source: Author)

In day time no one visits the outdoors as all are busy in their respective works. While in after noon children and elderly people visit outdoors. And children's usually in the evening as they are back from schools. The frequency of age group 20-50 is high in the night as everyone once back from work walk downafter dinner with the neighbors for stress reliving interactions. Also, on asking for freedom of choice of space for different activities, 55% of the households were positive with this. It was also noted that30% of the households interviewed were on a point where the spaces are not adaptable to all age groups. Looking onto this some common flexible spaces near the housing can be planned where that space might be used by different people at different times of the day both serving the city and housing.

Discussion with households also conveyed that religious, festivals and some private functions take place in the open space around. Specific cultural festivals and private celebrations are celebrated in the outdoors of the society.

Interviews with the people also talked about missing safe outdoor space for elderly people and children play area. Also, with this, 30% of the households interviewed were saying about missing a grocery store in just vicinity, 41% for a school ,83% for a library ,54% for vegetable market and day care facility in the vicinity.

Figure3, the households were asked to choose from the three givenadjective pairs (ordered/disordered, attractive/repelling, spacious/ congested) to know their opinions on the outdoor.

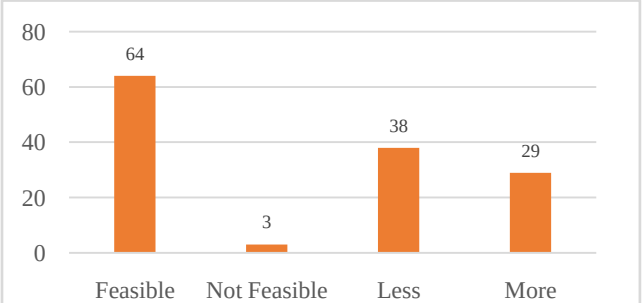

Fig 4: Number of households from (n=67) talking about public infrastructure connection options (Source: Author)

On similar basis, (figure 4) talks about public infrastructure connections of the housing with the city.

All the sample of households were proposed with a question 'satisfied Vs rate of property', the response rate was 80% were satisfied with this.

Nearly 80% from the sample of households were in a view that if they were tenant, they would suggest other to buy property in this housing or vicinity.

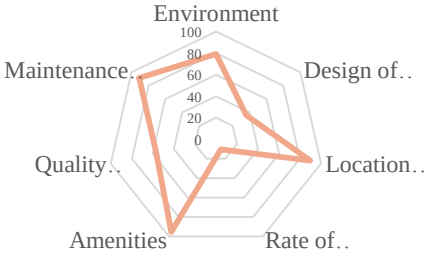

Fig 5: Thematic area inside showing the satiscaction of user with outdoor variables (Source: Author)

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In fig 5: the graph signifies that area inside the polygon is the cumulative of outdoor variables (environment, design of outdoors, location with respect to city, rate of property, amenities, quality infrastructure, maintenance and service) that leads to user satisfaction. The distance between the respective vertices of the two heptagon is the percent of the households prioritizing the variable for their meaning of satisfaction. Connecting all the points of each factor we get a polygon of which area inside it signifies the cumulative user satisfaction.

Conclusion

This paper examined about effects of outdoor variable for user satisfactionin housing.Satisfaction here refers to public convenience first. It was observed that for better satisfaction indoor factors cannot work in isolation but have to work in collaboration with the outdoor variables for achieving better satisfaction levels of the user.The seven factors stated above can become key principles for getting better results and the priorities on each variable can vary depending on the context of the housing.

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I would express my sincere gratitude from bottom of my heart for mentors Ar. Meghana Patel, Ar. Shraddha Gurjar and Ar. VaidheiLavand for guidance with how the methodology to be carried out and to present it as clearly as possible. I would also thank Miss. Shreya Shah for coordinating with the secretary of the Hyde park society and letting me to carry out the interview of the residents there.

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Feasibility Study for Integrating Natural Ventilation Through Skylights in Pune

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Abstract :The earliest kind of skylights were the open holes in domed ceilings known as the Oculi. As domes developed, the Oculi disappeared replacing the same with glass skylights which would stop the rain from entering the interiors. These skylights continued through the middle ages and are still used even in the modern era. In this modern era, sustainable structures are an important aspect of architecture, making natural ventilation and natural light the most important factors in a building. The increase of migrant population to urban areas has led to growing urbanization all over the world. It is observed that many areas in urban conglomeration ,the buildings or houses are placed very near to each other due to which natural light and ventilation have no enough space to travel through the windows. Hence, the other source through which light can be explored is through the roof. Skylights can be used for daylight and also as a natural ventilator. These are one of the architectural elements which are less studied and practiced. This study checks the feasibility of integrating skylights and natural ventilation which would help to reduce the use of electricity and contribute to sustainability. By the experimental method, this paper gives the feasibility of the integration of natural ventilation and skylights in a room in Pune.

Keywords -natural ventilation , skylights , urban congestion, ECBC,Pune.

I. Introduction

The idea of creating openings in the roof and using sun as the source of natural light to light up a room was developed in ancient Rome and continued through the middle ages. Oculi was the earliest type of skylight that was used in Pantheon. Oculus were the openings in roofs that would let in light as well as rain. Thus the use of Oculus gradually stopped as it was not practical to keep this kind of openings in a building where weather conditions are not favorable. This led to use glass as covering for these openings. Romans were the first to use glass in architecture. Thus adding a lantern shaped structure on top of the building, provided some insulation and also gave the benefits of natural light. The light channeling through these openings would create drama in the interiors. As architecture progressed, use of roof openings in different shapes increased which were later known as skylights (ii).

Coming through the ancient ages to the modern era, people are more concerned of sustainability which could be achieved by using natural elements that are favorable for environment. Using less artificial light and ventilation, would take a step forward towards sustainability. Using daylight and natural air in a building by strategically placing the openings, have become an important factor while designing a building. Windows or openings could be placed anywhere in the structure including the roof to let the air and light inside. The areas where window to wall ratio is very less , openings in the roof can be acceptable mode of natural ventilation and daylight. This includes the use of skylights in the ceilings or roofs which will give diffused light into the interiors and also act as an aesthetic feature. But these require more study.

Light effects of skylights depend on the materials that are used as covering of skylights. Skylight materials are divided into basic materials like glass and plastic and types of each respectively. Each material have different effects on light. The use of these materials will depend on the requirements of each project or as per the design. The material should also contribute to sustainability of the building. Growing urbanization has led to the increase in density of the areas leading to close placing of houses.Thus the light cannot penetrate through such small space and then through the windows to the interiors. Openings in roofs are an appropriate option for such conditions. This

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gives a solution of using skylights which would act as opening for daylight and also give natural ventilation.

Thus to find out the feasibility of such concept where integration of skylights and natural ventilation is suggested at the same time through the same source, some experiments are done using the simulation toolVeluxto find out the appropriate amount of daylight and air flow in a building.

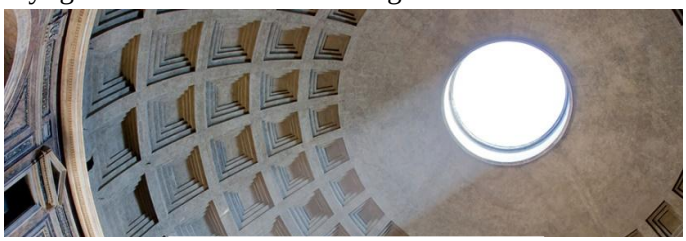

Figure 1 – Oculus (ii)

II.Literature review

A skylight is an opening in the roof or ceiling that provide daylight and natural ventilation to the space. They result in unwanted summertime heat gain and wintertime heat loss, thus manufacturers use various glazing technologies to reduce these impacts including heat-absorbing tints, insulated glazing, and low-emissivity (low-e) coatings(i). Framing material could be wood, metal , PVC ,etc. and fitted with glass or plastic to allow light or ventilation or both into a building. Earliest kind of skylights can be dated back to the 13th century in Rome. Romans have used domes in their buildings, which were completely open from top to allow and also rain into the space. Thus this type of skylights known as Oculus were not favorable to use further. Simultaneously, colored glass was invented nearly in 14th century and was used in small scale. Glass was then used on the top of the domes having wooden frames to stop rain and other atmospheric factors from entering into the interiors. These were known as roof lanterns. Wood as a framing material would allow moisture inside thus replacing that with metal. Later more clearer and larger glass was discovered. This made skylights more larger and clearer and non-colored glass allowed more light into the interiors (ii).

Coming through the middle ages to the modern era, rapid urbanization is observed. Urbanization is the process of population shift from rural to urban areas. It has been observed that 13% people were living in urban areas in 1900 which has increased to 29% in 1950 (iii). India is one of the cities where urbanization plays an integral part. Most of the rural population is migrating to the urban areas due to increasing job and educational facilities. This leads to the random development of the urban areas .Urban settlement of migrants tends to develop near the industrial sector duetheir jobs ,increasing the population density in that area. The increasing density leads to the need of more houses . Its been observed that most of the houses are placed very close to each other deteriorating the laws and giving no breathable space between the houses (iv). Artificial lighting and mechanical ventilation is used all the time as there is no enough room for the natural light and ventilation to pass through the wall openings. This increases the energy consumption of the building leading to non-sustainability. Including daylight and natural ventilation will reduce the use of electrical energy in the building (v).

India being a growing economy has seen rapid industrialization in the recent past and thus this made an adverse effect on the environment. This gives the need for sustainable development to reduce the impact of this industrialization.(vi).Skylights are an European concept where natural light is a scarcity. Using these skylights in Indian context where natural light is abundantly available with more than 300 sunny days is not a good option. But due to changing design trends and living patterns, using this western concept should not be problem is it is placed strategically and designed properly. They might create overheating in the room where there are no openings. So instead of creating openings in the walls to draw out the warm air from the top notch of the room, opening the skylights would be more feasible(xiv).Skylights are not been studied or practiced usually. Soproviding ventilated skylightswill be affordable and also sustainable.

Figure 2- Ventilated skylights(vii)

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III. Methodology

A quantitative method of obtaining desired results was adopted. A model room of 40sq.m in Pune city. As Pune lies in the moderate climatic zone, IMD data for daylight in Punewas used ,whereJune has the highest daylight and December has the lowest daylight. The average wind speed seen in Pune is highest in July and lowest in January(xv).The model room has pitched roof 30 degree inclined at a height of 2.5m.The room is enclosed from all the sides having no windows in the walls/facades for the purpose of simulation. Various sizes of skylights are placed on the roof to check the lux amount entering into the interior through the simulation tool Velux. The sizes of the skylights are referred from a reference literature study(viii). The model is oriented east-west and the skylights are placed on the northern and southern side. The northern side is the best to place openings as it gives even distribution of light without any glare.

The location for this model in Velux was selected by entering the latitude and longitude as 73.51 N and 18.3 E respectively of Pune and the months were selected asJune and December according to IMDwhich have the highest and lowest daylight respectively(ix).

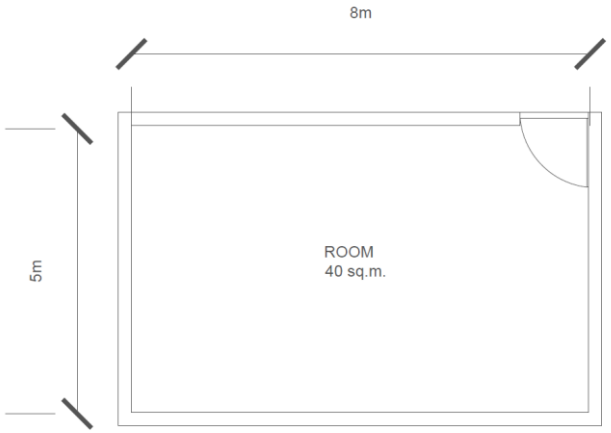

Figure 3 – Plan of the room.

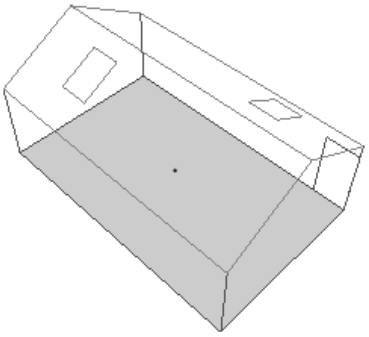

Figure 4 – 3D model of the room.

The following table gives the sizes of skylights which will open upto 50% of the skylight area, were used in the model to check the lux levels in June.

Table 1 – The daylight lux level for June.

Sr.no	Skylight sizes	Lux value
1.	1m x 1m	252
2.	1.2 m x1.2m	501.6
3.	1.2 m x 1.5m	751.2
4.	1.2 m x 1.8m	984
5.	1.5 m x 1.5m	910
6.	1.5 m x 1.8m	1128

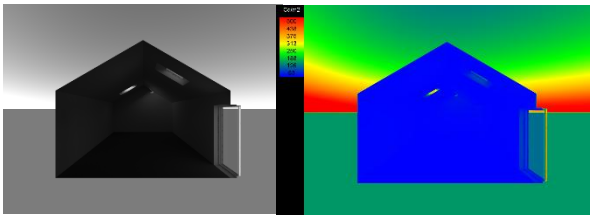

Figure 5 – Velux model having 1m x 1m skylight.

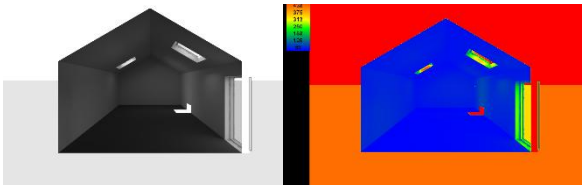

Figure 6 – Velux model having 1.2m x 1.2m skylight.

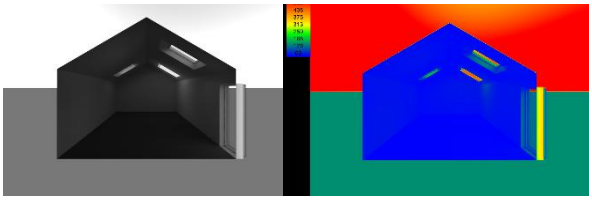

Figure 7– Velux model having 1.5m x 1.5m skylight.

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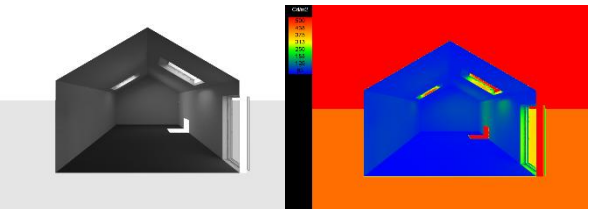

Figure 8 – Velux model having 1.2m x 1.8m skylight.

The values above are recorded in Velux and an appropriate lux level is established for the room of 40 sq.m. Appropriate value for lighting for a room is 500-1000 lux.(xi).Through this table it shows that the 1st and 2nd skylight does not allow enough light into the room.3rd,4th , 5th gives appropriate light into the room and 6th skylight would create glare as they allow too much light into the interior.

Table 2 – The air change per hour values through skylights.

Sr. no	Skylight sizes	Ac/h in a room
1.	1m x 1m	1.45
2.	1.2 m x1.2m	2.12
3.	1.2 m x 1.5m	2.61
4.	1.2 m x 1.8m	3.14
5.	1.5 m x 1.5m	3.27
6.	1.5 m x 1.8m	3.92

The above table shows the air change per hour(ac/h) values in a room through the skylights which would open upto 50% of the opening. Appropriate value of air change for a room in residential area is 3 ac/h-6 ac/h(xii). Thus 4th , 5th , 6th skylights are appropriate for natural ventilation into a room.

For the month of December, which has lower days of daylight , the first two skylights would not provide enough light and ventilation into the room. After comparing both the tables, the 4th and 5th skylight are common and provide appropriate levels of light and ventilation in the room even if the room is enclosed from all the sides.

From the study above, we find that the integration of natural ventilation through skylights is feasible. Looking into the norms of ECBC, the permissible skylight to roof ratio(SRR) is limited to 3-5% (xiii). While following these norms of Energy Conservation Building Code, we find, the appropriate skylight sizes are crossing the limits of 5% skylight area.

IV. Suggestion

Ventilated skylights are an appropriate option for a habitable room in Pune city where the houses are built in congested areas.First three skylight sizes(1m x 1m , 1.2m x 1.2m , 1.2m x 1.5m) from the table 1 give enough lux of natural light, but the air change value of the same skylights in table 2 does not satisfy the recommended air change value of 3-6 ac/h. Thus the feasibility of natural ventilation through skylights is proved.But the norms of ECBC restrict the sizes of skylights to 5% and no appropriate air change is achieved. If the norms permit some increase in the skylight area even by 1 or 2%, good amount of natural ventilation could be achieved through skylights. This would also give the users the whole of the wall area for usage and also solve the privacy issues through the openings in walls. For future use, if someone wills to use the concept it can also help in energy efficiency.

V. Acknowledgement

I would like to extend my gratitude towards my guide Prof. Aprajita Kaushik for her valuable guidance , inspiration and encouragement. Her immense patience and timely help has helped me to reach my goal.

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Child-Friendly Open Spaces: Comparative Analysis of Parks in Pune

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Abstract: The vision of a good city is to design spaces livable for everyone. In India, 39% of the total population are children below 18 years. Planning of a city from the vantage point of a toddler is the best way to start. A child friendly city includes child friendly parks, streets, and other public spaces. This research focuses on child-friendly parks and how does these spaces contribute in physical, mental and social development in early childhood. The focused age group is 3 – 8 years. The methodology followed is live case study along with activity mapping and photographic documentation. The inferences from the research would help in designing child-friendly public parks in future which will support healthier, safer and more exciting urban neighborhoods for young children, for those who care for them, and for everyone.

Key words – Child Friendly City, Public Spaces, Parks, Early Childhood Development, Urban Design, Children

1. INTRODUCTION

1.1 CHILD-FRIENDLY CITY

'If you find children happy, then the city is healthy.' (Ives, 2004) The needs and perspectives of children are largely overlooked in urban development, in spite of children forming a significant percentage of population. A child-friendly city is a city, town or community committed to fulfilling child rights as formulated in the Convention on the Rights of the Child. It is a city or community where the voices, needs and rights of children are an integral part of public policies, plans and decisions. Thus, a child-friendly city is a city that is suitable for all. All countries in the world, regardless of their level of human development, are now involved in implementing the 2030 Agenda for Development. The Child Friendly City Initiative (CFCI) supports local governments in implementing the 2030 Agenda through holistically addressing issues related to the health and well-being of children and families at the local level. (Louise Thivant, 2018)

The concept of child-friendly spaces has been inspired by the idea of child-friendly cities. It refers to developing better and healthier conditions for children within urban areas by focusing on child-friendly green spaces within the built environment. Children need open spaces, in order to connect and interact with their natural environment and

consequently, develop their skills and natural abilities to their full potential. The focus of urban planning should thus be to provide, among others, for green spaces designed particularly for children's needs.

1.2 CHILD-FRIENDLY OPEN SPACES

Public spaces like neighborhood parks and playgrounds are important elements of daily urban life for Infants, Toddlers and Caregivers (ITCs). For the 0-5 age group particularly, playing is a way to have fun, to socialize but also to learn. A big portion of this valuable playing time happens in designated play areas like small tot-lots, parks, squares or green areas. If a city invests in better quality of open spaces for children, it also invests in creating better citizens for tomorrow.

1.3 EARLY CHILDHOOD DEVELOPMENT

Playgrounds provide vital opportunities for children to play. There is substantial research showing the clear link between play and brain development, motor-skills, and social abilities. All learning—motor, cognitive and social—is accelerated by the act of play. Playgrounds that promote different types of activities are important for a child's cognitive, emotional, physical, and social development. Research on brain development shows that the most crucial time for a child's development is in the earlier years. (U.S. Department of Health and Human Sciences, n.d.) Children run, jump and play in a park which aids their motor skills and helps in the physical development. The playground maximizes opportunities to interact with their peers and allows them to express ideas and feelings, and develop their social skills. The act of play by a child stimulates brain development and has a key role in building the foundation and capabilities of the brain.

2. LITERATURE REVIEW

Research done by Cilliers and Goosen on 'Child friendly approaches in a city' stated that the necessity for the urban green spaces with the focus of planning for children within a city are regrettably not recognized due to the extensive

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growth in population, urbanization, adding to exponential housing demands within town and cities. (E. J. Cilliers, 2016) Research by Blinkert and Weaver suggested that conventional playgrounds with limited, fixed facilities and equipment, lack scope for imaginative or creative play. Natural play areas on the other hand are more adaptable and have more scope for creativity. (Baldo Blinkert, 2015) A study by Finnish researchers showed that even a ten minutes visit to an urban park significantly improved stress indicators. (Liisa Tyrväinen, 2013) Parks and open spaces should have a diverse landscape and varied vegetation, natural groundcover, shading and natural play materials. An abundance of literature and authors confirm that safety and security issues are the major problems faced by the children. The concept of child-friendly spaces should aim to enhance the freedom of movement and accessibility to all public spaces safely. Safety refers to physical design elements such as fencing, lighting and visibility. Perceived safety, on the other hand, refers to children feeling safe and comfortable within the space. Though all the studies have tried to find issues faced by children in a city, there is a lack of specific design guidelines to follow while designing a particular child friendly space.

3. METHODOLOGY

A qualitative research method has been followed to study the child friendly parks. The study was through live case studies of seven neighborhood parks in Pune out of which three parks namely Bhimale Udhyan- Bibewadi, Shivarkar Garden- Wanowrie and Anusaya Sabda Lonkar Garden- Kondhwa were chosen for the detailed study. The process of case study included photographic documentation, activity mapping and comparative analysis of design parameters like furniture, color, texture on the basis of safety, accessibility, anthropometry, inclusiveness, and playfulness. The parks were visited on weekends during evening when there was maximum footfall. The parks were studied holistically to understand different zones inside a park namely dedicated play areas, partially child friendly areas, restricted areas and built structures. Activity mapping of users inside the park were documented. The identified users were children of age 3-5 years, 5-8 years, caregivers and other users.

4. DATA COLLECTION AND ANALYSIS

Table 1 shows a comparative analysis of the three parks studied on various parameters. All the three parks consisted of four zones namely dedicated play area, partially child friendly area where there was potential of being more child friendly, restricted areas included spaces which were not allowed to be used, and built structure included pavilions, toilet blocks. Through this zone mapping, it was analyzed that how the area of these zones affected the children and their activities. Dedicated play areas were located at a corner of a park which restricted the kids to experience the entire park. Activity mapping of these parks were documented to understand the concentration zones for different users. Children of age 3-5 years were mainly in the dedicated play area along with their caregivers. It was observed that children of age 5-8 years liked to play among their friends but within the vision range of their caregivers. Hence the location of the furniture determined the play zones. Surface materials used for the play area and the other spaces were also identified to understand how the texture of these materials mattered inside the park.

Figure 1,2 and 3 are the images of play area of all the three parks studied. The use of different surface materials and textures is evident in these images. An urban tactical intervention by TARU Leading Edge, was implemented at Lonkar garden, which included painting of seats and ground surfaces with numbers, characters, color games, and retrofitting of existing pergola infrastructure as sensory boxes, using hanging xylophones, rope art and wall art. This intervention aims to develop young children's cognitive, emotional and social skills through introduction of visual, sound and sensory play.

Figure 1: Play area of Bhimale Udhyan
Source: Author

Figure 2: Play area of Shivarkar Garden
Source: Author

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Figure 3: Play area of Lonkar Garden
Source: Author

5. DISCUSSION

From the data collection and data analysis of the case studies, we can deduce that a park should entirely be child-friendly and thus should be designed accordingly. The design of a park can have a direct impact on a caregiver's perception of its safety and their willingness to use the space. If parents or caregivers know that their children are safe within the margins of a play area, they will relax more and be less stressed. Safety in parks needs to be considered in its overall layout, clear vision lines, clear signages and lighting system. Urban furniture in parks, if well-chosen and placed, can become playful elements for children and toddlers. For kids, colorful benches can become exciting elements to climb, crawl, and have different playful experience. Increased contact with nature has benefits that impact the child's overall development. Similarly for caregivers, access to a green space will have a direct bearing on their mental health.

6. CONCLUSION

This research helped in analyzing parks and their effects on the child development. The findings of this research can be used as the design guidelines to create a safe, healthy and exciting park. This small step can be a great initiative towards a child-friendly city and eventually creating a child-friendly world.

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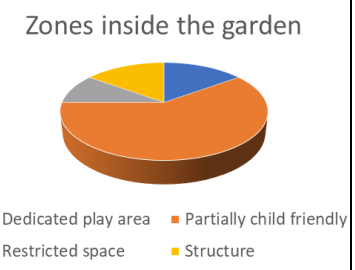
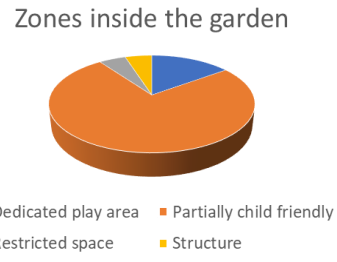
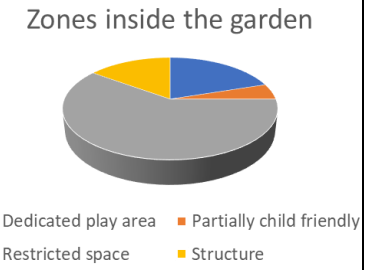
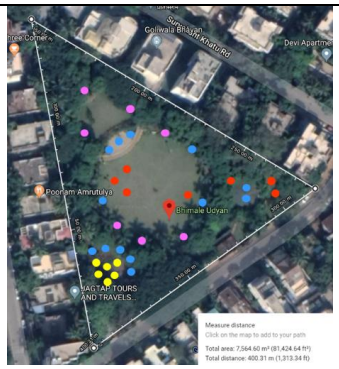
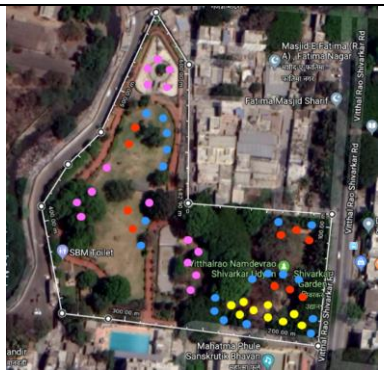
Table 1: Comparative Analysis of Live Case Studies

	Case Study-1 Bhimale Udhyan	**Case Study-2** Shivarkar Garden	**Case Study-3** Anusaya Sabda Lonkar Garden
Description	Bhimale Udhyan, located in Bibewadi in a residential neighborhood, was studied holistically to understand different zones inside the park.	Shivarkar Garden, located in Wanowrie in a residential neighborhood, was studied holistically to understand different zones inside the park.	Anusaya Sabda Lonkar Garden, located in Kondhwa in a residential neighborhood, was studied holistically to understand different zones inside the park.
Zones inside the park	 	 	 
Activity Mapping Kids: 3-5 years Kids: 5-10 years Caregivers Others			
	Design Parameters:		
Furniture	-Total of 10 play equipments were provided in the dedicated play area -Benches were provided in the periphery of the play area and the central ground	-4 big play equipments were provided in the dedicated play area -Boundary plinth of this play area was raised to act as seating for the caregivers -Benches were unevenly located in the entire park	-2 big play equipments were provided in the play area -The play area was lowered than the usual ground surface and the peripheral area was used as seating by the caregivers -Seating was provided in two different parts of the park
Surface Materials, Texture	-Surface materials used in play area: Pebble Gravels -Other areas were covered by soft grass -Use of colorful paver blocks	-Surface material used in play area: Sand -Natural ground cover was maintained on the other parts	-Surface material used in play area: Granular Gravels -A lawn was maintained in the central area -The pathways were painted

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Impact of High-Rise and High-Density Buildings on Sustainable Living W.R.T Mass Transit Systems: The Case of Mumbai, Maharashtra State, India

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Abstract : Mumbai, India's largest citykeeps drawing people from all over the country; creating spatial crisis created by the ongoing urbanization. This effect of urbanizationis addressed through high rise and high-density buildings. This paper aims to study the impact of transit-oriented development along the major corridor of high-rise and high-density buildingsby studying the areas with similar scenario using parameters like travel patterns, routes and modes of conveyance; to study the change in land use pattern in the transit corridor. This paper critically analyzes the role of connectivity systems in contributing to the sustainability of a city.

Keywords**: Sustainable living, High-rise and high-density buildings, Transit-oriented development, Mixed-use development**

1. INTRODUCTION

1.1 What is sustainable living?

According to UN standards sustainable living can be described as an ability of coping and recovering from stresses and shocks, and meanwhile flaring up the capabilities of the assets and creating similar opportunities for the next generation.Itis a lifestyle attempting to reduce carbon footprint and energy consumption by minimizing the use of earth's resources like land, water, trees, etc.
Sustainable living on a city level alsomeans maximizing the utilization and efficiency of the public transport.

1.2Impact of mass transit systems on sustainability

The major domains of the sustainable development of a city are urban forms, transport and infrastructure. These are inter-dependent on each other; the corridor of transit system impacts on the urban form and the land use patterns, better infrastructure leads to better and efficient urban forms and deintensification of the problems of transportation systems.
Mass-transit systems encourage mass interchanges, ingress and egress of the people therefore creates opportunity to accommodate larger volumes while avoiding intensification.

1.3Impact of high-rise and high-density buildings on sustainability

When a city grows in an unplanned manner it leads to decentralization;slowly creating urban sprawls which further creates distinction between the people on the basis of their income as the high-income groups would prefer their private vehicles and thus the public transport will become the transport for the poor.
A high-rise and high-density building is a new urban form; having mixed uses to cater the current needs of the people: housing, employment, health care, education, recreation and services; increasing pedestrian mobility. This leads to the centralization of labour and promotes mixed land use.

1.4Mumbai: Area of study

Mumbai is the most important financial and trade center of the country from the time of the British rule and even before.
In 1688, East India Company started building docks, the trading posts and a fort; this attracted industries and trading communities like the *Parsis*, *Gujratis*, *Marwaris* (from Rajasthan) and started setting up their business practices in the late 19th century. These immigrants shaped the city and their traditional livelihood gave character to the place. Work opportunities were created which attracted people from all over the country.
The mass transit systems were first adopted here. In 1849, the Great Indian Peninsular (GIP) Railway Company was incorporated under the British rule along with the East Indian Railway Company. The first railway tracks were inaugurated on April 16, 1853 between Thane and Bombay (then, Mumbai now). In 1855 the Bombay Baroda and Central Indian Railway Company was founded and they undertook the project to build a railway line from Bombay to Surat. Later, they established the first suburban line, between Virar and a station in *Bombay Backbay*, in 1867. The Harbour Line (of Mumbai railway network) of the GPI. Ltd. started in February 1925 simultaneously with the electrification of the suburban railways.

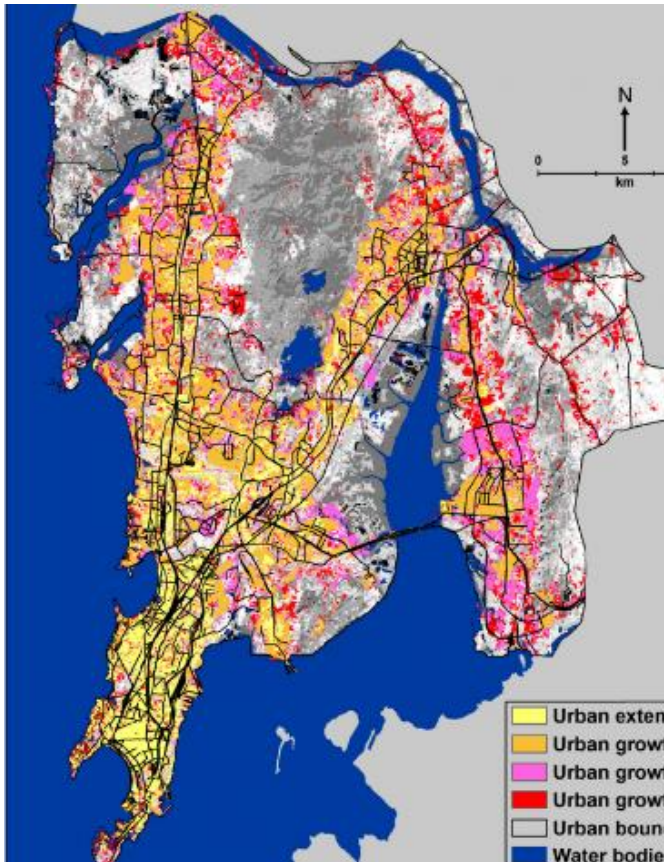

Fig. 1 : Growth of the city from 1973 to 2010 along the main roads

(Moghadam & Helbich, 2013)

2. LITERATURE REVIEW

1.1Understanding the impact of transportation in the case of Curitiba, Brazil.

The city observed drastic increase in the population in the 1960s wherein the population grew from 120000 to 361000; to cope with it became the major concern. The city responded by widening the roads for dedicated public bus lanes and the city got the world's first bus rapid transit system (BRTS).

While the transit lanes were planned simultaneously the mixed-use corridor with high densities were planned for the decentralization of the city core. And the areas with the centralization of the activities were directly linked with one of the modes of rapid transit systems. It was observed that the low-density areas were responsible for increasing the usage of private vehicles. So, the urban planning city was an integrated approach of the land with the transit systems.

2.2Understanding the impact of transportation in the case of Copenhagen, Denmark.

It is the most populated and the capital city of Denmark and the most bicycle-friendly city in the world.

The city has a substantial road network which led to colossal traffic, to deal with it, the city has undergone several strategies to promote sustainable modes of transportation.

The government adopted the *"Finger Plan"* in 2007, which is a national planning directive in order to avoid the creation of urban sprawls and the intensification of the city core.

It was called so because it aimed to regulate the mixed-use development of land along the major transit corridors. These transit corridors were the fingers and the city core: the palm of the hand.

2.3Soria Mata's theory of linear city

Arturo Soria Y Mata introduced the idea of the linear city in the and challenged the theory of the city developing around the nucleus He believed his concept of the linear city would be more apt and efficient in the modern context. He believed that it would enable controlled growth of the city with organized development of infrastructure and transit systems. It also ensures mixed land use with decentralization of the assets and simultaneously de-intensifying the city.

Both, Copenhagen and Curitiba are a product of this theory.

3. ANALYSIS

3.1The impact of transit-oriented development on built-mass.

Transit-oriented development is a type of urban development which promotes mixed-use of land with high density in order to create opportunities for people in walkable distance.Around mass-transit stations are mixed-use areas with smaller building footprints and taller structures catering different needs of the people; making the city pedestrian friendly.

3.2The impact of rapid transit systems as an asset of sustainability.

Rapid transit systems are a core component of sustainability of a city. With the intensification of buildings there will be concentration of activities, thus leading to less demand and use for transport systems.

3.3Analyzing the role of connectivity in Mumbai's sustainability.

In India, Mumbai is the first city to get a mass transit system. Being the economic capital and the largest city, Mumbai has the manpower and economy to bear the regular influx of immigrants while maintaining its existing transportation networks and experimenting with new systems and additions to the existing.

4. FACTORS CONTRIBUTING TO THE CURRENT SITUATION

4.1The industrialization of the city

It 1853 the effect of industrialization spread in the city, it started with the construction of railway line in the Bombay presidency; India became the main supplier of cotton to the world; simultaneously promoting railway that led Bombay to become an industrial center.

4.2Network of transportation system

The government has taken steps to implement the existing scenario of traffic prone mega-city. The Mumbai Urban Transport Project (MUTP): Phase I, Phase II and Phase III undertaken by the Mumbai Metropolitan Region Development Authority (MMRDA) is aided by the World Bank to improve the road and train network.

4.3Effective use of transportation systems

The city has 4 major rail-corridors and 5 government bodies operating the bus services operating at the sub-city level for the convenience of the people, and there are routes connecting these sub-divisions; micro to macro level approach in order to maximize the efficiency of the transit systems.

4.4Influence of technology

The government body has acknowledged the infrastructure deficit in the past and is attempting to implement the issues by adopting the latest smart systems. Mumbai being a metropolitan city and the economic capital has easy access to the latest developments and their use has shown a significant increase in the efficiency of the transit systems.

4.5Scope of experimentation in Mumbai

Mumbai haseasyaccess to the latest advancements in technology and a fully functional sets of various transit systems; addition of new systems would be beneficial, but in the worst casescenario, if it fails, the city pre-existing systems willsupport and cater to the current needs.

4.6Floor Space Index (FSI) along the transit corridors: Present vs Development plan 2034

The city has witnessed the urban growth along the major transit corridors. Because of geographical constraint and inefficient supply (of area), the city grew vertically with high density; with the increase in the proximity to the transit corridors and station, the density increased. But due to the regular influx of the people, with time, the density became uniform throughout the city.

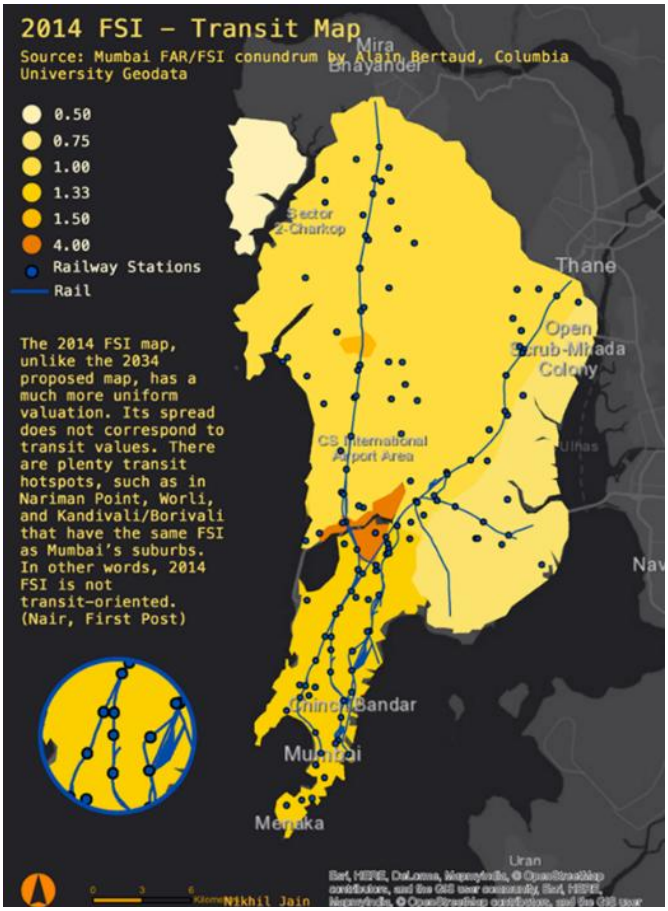

Fig 2(a): 2014 FSI- Transit Map

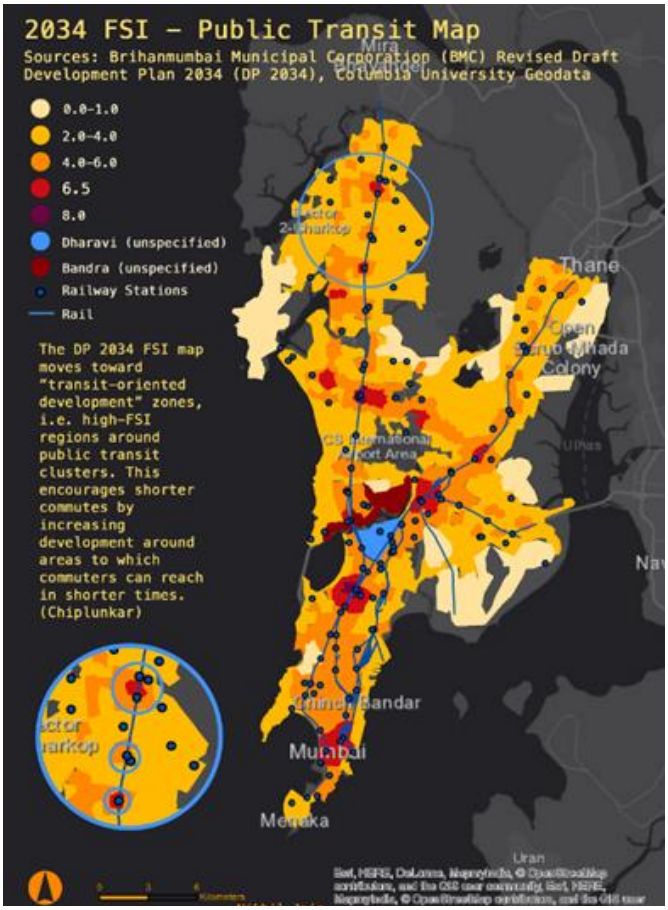

Fig 2(b): Proposed 2034 FSI- Transit Map

According to the new development plan, the government has substantially increased the floor space index (FSI) along the major transit corridors.

4.7Changing Land Use's impact on sustainable living

Mixed use land development and transit system development are two interdependent parameters of the urban development contributing to sustainable living.

Mixed-used development leads to concentration of different kinds of space, thus promoting the pedestrian mobility and use of public transport.

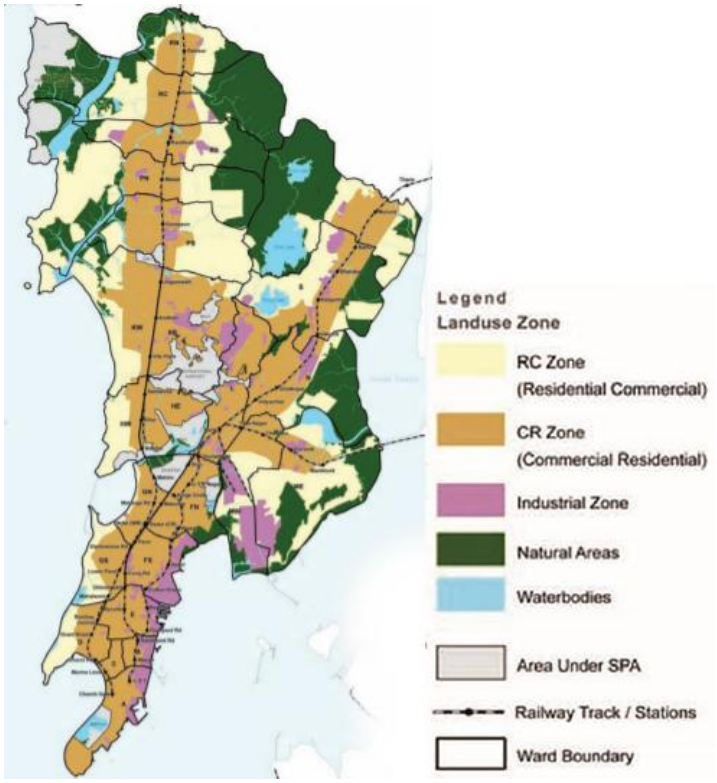

Fig 3: Land Use Map

5. DISCUSSION

Transit oriented development is generally linear, engaging various kinds of activities on a single corridor. Linear cities are always benefitted with transit-oriented development. Mumbai being a linear cityhas benefitted immensely because of its development along the mass transit routes.

It has been identified that along with Mumbai's geography, its rich history is responsible for the current image and urban character and functioning of the city. The city flourished because of the mass transit systems and has sustained time successfully because of it.The urban development was caused because of the development of transit systems.

6. CONCLUSION

All the transformations that have happened were induced by idea of development of transit systems which in-turn led to the mixed usage of land by concentration of various activities in a place;thus density increased and the city grew vertically.

All these transformations and development indirectly led to sustainable living.

ACKNOWLEDGEMENT

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Transformation of Organical Development of Urban Public Place to Public Plazas

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Abstract: ***In the current socio-economic life there are multiple public spaces designed and there are many that are eventually created over the period of time. These are the places used by public for recreation in everyday life. The aim of the topic is to understand how an organical (unplanned) development of public space is transformed into public plaza. The objectives of the research include study of organically developed space, public space, typology public places, public plazas and function of public place as public plaza. The Case studies are based on two different spaces in two different districts in Maharashtra state. Considering the diverse cultures, regions and religions operate at different levels regarding the boundaries of public vis-à-vis private, the nature of spaces is constantly changing. there's a need to create interconnected ecosystem with the city fabric to allow the organic (not through a formal planning process) to constructively engage and mutually coexist with the inorganic(planned) and to see the cities as the sum of its multitude of spaces and people's interactions in them as a reflection of their culture with due course of time and not see cities as buildings and streets.***

Key words – Organical development, Public Spaces, Public Plazas, Transformation, Planned Spaces.

1.INTRODUCTION

In the current socio-economic life there are multiple public spaces designed and there are many that are eventually created over the period of time. These are the places used by public for recreation in everyday life specially to socialize hang out, public events or community celebrations. Although public spaces can be indoor but urban designs are mostly interested in outdoor spaces (between the buildings spaces, squares, markets, parks) are the most common types of places which act in terms public plaza. They are often located at major cross roads, at the end of two busy streets or adjacent to a special natural feature (John Martoni 2010).

In moving through and around the public space we gain opportunities to engage with its private functions and explore how it could conceptually inform the interaction between space of public and private use. There's need to see the cities as the sum of its multitude of spaces and people's interactions in them as a reflection of their culture with due course of time implemented in the usability of public spaces.

2.RESEARCH QUESTION:

How an organical development in public spaces is converted to public plaza?

3.SYNOPSIS:

AIM: To understand how an organical development of public space is transformed into public plaza.

OBJECTIVE:

- To study organically developed space.
- To study public space.
  - Typology of public places.
  - Study public plazas.
  - Study functions of public places as public plazas.

SCOPE:

The Places which had a significant meaning eventually start serving as a public place, that enhances the vibrancy of a city life. City life from the point of view of metro cities to the district level cities.

LIMITATION:

Study is limited to the places or space which evolved into public plazas over the course of time in the districts of Maharashtra in India.

4. RELEVANCE OF THE TOPICS:

Indian cities and public spaces within them are fast evolving and being driven by global economy, western influence and rapid urbanization. Good spaces serve as a stage on which the daily drama of a city's public lives is enacted by providing a unique window into the socio cultural fabric of the city. Considering the diverse cultures, regions and religions operate at different levels regarding the boundaries of public vis-à-vis private, the nature of spaces is constantly changing. there's a need to create interconnected ecosystem with the city fabric to allow the organic (not through a formal planning process) to constructively engage and mutually coexist with the inorganic(planned) and to see the cities as the sum of its multitude of spaces and people's interactions in them as a reflection of their culture with due course of time and not see cities as buildings and streets. (Dr. Devdutt Pattanaik, celebrating public space in India)

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The growth of cities characterized as either new development or re-development and densification of existing city areas extent to informal settlement, supported by infrastructural development in spurts. Underlying the apparent chaos there is a strange order in way the public places in our cities work, and there is unique character and liveliness associated with each of these spaces that become an integral identity of the city.

5. LITERATURE REVIEW:

Organically developed space:

From the ancient times, towns and cities are classified into different types according to their growth such as 'naturally' or 'organically' and 'artificial' or 'planned'. There exists a continuum from organic to planned growth. Organically growing cities develop much more slowly than those which are planned. Cities which grow naturally are formed from through a small scale growth then those which lead to planned growth. Organic change involves both growth and decline, while planned change is more asymmetric, frequently embodying growth nut rarely dealing with decline. More complete picture of the urban development is based on backcloth of natural or organic growth both in space and time. Thus there is a requirement of built environment with consideration to organic change of space. The organically growing public spaces play a major role to the urban development, these spaces need to identified and recognized.

Public spaces:

Public space is a social space that is generally open and accessible to people. It may be a city level converging spot or waterfront spaces or other area within the public realm that helps promote social interaction and a sense of community. Possible examples of public place includes city plaza ,town squares ,market places , high streets and malls ,city level parks and public greens, water edge boulevards and spaces, open spaces within public buildings or spaces within private buildings .a space where social interactions and economic exchanges take place and give birth to string sense of community and commerce-where friends meet , strangers interact ,where homeless or dejected ponder over what to do ,kids play, also where political demonstrations ,religious processions and cultural celebrations take place. Vibrant public places are both democratic and equitable in nature. These belong to homeless as much as they belong to the millionaire.

Many of our public spaces are crowded, chaotic, dirty and unsafe-yet they are alive and throbbing with vitality and dynamics. These places celebrate their democratic and multifaceted nature and offer something of functional utility and value to everyone. To understand their richness and beauty we need to identify the characteristics of these public places and how they evolved over the period according to the requirement of the public. It is equally important to note whether specific planning efforts and formal design contributed to create a sustained and enhanced character of public space or if the space formed historically, or in organic (not through a formal planning process) manner and grew in its importance as the city grew around it. This created spaces turns as public plaza a community amenity that serves a variety of user including building tenants and visitors.

- Devdutt Pattanaik "the flowered gaze'' in Hindustan times june2011
- http://www.pps.org (project for public places)
- LUMEN 2014 City Architecture as Cultural Ingredient

Public spaces are found to be of four kinds – examined from a built form perception.

- Spaces which are intentionally carved out in its current form as part of formal designs.
  Eg. the Connaught place inner circle and its central park in New Delhi.
- Historic spaces parts of old historic towns or monuments, which originally had a specific design function and scale, but after hundreds of years later, its current schema within the city.
  Eg. temple square at Jagannath Puri.
- Spaces which are geographically built and available, and experience has been accentuated by means of some intelligent and sensitive design interventions by city planners.
  Eg. Marine Drive, Mumbai.
- Spaces which through their incidental location in the overall city scheme have over the years became a focus point as the city has grown around them.
  Eg. South extension market, Delhi.

Functionally, these spaces can be broadly classified into following categories:

1. Public building and monument plaza.
2. City squares and cultural spaces.
3. City level urban parks.
4. Bazaar streets and market places
5. Waterfront spaces
6. Religious spaces
7. Ancient heritage monuments spaces.

- Celebrating public spaces in India by Archana Gupta and Anshuman Gupta forwarded by Dr. Devdutt Pattanaik.

The main focus of public spaces throughout remains to re-define our gaze, understand and celebrate the liveliness, timelessness and the beauty of these great Indian urban public places.

6. METHDOLOGY:

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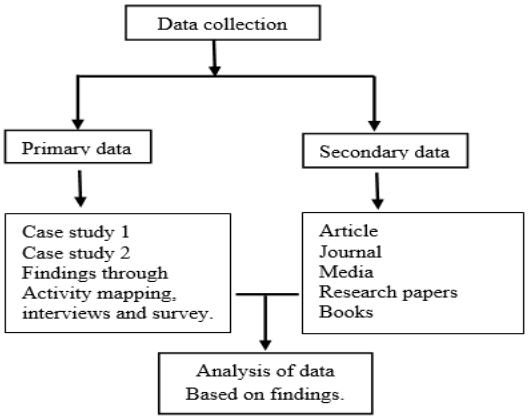
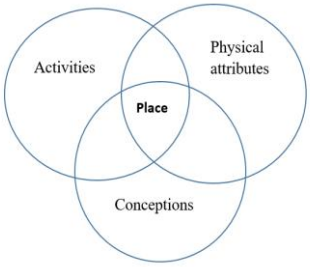


Primary data: Consist of the case studies of the selected two organically developed public spaces. Research method will be followed by the activity mapping of these places along with the interviews and survey.

Activity mapping: It's the method of observing people's movements that relate to the physical characteristics of built environment components and its attribute. It is observing the day to day activity of the people in the space. This mapping demonstrates and describes how activities are allotted and what type of activities take place in the space.



Basic elements of place
By Cater (1977)
Activity mapping method will lead to know the unique identity of the place.
By considering the Montgomery (1998) there consists of two main concepts 'diversity and vitality' which will define the range of activities within that place.

Diversity: This concept refers to primary uses and activities of the place.
Vitality: This concept includes the number of people within the place during day and night time and is analyzed by the number of cultural events taking place along with the street activities.

This method will help identify the proposed concept of organical development into inorganic development and its potential relationship between people activity and physical setting of the place.

- Activity mapping of the places:

This mapping demonstrates and describes how activities are allotted and what type of activities take place in the space. Activity mapping method will lead know the unique identity of the place.

- Survey of the place:

This survey is to ensure that each respondent is able to answer the questions at a level playing field to biased opinions that could influence the outcome of the research. This involves asking people for information through the questionaries' about the space they have lived through. By the general questions how the space severed over the time and changed its functions.

- Interviews:

This method is appropriate when there is need to collect in depth information on people's opinion, thoughts, experience and feelings. This interview can be conducted face to face or over the telephone with the local people professors etc.
Here people spoke about the place being developed or changed according to them over the period of time.

The research can be conducted in the district level cities of Maharashtra such as Satara and Karad.

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SATARA: The surrounding area the Rajwade in Satara.
KARAD: The surrounding areas of Priti sangam -ghat in Karad.

7.DATA COLLECTION:

Case study 1 (Ancient monumental building):
RAJWADA

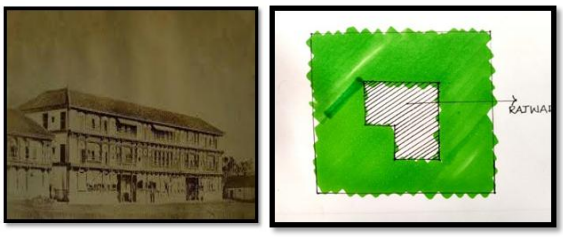
Figure. Rajwada

Rajwada located in the Satara district of Maharashtra. An historical place built as the residence, for the descendent of Maratha Empire. It is situated in the core area of Satara city. It is one of the ancient monumental historic building in Satara.

Rajwada built as the residence for the descendants of Maratha Empire in 1844 was surrounded by the green land. There has been development of the space surrounding the rajwada over the time. There is primary school built by the descendants of Maratha Empire in 1937. There is a Aryangal hospital built in 1943 as the health facility for the people in Satara and surrounding area. Rajwada mandia is the vegetable market building allotted to the
increasing encroachment surrounding Rajwada. The Panchpal haud is the Durgamata Mandir built in 2017 due to the importance and worshipers of the goddess around that place from an ancient time. These are the fewer places surrounding the Rajwada which mark the landmarks and the buildings that were constructed over the time as per the requirements.

8.FINDINGS AND CONCLUSION:

Figure. Rajwada Mandai-2004, Rajwada Choupati-2018 area

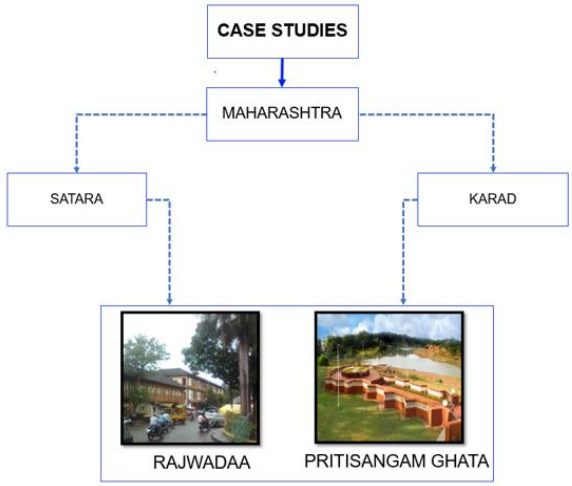


1950:

Rajwada built as the residence for the descendants of Maratha Empire in 1844 was surrounded by the green land. During 1950 there were still very few built structures around the Rajwada it was surrounded by the green land. The area in front of the wada was used for the rest area of animals like horses and elephants.

1960:

Figure. Weekly Market



By 1960 there was an increase in the settlement around the wada there was primary school built and a health facility introduced. With the increasing needs of the people there started weekly market, where people from the nearby villages would come and sale the goods.

1980:

Figure. Part of Rajwada-Primary School

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By 1980 the descendants of Maratha Empire had moved to the new Rajwada building. The part of wada started functioning as the primary school. There was an increase in the people migrating to Satara. There was also increase in the vendors in the weekly market (on Saturday). Hence the daily market began which would be situated in the lane between the wada and the school.

2000:

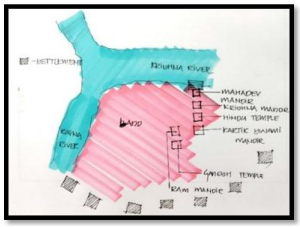
By 2000 Rajwada functioned into two activities in two divided parts of wada one as the Pratap Singh Raje Bhosale primary school, and the other part as the justice court. The issue of encroachment around the wada had not yet stopped there was a rise in it. The area surrounding the wada had grown live due to the public activities held on daily bases. There were stalls of eatables being set along with the market.

Figure. Encroachment stalls, DP 2001 Rajwada area

2019:

By 2014 Rajwada mandai building was allotted to the

people holding vendor license. Since there was great disturbance in the activities held in the wada. This though reduced the number of encroachment but it still did exist. Though the market moved to mandai building the food stalls replaced them creating the area called Rajwada Choupati. There are yet many issues regarding the impact on economy of people being displaced, current usability of the space in front of wada, vibrancy of the space etc.



CONCLUSION:

Over the period of 50 there has been a change in the activities of the Rajwada along with its surrounding area. The function of the wada had an impact on the activities held outside it. From a weekly market to the choupati there has been an evolvement of the space surrounding the Rajwada. Though the activities differed the vibrancy of the space took its own form throughout the time. The people engaged in the activities also differed from the migrated farmers to the license holding vendors. The vibrancy of the space evolved creates its own identity in the city. This organical development of the public place serves as the public plaza.

Case study 2 (Geographically built- water front space): PRITISANGM GHAT

Pritisangam ghat is a place where Krishna river and Koyna river meet each other. It is situated in Karad. Both rivers originate from Mahabaleshwar and meet each other at Karad from front. This sangam is very rare in world where two rivers come from front and take a turn and become one river.

8.FINDINGS AND CONCLUSION:

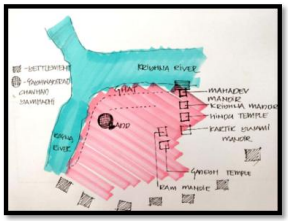
Figure. Pritisangam Ghat, Temples by the river

Pritisangam ghat is a place where Krishna river and Koyna river meet each other. It is rare geographically formed sangam. There are several legends connected with the formation of rivers and the establishment of the temples. eg. Rivers are considered sacred and believed that a holy dip in these rivers will erase all the sins. Hence there are various temples located at the sangam Mahadev temple, Ganesh temple, Kartik Swami temple etc.

Due to the existence of the water body there has been a town and settlement grow along it in Karad.

Figure. Growing settlement around Ghat

Since throughout the history of human civilization river valley is an ideal location for human settlement due to importance of water in human life. The Ghats are more intricate spaces within the city, and their dialogue with the city is experimental.



After the death of Yashwntrao chanvan (the first Chief Minister of Maharashtra) In 1984

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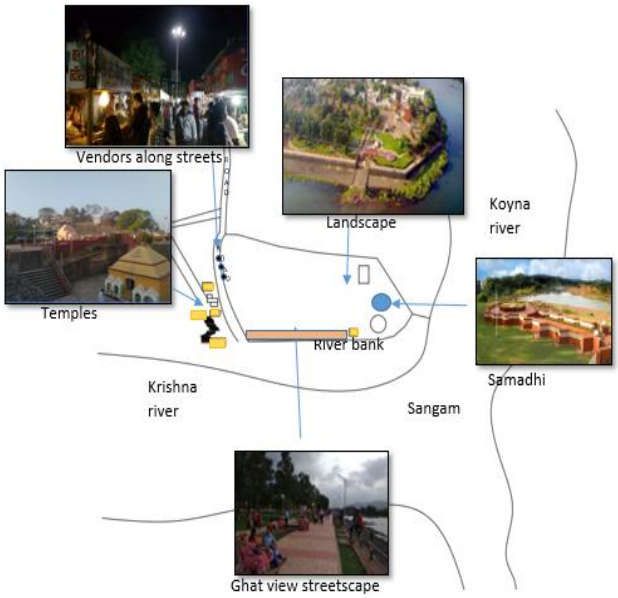
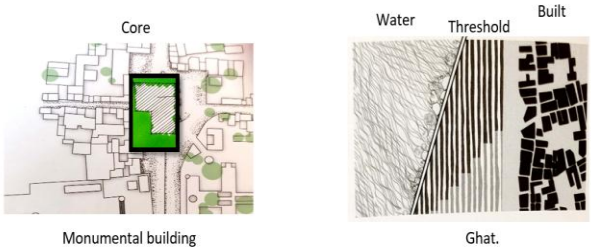


his samadhi (resting place) was constructed along the



Pritisangam Ghat.

Figure Ghat view and street, walkways along ghat

Along with the religious believes like sangam temple and the scenic view of sangam, the Samadhi of Yashwantroa Chavan also become major reason for people visiting the ghat area.

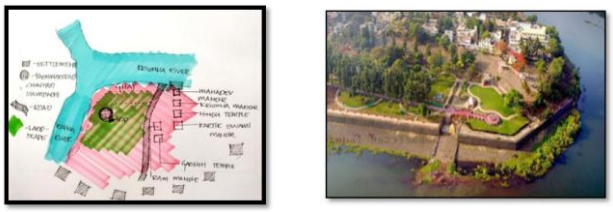


Figure. Area surrounding Pritisangam Ghat

Figure. Landscape developed around ghat

Since ghat is the edge that is activated by the locals for whom this is a major breathing space of the city and also has become one of the tourist place in Karad that has drawn by the combination of natural plus man – made scenario. The number of people visiting ghat has increased the area along the Samadhi and the temples have been redeveloped with streetscape, landscape, garden, kids play area and walkways and scenic points.

Figure. Pathways along garden, Vendors around street

Increase in visitors there has been increase in the public activities and the streets leading to ghat and areas along the landscape developed is crowded with the encroachment vendors and has started serving this public place as the public plaza creating one vibrant atmosphere in the city.

CONCLUSION:

started evolving. Vibrant public waterfront space became the signature of the city. The same space with the sangam of rivers today serves as a significant public plaza with diverse mix of public activities that adds to the unique factor of city. From the religious believes to the Samadhi construction there was an increase in the importance of the space. There is increase in the public engagement surrounding these place.The place that was geographically created over a period of time

8. DATA ANALYSIS:

The reasons for the conversion of organical development of places as public plaza:

The original purpose of the space.

- The change in its functionality: as seen in change in the functioning of Rajwada.
- The change in surrounding of the space: starts creating an identity seen in the Pritisangam ghat.

Public spaces being the most vibrant and live identity of the city sometimes remain unorganized and unrecognized due to the organically development of such spaces. These are prominent spaces that is witness to the majority of community and city level events like festivals, lectures, national days, religious activities etc. These spaces have the potential with time, to eventually integrate itself deeper into the fabric of the city. Public spaces in historic cities are recognized and associated with a corresponding historic monument. In the

Evolving fabric of traditional cities, these monuments and surrounding areas are interwoven within the fabric of the city. Water attracts people, provides a focal point in the

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city for the day-to day fundamentals of life as well as a backdrop for celebration and rituals, recreation, fishing, tourism etc. Hence we find many public spaces built around rivers, lakes etc.

The spaces such created are then activated by the tourists who visit it as well as the directly linked livelihood and allied cultural activities associated with the spaces. The scale may be larger enough with time to develop and sustain a significant urban area serving as a developed public plaza.

ACKNOWLEDGEMENT

Primarily I would like to thank God I would like to express my deep sense of gratitude from the bottom of my heart to my guide and co-guide Ar. Revati Daware and Ar. Seemanthini Chaphalkar for his valuable guidance, inspiration and encouragement. Indulgence in this work helped me to reach an irreproachable destination.

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The Urban Memory Association in Public Open Spaces:

Case of Mahatma Phule Mandai, Pune

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Abstract: ***Urban spaces define the historical and cultural character of the city. Indian streets are viable public spaces which retain the functional character yet providing a psychological meaning to people's lives. The memory that people make with a space leaves a lasting impression in their minds, advancing from the past to the present. The streets around the Mahatma Phule Mandai in Pune highlights the city's social and political development. The image of a place related to the associated memories of the people with the place has not been studied yet. The research methodology of this paper involves reviewing the historical development of the Mandai, cognitive mapping and interviewing the users of Mandai.***

Keywords: ***Urban space, cultural character, viable public space, memory, image, associated memories***

I. INTRODUCTION

1.1. Urban Space

Urban open spaces are a critical site for cultural, political and economic life from the civilizations to the present day. (Stanley)People interacting in such urban spaces is an important dimension of the public space. (Zahrah, 15-17 June 2011)The image reflects the psychological inheritance of the people relative to the place. The quality of life of people in urban areas is the outcome of the interaction of people with the urban environment. Being a cultural product of its setting, such spaces project a complex social and political meaning to the people. Indian public spaces provide a physical setting for socio-economic activities. The streets in religious precincts showcase a strong sense of religious spatiality, reflecting social functions. (Sehgal, 4 May 2017) The narrow streets are perceived as humane, warm and personal; adding to the values of the space.

Do such psychosocial processes in such public spaces have continuity in time and space, as the memory of life in a big city?

People tend to experience the world that is connected physically and mentally with the past events. Memories act as a threshold of the past events. (Ahmadi Oloonabadi, 2011)Even when an event happens and time elapses, it is the space of the event that remains in our mind. This feeling of familiarity of a space creates the sense of the place. (Mowla, 2004) Memory is the diffusion and transformation of meaning across time and space, both to the rituals of everyday life and to the special moments of remembrance. (C.J., 2004)Memory associated with a space highlights the psychological significance of the place. Such places become the focal points of cultural spirit, increasing social interaction. The space association can add to the memory, meaning and perception of the place, but at the same time the loss of identity can also weaken the depth of the meaning and attachment to the place. (Sumaiyah Othman, 19-22 March 2013)

1.2. Introduction to Pune

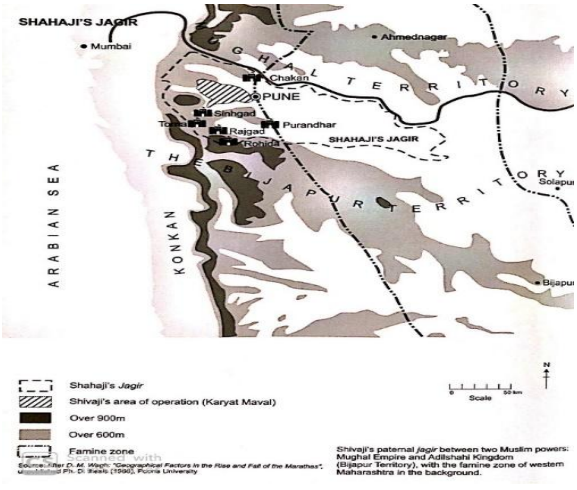

Figure – 1.1 Map of Pune showing the provinces

Source: Book: Pune Queen of Deccan

Pune, the second largest city of Maharashtra, is located on the Deccan plateau, along the Mutha river. Pune was the seat of the Peshwas in the 18th century, which was a strong political center on the Indian subcontinent. The city is also known as '*Puṇyanagara'* meaning "city of virtue". Pune reflects the blend of traditions with modernity. The old

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core area of Pune consists of 18 peths and is symbolic due to the presence of the Maratha culture; epitomizing arts and crafts, music and dance. The peths represent the cultural past in harmony with the chaotic present.

1.3. Mahatma Phule Mandai

The Gothic-style building of Mahatma Phule Mandai, located in the old core of Pune, is the biggest decentralized market of Pune. The market building taking 4 years, was completed in 1886, with the structure carved in local grey stone and wood. The structure is dominated by an 80 feet central octagonal tower, with eight entry wings signifying eight directions. Gothic arches flank the entrances of these eight wings.

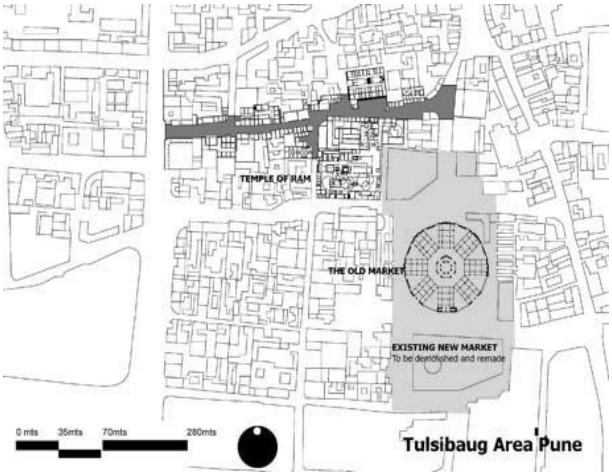

Figure – 1.2 Plan of Tulshibaug, Pune

Source: Internet-Shirish Joshi

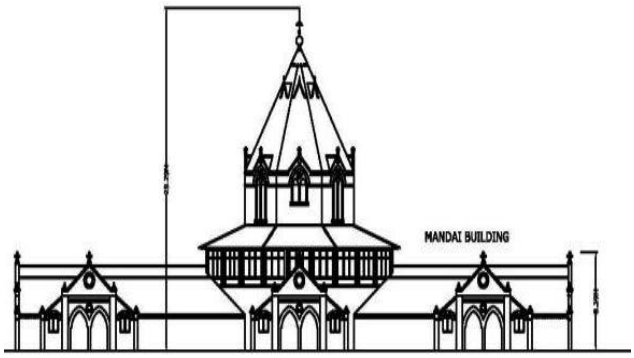

Figure – 1.3. Elevation of Mahatma Phule Mandai

Source: Kimaya

Originally called Reay Market, the Mandai was built by the Poona Municipality also serving as their Municipal office. The British era in India, especially in Maharashtra was characterized by the display of power by the Britishers against the Peshwas. The Reay Market stood as a symbol of might, erected right in front of the Tulshibaug Mandir. The height of the structure was intentionally kept taller than the shikhara of the Tulshibaug Mandir, to show the domination of British over the Peshwas. The Post-Independence period was marked by an ironical turn of events. The Mandai was renamed after Mahatma Jyotirao Phule, the very man who opposed its construction. Over the years, the Mandai has lost its symbolism, following the urban growth of the city. Once the tallest structure in Pune, the Mandai became an agglomeration of social and cultural events. With around 526 stalls of fruits and vegetables, the area is a vibrant market place, showcasing activities like Ganesh Chaturthi, Gokul Ashtami, Ram Navami. (HOLEY)

This place has now lost its beauty and age-old symbolism due to the unplanned growth around, and placement of intrusive elements.

II. METHODOLOGY

The methodology followed in this paper is collecting historical data regarding the growth and development of the Mahatma Phule Mandai; analyzing the space on the parameters stated in the Kevin Lynch theory and also understanding other aspects reflecting the sense of the place. A study of the qualitative aspects of the space was done. A series of interviews was taken of the users in and around Mandai; the buyers, the sellers and the visitors. An open-ended questionnaire was prepared to assert the symbolism and meaning of the structure in the people.

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Figure – 1.4. Evolution of Mandai- Mahatma Phule Market (Reay Market) circa 1900, 1920, 1980

Source: Book: Pune Queen of Deccan

Figure – 1.4. - Mahatma Phule Market- Present day

III. RESULTS

3.1. Kevin Lynch Theory

Kevin Lynch in his theory of imageability discusses the quality of cities according to the legibility factors of the elements perceived by the observers. People create mental images of a city as a result of their memory and meaning. The theory emphasizes on the component of 'identity' and 'structure' of the urban elements as two important factors in affecting environmental image. Lynch highlights the five major urban elements that enhance the imageability; which are paths, edges, nodes, districts and landmarks. Lynch states vitality as the degree to which the form of places supports the functions, biological requirements and capabilities of human beings. Vitality also refers to the degree with which an urban space is socially successful. (Oktay, 7-9 December 2011) He also defines spaces according to the extent to which a place feels alive or lively.

3.2. Application of Kevin Lynch theory in Mahatma Phule Mandai

Kevin Lynch established a connection between psychology and environment by asserting such parameters. (Kevin Lynch mapping method: Physical & Spatial Characteristic Of Environment)

The mental map created by people of a city are based on the following parameters as stated by Kevin Lynch. The analyses of the Mahatma Phule Mandai is done on these five parameters.

3.2.1 Path: Path is the most legible element in the city image, signifying the linear form in which the observer walks. The path leading to the Mandai is marked by narrow, congested lanes in the old core of Pune. Earlier, the path towards Mandai was traced from the monumental fortification of Shaniwarwada.

3.2.2 Edge: The Tulshibaug Ram mandir was an important structure created by the Peshwas during the British rule to remind people of the glory of the Maratha empire and boost their morale. The Mandai came up right in front of the temple, with its height bigger than the shikhara of the temple.

3.2.3 Landmark: The Mandai itself stands tall as a landmark, right from the era it was established. It was the site for remarkable cultural and social events. The land once marked a space for protests, cultural gatherings and festivals.

3.2.4 Node: The node acts as a prominent market space in Pune, where fruits and vegetables are sold at a cheaper price than the rest of the city. The node is characterized by stalls of the vendors.

3.2.5 District: The Tulshibaug complex is a prominent market area in the city and the peths have a distinguished urban pattern from the rest of the city. (Lynch, 1960)

3.3. The qualitative aspects can be studies under the following heads which define the sense of the place.

3.3.1 Identity: Identity means a distinction from other objects or place. The Gothic building of the Mahatma Phule Mandai holds a strong identity right from the time it was built, making it unique for the place it was built in. The events also mark the identity of the place, adding to the spatial attributes and memory of the place.

3.3.2 Structure: Structure means a relationship to larger pattern of other elements; the object is not seen isolated from the surroundings but as a part of all the environmental components.

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3.3.3 Meaning: Meaning means a practical and emotional value for the observer. The meaning of the space is relative to its culture. People relate to the activity which in turn associates to the mental image of the inhabitants. The Mandai is a space for major cultural, social, economic activities of the city.

3.3.4 Association: The association that one has with the Mandai is symbolic. The vendors at Mandai have a strong association with the space. There have been generations of vendors sitting at the same place from years together.

3.3.5 Congruence: It is the relationship of the form to its function. The degree of congruence is less in the case of the Mahatma Phule Mandai. The structure was designed as an office space for the Municipality; now the Mandai serves as a market space.

3.3.6 Transparency: There is a degree of visibility of Mandai. The events in and around Mandai have immediacy to the passers-by.

3.3.7 Legibility: Lynch considers legibility as the physical and spatial characteristic of the environment. The visual sensation of colour, motion, smell, touch and sound are cues of the orientation in Mandai. The legibility of Mandai enhances the identity, structure and meaning of the surroundings.

3.3.8 Accessibility: The accessibility is defined as the ease of the ability of reaching a place. The accessibility is through narrow, bustling lanes of the old core of the city, with markets and pedestrian crowd.

3.3.9 Usability: Today the use of the structure has shifted from the intended use. It was built as an office space of the Poona Municipality.

3.3.10 Visibility: The location of the Mandai is prominent, with high visibility. The visibility in the 18th century was defined from the Shaniwarwada.

3.3.11 Visual Attraction: It is concerned with the physical characteristics of an object to strengthen it as a landmark. The characteristics that shape this factor are:

Façade: The façade signifies the Gothic era of architecture, with a building made in grey stone and wood.

Shape: The Mandai is a prominent structure in plan; octagonal central tower with eight flanges radiating out in eight directions.

Colour: The grey building in the midst of the vernacular constructions of Pune is remarkable and hence memorable. (Kevin Lynch mapping method: Physical & Spatial Characteristic Of Environment)

IV. CONCLUSION

The world has evolved continuously and will not stop. Cities are fast changing. Factors like increasing population, sprawling development, failing infrastructure affect the growth patterns of the cities if not looked after. The modern Indian cities have lost their degree of homogeneity and also their expression of the culture. Such urban areas have been transformed into inhuman spaces which reduce the quality of life of the public.

On analyzing the mental image of the Mahatma Phule Mandai, we assert the influence and relation the structure has on the people using the space. The Mandai holds a strong historical significance in terms of the events as well as the association that the people have with the structure. The users of Mandai reminisce the space. One major finding is that the surrounding structures dominate and diminish the presence of Mandai in the present day.

Such prominent structures of the past shall be preserved and there should be stringent laws regarding the growth in the surrounding areas.

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I am grateful to D.Y. Patil School of Architecture for inviting me to write this paper. I would express my deep sense of gratitude to my mentor Ar. VaidehiLavand for her guidance, inspiration and encouragement.

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Transformation of Transitional Spaces in Traditional Maharashtrian Residential Built Form.

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Abstract : The transitional spaces are the spaces which connect two or more different spaces, these spaces also act as buffer zones for indoor and outdoor spaces. Looking at Indian architecture, there are features like pavilions, courtyards, terraces, vestibules and thresholds which accentuate transition. In Maharashtra, the transitional spaces are observed in residential built environment performing similar roles traditionally. These spaces play an important role in the various festivals, social and cultural activities. The research focuses on the physical aspect of the space. The research examines the various transitional spaces used in Maharashtrian architecture by investigating the transformation of transitional spaces according to different timelines. The paper concludes with understand the transformation of transitional spaces according to the time and how the traditional values are adopting the change in the transitional spaces.

Keywords: Transition space, Maharashtrian residential built form, Maratha Architecture, buffer zone, traditional aspects, socio cultural association.

Introduction.

What are transitional spaces?

The transitional spaces are the spaces between indoor and outdoor spaces, these spaces act as a buffer zone for going in and out. It is also defined as a link or a connecting space between two enclosed spaces. These spaces are mainly provided in structures like educational buildings like schools and colleges, research centre, commercial buildings, and even residential buildings. Transitional spaces are mainly created to give user an experience of a buffer space or a zone to connect indoor space and outdoor space. It can be also link between public space and private space. Transitional spaces usually consists of entrance foyers, corridors, buffer zones, lobbies and other transitory areas used inside a building.

In Indian architecture, the transitional spaces plays a very significant role, especially in residential buildings. The transition spaces marked the boundaries of the living space. These spaces played a role in dividing and connecting the inner and outer space. The gate, the security door, the threshold. These spaces were decorated and ornamented to highlight the transitional space.
In traditional Maharashtrian architecture, the typology and form have been transforming with the time. They vary in usage and connection. In earlier times the villages were scattered and were having lot of space to construct their home, hence the transitional spaces during that time were large as compared to transitional space present. In the transitional various activities are happening since many ages like welcoming ceremony of bride after the wedding, performing pooja in these spaces for festivals like Ganesh Chaturthi, Diwali, drawing Rangoli daily, etc. These cultural and traditional activities are connected to these spaces. As the transitional spaces transformed the cultural and traditional activities also transformed with them.

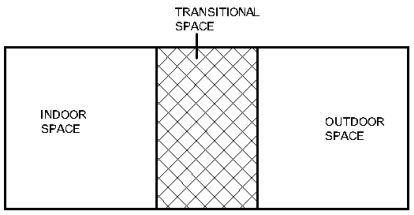

Figure 1: Transitional space

Research Background

Architectural spaces that can envelope like a physical presence. Transition is in between state. In architecture it is defined as a link or a connecting space between two enclosed spaces and also in the circulation spaces, in the form of corridors, stairwells and atriums, it cannot be avoided in design of most of the building. The percentage of these spaces may vary according to the function. Their functionality also varies according to the appropriate requirements of the user.

These in between spaces offer an opportunity to interfere and create a space which re-engages the person, in that space or passing through that space, through repetitive interruptions or pauses. The spaces could create a subtle interconnections. Which can be exploited and temporal experiences could be defined through architectural interpretation of transitional spaces.

The use made of the spaces outside the home the home is more obvious in southern societies. In Mediterranean countries, balconies and courtyards are for women, while the men occupy the public square markets.

However, according to J.Miller, countries of the north do not do not ignore this use of the threshold, and we are familiar with the symbolic use of the threshold of the Amsterdam

house with its three vanished ceramic steps. It recalls a truth that these extra spaces are really much more useful to poor than to rich and that the street has always been the poor man's sitting room. (Nicole elb harle, roles and meanings of transitional spaces)

Transition space plays an important role in residential spaces. These spaces are used maximum during festive events. In Maharshtra transitional spaces have both traditional and social importance.

These spaces are used for various purposes like, drawing rangoli, celebrating festivals,etc. These activities are performed by people since many years.

As these spaces have traditional importance as well as social importance. Social importance is when any guest or a respected persons visits a house they are welcomed at the entrance or in the transitional space.

These socio cultural activities have transformed along with the transformation of the transitional spaces in residential built form.

Research Methodology.

Transitional spaces plays an important role in residential spaces. These spaces are used for various purposes like activities during festivals, etc. In Maharashtra residential traditional transitional spaces have both traditional and social importance. This research is done by studying various traditional structures of Maharashtra which have transitional spaces according to the different timeline and how the transitional spaces are transforming. And along with these spaces how the traditional and cultural activities are transforming. This research only focuses on the physical aspects of the space and the socio cultural activities related to it. The research methodology is by doing the case study of various structures according to the timeline.
In this research I have took three different structures according to different time line and having different volume of transitional space.

- Vishrambaugh wada, Pune.(1807)
- Jagtap's Residence, Nashik.(1970)
- Arunodaya Society, Pune.

By studying these spaces, the various cultural and traditional activities happening in these spaces are noted. And the socio cultural aspects are studied.

Scope and Limitations

This research is based on the physical and socio cultural aspects of the transitional spaces. And it is only restricted to the traditional maharashtrian residential spaces.

Vishrambaug Wada, Pune.

This wada was constructed in year 1807. The place was owned by bajirao peshwa the 2nd. Following activities used to happen in the transitional space of the wada.

Activities:

During various festivals the transitional space is decorated and ornamented in various ways like: tying garlands made of the various natural elements like mango leaves, marigold flowers, and jasmine flowers. The space was decorated mainly during the festivals like Diwali, Ganesh chaturthi, dussehra, gudi padwa, holi, navratrti and many more. According to the each festival the transitional space is used in different pattern and different activities takes place. Some examples of usage of these spaces are: lighting oil lamps during Diwali, drawing rangoli during various festivals.

Socio cultural activities:

In olden time or during the peshwa era, when the peshwas or their commanders used to return from war or from abroad after many days to the wada they used to be greeted in these transitional spaces, the ladies used to greet men with the aarti thali. If any elders or respected person comes to visit the place he is also greeted in the same way in the transitional space. In the same way after marriage, when the bride enters the wada she is greeted in the transitional space and various other cultural activities happen in that space.

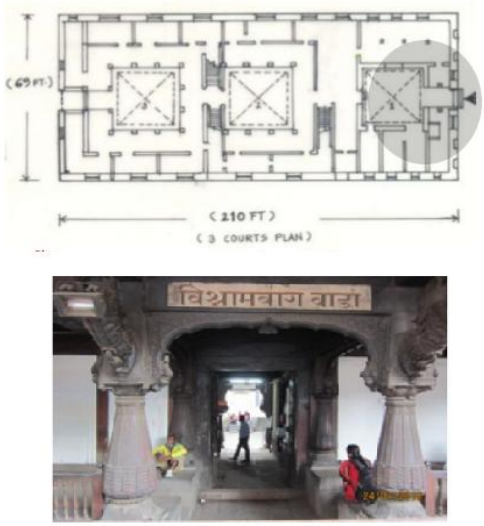

Figure 2: Plan and photographic study of transitional space at entrance of vishrambaug wada, pune.

When the wada was constructed there were no security doors or the security guards so the soldiers were appointed as the guards and they were appointed at the entrance in the transitional spaces.
If any goods seller or a stranger wanted to enter the wada they were asked the purpose of visiting the wada from the inner end of the transition space, the conversation between owner and the stranger used to happen from the both ends of the transitional spaces, in short the transitional space used to act as a security space in those times.
Similarly when a person used to pass away in a family different rituals takes place in the transitional space before taking the deceased to the cremation ground.

Jagtap's Residence, Nashik

This is the residence of Jagtap family which was constructed in the year 1970, almost 163 years after the vishrambaug wada

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was constructed. Between these times many things happened that affected the traditional mahrashtrian architecture like, British rule in India, modernism, etc. According to the time the size of transitional spaces changed according to economy classes of the people, in most of the cases the transitional spaces got reducing in the size. The transitional in Jagtap's residence is less than the transitional space in vishrambaug wada.
The activities happening in transitional spaces are similar but some of the activities got transformed and some are still the same. Some of these activities changed but the purpose still remained the same. Along with that the material used for ornamenting the transitional space also transformed along with the time, e.g. Along with garlands people started using electronic lighting, various light, etc.
Following activities happen in the transitional space of the bunglow.

Activities:

Most of the activities happening are similar to the previous example. Some activities are cleaning the space daily with water daily then drawing rangoli, this was done every single day in this space. During festivals the space is decorated, this space is less in area as compared to the wada. During ganeshotsav the idol is worshipped in the space before bringing it inside.

Socio Cultural Activities:
When any family member comes home from abroad or a guests visits the home from they are greeted in the transitional space. If any salesman or postman knocks on the door they wait in the transitional space till the owner unlocks the door and meet them. On the occasions like birthday parties or any function the transitional space is decorated with garlands flowers, etc. by doing this the people around also notice the activity going inside the house.

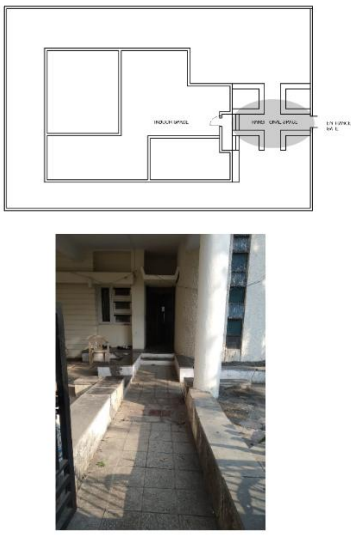

Figure 3:Plan and photographic transitional space at entrance of Jagtap's Residence, Nashik.

Arunodaya Society, Pune

Arunodaya society is a building with multiple number of flats. This structure is designed by reknown architect Girish Doshi. The building has common transitional space for all the flats. When there is any function or festival this transitional space is used. The people celebrate all kinds of festivals together.
Other activities happening in the space is as similar as mentioned earlier. Apart from the common transitional space the flats have their own small transitional space and security door that also acts as transitional space.

Figure 4 : Plan and photographic transitional space at entrance of Arunodaya Society, Pune.

Results

After studying the transitional spaces of all the three structures which were constructed in different periods. The transformation of these spaces is very interesting.
The size of transitional space got reducing according to the time. Some factors affected the transitional spaces. That are poverty, increase in population, economy factor, etc.
The transitional spaces changed but the cultural and traditional activities related didn't change although purpose of some activities changed.

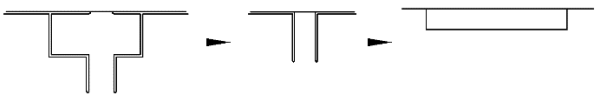

Figure 5: Transformation of the transitional spaces.

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Table no.1

In 18th century there was lot of space to construct residential structures, so we can see large transitional spaces.	In 19th century structures the transitional space in the structures got small a little bit as compares to the earlier structures.	The structures from 20th century onwards have less area for the transitional spaces, and we can get to see the more of a common space acting as a transitional space.
The traditional and cultural activities are followed in great amount in the transitional spaces.	The traditional and cultural activities are followed but some of the activities has changed.	The space is less and still some of important cultural and traditional activities happen in the transitional space.
The space was decorated and ornamented with the flowers and garlands.	The space was decorated and ornamented with flowers along with electronic light lamps and lightings.	The space is ornamented with various types of the new materials available in the market.

Conclusion

In Maharashtraian residential structures the transitional spaces has transformed gradually, the space has become lesser in size as compared to the earlier. This didn't affect any traditional and cultural activities. The material used for the decoration transitional spaces also changed or rather upgraded as the transition spaces transformed. In future these spaces will get thin and still the activities and importance may continue.

Acknowledgement

I would like to thank the whole RIA faculty of MMCOA for guiding me throughout the paper. Especially Ar. Ravindra Patwardhan sir and Ar. Girish Doshi sir for mentoring about the research.

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Understanding Parameters of Approaching The Wetlands as a Sustainable Ecology

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Abstract : Water is a crucial element of life. Humans have always designed the settlement close to water. Though water demand is rapidly increasing, the usage, ecological values are changing dramatically. India is blessed with wetland ecosystems of unique habitats but, are under tremendous pressure due to land degradation, water pollution, encroachment, and other human - nature conflicts, lead to declining hydrological, economic and ecological performance. Wetland study reveals a balanced, meticulously interwoven humans and ecology maze of transactions. Ujani Wetland at Bhigwan generates economics supporting various ecological, traditional, religious, recreational, transportation, and community-based activities. This paper would help us understand the parameters of approaching wetlands as sustainable ecology.

Keywords: Ujani, Wetland conservation, community, sustainable ecology,

Introduction

Traditionally, water was seen as the responsibility of people. The community collectively used to the responsibility of not only using water wisely but also of maintaining the water bodies. Today, as water pipelines have been provided to each tenement, it has led to the neglect of the water bodies and catchments areas.

People are used to receiving water at the turn of a tap and are no longer concerned about maintaining water bodies.

On the other hand, there is still hope as worried citizens across the country have mutually come to fight to stop this degradation of urban water bodies. Rivers and their associated wetlands and lakes form a chief factor in larger landscapes having economic nature as the provider of sustenance and resource of raw materials, communication, transport, choice of settlement site, business generator, ecological, biodiversity zone. The ethnographic matter is to be drawn from communities based on Bhima River near the concerned area of study- Kumbhargaon, Bhigwan.

Figure 1Types of wetlands as per RAMSAR definitions (Ghosh, 2005)

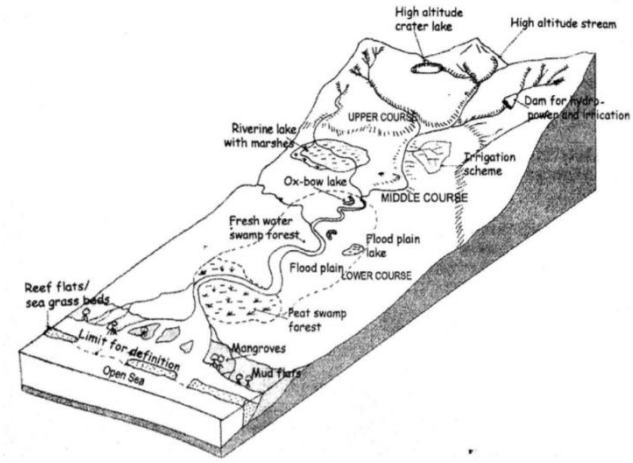

Figure 2: Bhigwan wetlands famous for winter visitors, flamingos

"Waterfronts have scenery, optimum climate, and fertile soil as agriculture and source as needs.

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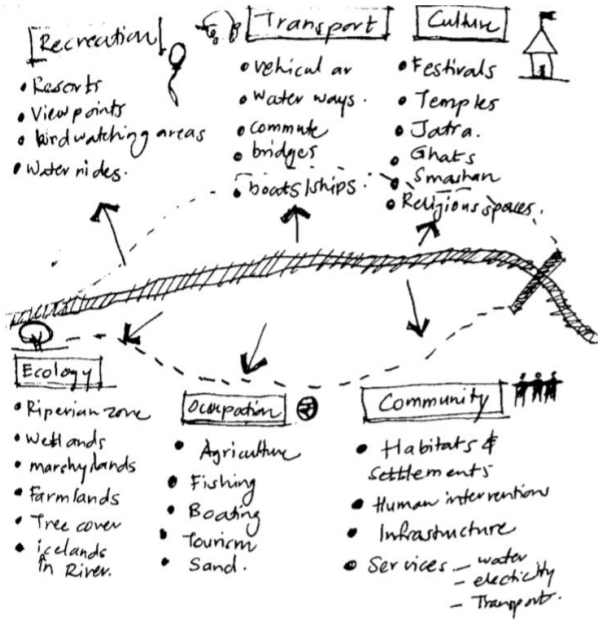
Running and still, waters affect the environment in both urban and suburban."(MITSCH & GOSSELINK, 1986.)Aim expresses that the systems made according to the natural factors vital to achieve "Wetlands are parts of the earth's surface between these terrestrial and aquatic systems. Thus shallow lakes ponds, marshes, bogs, swamps, dead river beds, tanks, borrow pits, are all wetlands irrespective of their extent, duration of waterlogging, climatic regions in which they exist, their water quality and degree of human intervention."(Ghosh, 2005)



Flowchart 1 Aspects of wetland study. Courtesy: Author

"One unique characteristic of wetlands is the presence of water and water-saturated soil. This may again either be a permanent or seasonal feature. During the period of waterlogging, wetlands should support hydrophytes"(HOLLAND, 1987)Wetlands are transitional zone between the dry terrestrial and wet aquatic systems, having characteristics of both the systems, as well as some of its own, which are unique. The diversity of character, size, type, and mode of occurrence of wetlands has given rise to different indices of describing them.

Wetlands have been observed as an outcome of an evolving traditional practice, which is interpreted here by using a subjective tool – ecology. Living creatively with nature is how the mindset of these local people has been defined and it can be verified in many other ecosystems where people with similar mindsets have succeeded in establishing sustainable means and peace of exploiting natural resources.

something in terms of function and aesthetic. At the same time, it indicates that the human follows nature knowingly and unknowingly in the developments.

Figure 4 Bhigwan satellite image. Source Google maps.

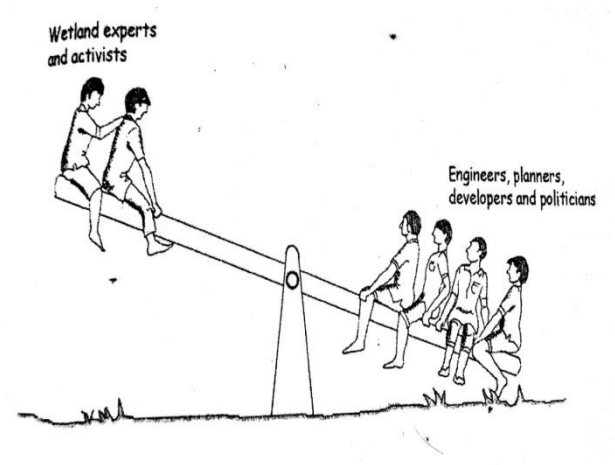
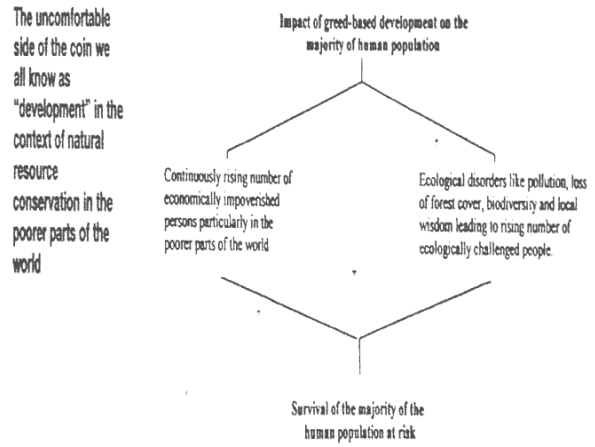


Figure 3 Wetland conservation needs its own constituency a strong support base. (Ghosh, 2005)

Urban settlements, with their ancient history, are existing formations that develop and transform constantly. Although there are several economical, transportation and safety problems for their establishment purposes and for the locations where cities were founded, geographical conditions also significantly affect this cause. Water resources transform humankind's settlements and the ecological chain. The relationships, similarities, and differences between human activities and ecological events need to be studied to understand the topic in depth.

Material & methodology



Flowchart 2: Development and conservation as sides of same coin. Source (Ghosh, 2005)

Today, Care for nature, has become concerned agenda for every government. Ecology and economics have never come so close to each other. There is very little research to satisfy this investigator, there exist enough intellectual collaboration in pedagogy proposals combining these two disciplines. Ecological interpretation challenges to bridge the gap between the traditional/ local wisdom are concerning humankind's connections with nature, and the typical planning and design process.

Wetland functions and benefits

The wetlands are frequently assessed from an anthropocentric approach. white evaluating wetlands, opportunities provided by the wetlands to are only measured. The effectiveness can be observed from the flora and fauna it maintains, the contribution for maintaining global air and water cycles, ecosystem values. The populations thrive on wetlands range from human, waterfowl, aquatic animals, trees, to a host of other micro-organisms. Plants provide food, protection, wood, medicinal elements, and a host of other non-edible uses. Animals and birds provide food, oil, fur, skin, feathers, and other items.

Ramsar Convention defines wetlands as 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, including areas of marine waters, the depth of which at low tide does not exceed six meters'.

"Wetlands are helpful in nutrient revival and recycling, discharging excess nitrogen, deactivation of phosphates, detoxification, chemicals, heavy metals absorbing using plants, treating wastewater, controlling floods, recharging aquifers and groundwater, wells, and reducing surface run-off and subsequent erosion." (G. E. Hollis, 1988)

Wetlands: misconceptions and misuses

The association between wetland area and inappropriate value is complex Traditional economics holds the universal notion that the less there is of some product, the more precious it is. This is the universal law of scarcity & applies to wetlands. In areas, wherever most of the natural wetlands have been drained, the wish for the conservation of the remaining few wetlands is frequently very strong.

The value of wetlands: the significance of scale and setting

Wetland in a setting with moderate but not excessive urban built development and it will have the strongest ecological value because an adequate human population is present to benefit from those values, but the population is not so large as to overwhelm the wetland functions. The ecological values of wetlands are based on the biological population residing next to it or within the wetlands (William J. Mitsch, 2000)

Research Methods

Bhigwan is 120 km from Pune city towards Solapur. While this research was in progress, 3 visits were made to understand the site, context and overall condition holistically. Visits were planned in different seasons, time frames, considering the flow of visitors, birds, availability of water in the wetlands and other climatic parameters. Visitors have been interviewed with non-structured interviews understanding their ideas and aspirations about ecological conservations and development programs. This site is being documented by the government for declaring Bird wildlife sanctuary. The wetland is being reviewed by ecologists' environmentalists, engineers, bird watchers, planners, and wetland experts, for declaring important RAMSAR sites in Maharashtra.

Results

Water demands are increasing rapidly, but the water used and societal values placed on the water are changing dramatically. Water is the resource forsurvival, the sustenance for a living; the resource needed for Agriculture, manufacturing, fishing; and it provides the habitat for much of our wildlife. Water in current society is more than a simple physical

entity, it's symbolic values, and non-instrumental uses are growing significantly.

Decision-makers, authorities, policymakers may also find this research work of some use for putting it ahead of them an unspoken and hence unheard treaty for its sensible use. They should directly adapt to the framework of traditional, age-old proved, well-established wisdom in the field of wastewater management and wetland treatment in particular for sensible sustainable growth. So-called 'Development models' are undergoing fundamental changes.

Wetland performs and hence values have the meaning and potential to last for a very long time. So-called 'Modern agriculture' or industrial/ commercial/ manufacturing/ production activity are usually not sustainable and resource-depleting (soil loss; use of fossil fuels) so the life span of these human-based options is short-lived. Also in large public works project periods extends over 50–60 years. The importance of this issue is that, when wetlands are getting lost during development, then the loss of activities, functions, relationship with the context and values with the community are rarely possible.

Comparing temporary (just) financial gain from a non-wetland commercial use of a piece of landscape, with long-term wetland values may not appropriate. Not so thoughtful social decisions of assigning unnecessary value to wetlands, in addition to the danger of comparing ecosystems, is that it will be possible to find a more profitable utilization of the land if temporary economic studies are made forever.

Here, wetland cost, estimates cannot compete very well with the financial returns of sugarcane and rice in the Baramati region hence, drainage will be economically favored than wetland conservation if the traditional cost-benefit analysis is carried out. Values are influenced by religious, cultural prejudice and financial system. In Bhigwan, there are good reasons why we need & aspire to protect nature; developed countries, having already taken care of the fundamental needs of their population, are principally and actively involved in enriching ecosystems- including wetlands, for their commercial, environmental, aesthetic as well as more functional attributes, not that all of this contributes to direct financial benefit. Here, various settlements live in and around wetlands and use them for daily survival – for the production of food and thread. Yet, generally, they try to keep the usual wetland purpose intact, meaning unchanged, boundaries unbroken and values are preserved. The beliefs that we assign to wetlands are not different from the learning and culture from which we arrive. Here, In Bhigwan the fundamental needs of food and shelter are not taken granted and yet they have a unique view of the economics of wetlands.

Conclusion

One cannot survive without the other; they are 'dependent arising this relationship is an exponential, growing, and spiral course of action. "If this exists, that exists; if this ceases to exist, that also ceases to exist." Hence, "If wetlands and ecological habitats are to be conserved, the dependently arising communities need to be conserved."

Acknowledgement

I would like to thank and express my gratitude towards various my guide, experts, architects, environmentalists, activists, bird watchers, and villagers who have helped me in exploring this research topic about wetlands of Ujani, kumbharwadi, Bhigwan, Indapur, Pune, Maharashtra, India.

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To Study Carbon Footprint in Coliving Space

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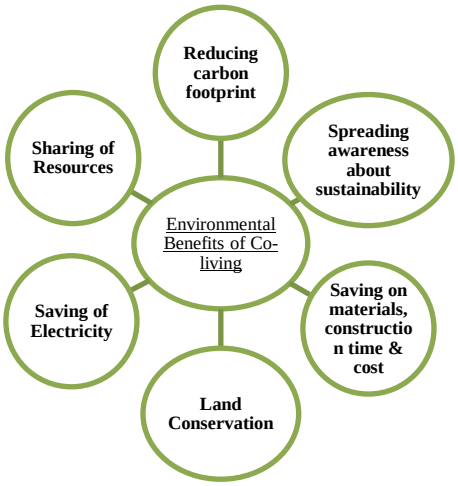
ABSTRACT: Coliving spaces share essential resources such as gas, food resources, appliances, and, spaces etc. By sharing such resources, co-living spaces reduce the energy consumption for appliances. Individuals occupying the coliving spaces help achieve a sustainable approach for reducing carbon footprint. This research aims to study and identify how the sustainable benefits of coliving spaces helps toreduce the carbon footprint.The methodology adopted for research is on the basis of case studies and observations. The amount of reduction in carbon footprint can be observed through a comparative analysis. The study is focusing on a user of 18-35 year age group covering the major millennium populated areas in Pune.

Keywords: Co-living, Millennium, Sustainable, Environment, Carbon Footprint, Communal Living

INTRODUCTION

As per a recent research, India's millennial population is expected to grow from 28% of total population in 2016 to an estimated 42% of the total population by 2025[i]. Having co living environments, with a millennial consumer in mind, will henceforth become a necessity. Co-living spaces are shared living spaces in which residents have individual rooms and share common spaces such as kitchens and living rooms. These living spaces have become quite popular with young professionals and digital nomads as convenient housing arrangements for those that are new to the city or pursuing higher education in non-native cities. Co-living spaces run on the principle of collaboration. Such collaboration is a necessity for sustainability as creating a sustainable environment is not just the responsibility of governments or environmental activists. Since each one of us leverages our planet's resources, working together to create a greener and more sustainable environment becomes everyone's responsibility too.The central idea behind coliving is living with purpose by focusing on building an ecosystem of support, connection, and collaboration. Within this system of community support, all kinds of resources are shared, swapped and borrowed. This encourages community members to create more sustainable everyday routines. This also helps to reduce waste and consumption. Domestic appliances and tools can be used communally,sustainable practices and pro-environmental behaviors, such as better recycling, composting, using less hot water and heat and carpooling are greatly encouraged Furthermore, there are shared communal cooking spaces, where community members can cook, bake and eat together, ordering ingredients in bulk, which both saves money and cuts down on food wastage, as well as reducing energy use. Leftovers are refrigerated or saved for lunches the next day. Coliving thus helps you to have a smaller footprint, contributing to the building of more resilient, sustainable, and environmentally friendly cities and societies.All the co-living spaces work on the principle of four C's. '4C' in their business simply represent cost, comfort, convenience, and community



Hence, Coliving spaces has certain sustainable parameters which makes that more user friendly as well as in benefit for the environment as it saves energy time, and reduction in the carbon footprint "A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product."It is calculated by summing the emissions resulting from every stage of a product or service's lifetime (material production, manufacturing, use phase, and end-of-life disposal). There is much research conducted on Coliving spaces, defining its need & the requirement for the millennium population and acceptance by the users. Whereas no consideration of sustainable relation of coliving and environment is listed, so this research is carried out identifying the existing coliving spaces in pune and concluding how much amount of carbon footprint can be reduced by calculating through a calculator developed by an organization (x) as well as individual footprint of the user when compared to a non coliving model.

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METHODOLOGY

Co-living spaces are modern housing solutions that enable residents with similar intentions, interests, and values to share a residential space like a hostel or a dorm. Such co-living spaces can promote a sense of community within the individuals who share the space. These shared spaces can contribute to a much larger cause too - the sustainability of resources.Consumption of non-renewable energy sources leads to high greenhouse gas emissions, resulting in increased carbon footprint. This phenomenon leads to global warming and climate change, which in turn is responsible, to a large extent, for the extinction of animal species. Hence, we have held a moral responsibility to reduce the impact of climate change using sustainable solutions. Generally, co-living spaces share essential resources such as gas and electricity.

DATA COLLECTION	EXPLORATION & RESEARCH	FINAL OUTCOME
➢ Defining the term & need ➢ Identifying Research gap	➢ Case study ➢ Observations& Findings ➢ Interviews	➢ Analysis ➢ Conclusion

By sharing such resources, co-living spaces reduce the energy consumption for appliances, like thermostats and air conditioners. Individuals occupying the co-living spaces help implement a sustainable approach for energy consumption to ensure a reduced carbon footprint. Co-living spaces can help in developing communities of motivated individuals who are well informed on sustainability. These communities can further create networks with other individuals who are passionate about 'green' initiatives. Together, these individuals can focus on using renewable energy sources and reducing air and water pollution. Such communities of proactive individuals can set an example and educate people from their experience of co-working and co-living. Also Sources of Emissions in the coliving spaces considered as parameters are mentioned:

1. Food
2. Electricity
3. Household Emissions
4. Personal Transportation

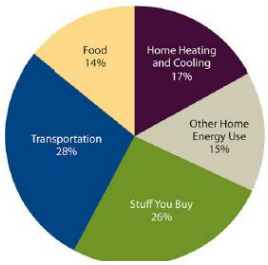

Fig.1 Sources of Emission

CASE STUDIES

In India, the co-living concept is gaining widespread acceptance and has brought to the fore some new models in the private rental sector. Though the concept is novel, it's here to stay, as India's millennial population currently accounts for 440 million(vi). The growing interest for co-living spaces in cities such as Bengaluru, the National Capital Region (NCR) and Pune has been instrumental in many investors sitting up and taking notice of this emerging sector to diversify their portfolio and risk. The renting philosophy for co-living spaces is derived from millennial behavior where such renters share less utilised areas such as living spaces, kitchen, balconies, etc. in order to make an economical rental decision and be part of a working community. To cater to this sort of renting philosophy, many buildings in prime locations such as city centers, near employment hubs like IT parks, special economic zones or universities are being redesigned, repositioned and rebranded keeping millennials in mind.

From saving energy to reducing waste packaging, sharing living space has the potential to reduce our environmental impact. Living more communally can have great social and personal benefits. Co living projects can make eco-building cheaper, as materials can be bought in bulk, and the cost of land can be shared. Here are the few cases of coliving in pune describing the shared parameters

Sr.No.	Name	Parameters
1	FLO COLIVING	Energy saving , sharing resources, spreading communal living
2	YOUROWNROOM	Sharing resources & provide coworking in coliving
3	URBAN NOMADS	Emphasizing on cultural interactions with living
4	HELLO WORLD	Sharing ideology with communal living
5	BEE URBAN COLIVING	Comfort, Safety & Nurturance in living

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Fig.2 Coliving Private Space

Fig.3 Coliving Dining Space

Fig.4Coliving Living Space

Fig.5 Coliving Private Sharing Space

RESULTS AND FINDINGS

- FLO COLIVING, Kharadi
  (COLLABORATE | COLIVE | COSHARE)

FLO, a co-living venture by Panchshil Realty for the people of today and creators of tomorrow was founded to create a solution to a seemingly insurmountable problem: the hassles involved with renting a home. This aims to enhance and simplify the rental process and home experience while creating an environment where ideas, passions and people thrive.Proximity to all major IT hubs and important landmarks in Pune, making our residents' commute significantly shorter and simpler while reducing our carbon footprint

Total greenhouse gas emissions	29.948 t CO2eq
Individual Carbon Footprint of each member	4.99 t CO2eq

- YOUROWNROOM, Amanora Town Park, Hadapsar- Kharadi Bypass, Pune

YourOwnROOM is a Residential Proptech rental and property management business. We provide strategically located good quality Co-living and Family managed homes to millennials tenants that are safe and comfortable.

Total greenhouse gas emissions	19.501 t CO2eq
Individual Carbon Footprint of each member	3.19 t CO2eq

- URBAN NOMADS , Koregaon Park, Pune,
  COLIVING, COWORKING, COLLABORATION & MORE

We offer flexibility, the ease of renting fully-furnished spaces, smoother, technology-enabled renting experiences and the chance to live alongside others of similar age, experience and mindsets

Total greenhouse gas emissions	30.055t CO2eq
Individual Carbon Footprint of each member	5.01 t CO2eq

- HELLO WORLD , Hinjewadi , Pune

This has created a world to turn your experience of co-living and student living into a pleasant one. Hello World is keen on creating comfortable spaces that embody the freedom paradigm of lifestyle and work for our tenants. They have created a world to turn your experience of co-living and student living into a pleasant one Hello World is keen on creating comfortable spaces that embody the freedom paradigm of lifestyle and work for our tenants.

Total greenhouse gas emissions	31.059t CO2eq
Individual Carbon Footprint of each member	5.02 t CO2eq

- BEE URBAN COLIVING, Viman Nagar, Pune
  (COMFORT, SAFETY, NURTURANCE)

Bee Urban is a fast-growing Youth Co-Living concept committed to providing world-class housing experience to students and young professionals. The Bee Urban experience is based on basic values of comfort, safety and nurturance and our state of the art hostels provide for a secured, warm and pleasant living experience that delivers an enriching environment, encouraging friendships and self-development.

Total greenhouse gas emissions	28.546t CO2eq
Individual Carbon Footprint of each member	4.35 t CO2eq

Also in comparison to these coliving models, one non coliving model is identified to compare the results with respect to carbon footprint.

- SINGLE PERSON ACCOMODATING ONE FLAT (Non Coliving model)

In this model single tenant is using all the facilities which are shared in coliving model such as kitchen, dining, living, working space, except private spaces such as bedroom and

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washroom. Thus carbon footprint of this model is mentioned:

Total greenhouse gas emissions	21.035 t CO2eq
Individual Carbon Footprint of each member	4.35 t CO2eq

COMPARATIVE ANALYSIS:

On comparing coliving & non-coliving models, the reduction of carbon footprint is found and with this the individual carbon footprint is observed. This can be very well stated that if consider for a non coliving model, carbon footprint of a single person is consuming 4.25 CO2 eq and 5 persons staying in coliving model consuming carbon footprint as 19.50 t CO2 eq. therefore considering 5 non coliving models the total carbon emission will be

= 5* 4.25 t CO2 eq = 21.25 t CO2eq

So on comparing the cases, the results are identified as it is emitting more carbon and the carbon footprint is found less in a coliving model.

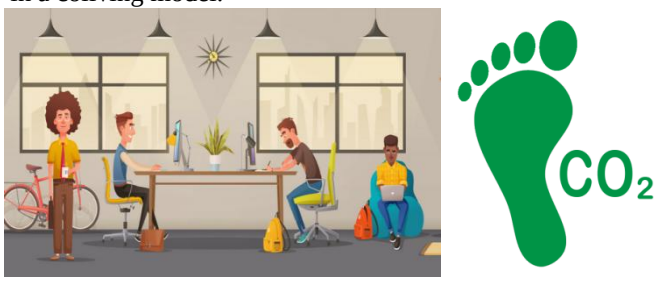

Fig.6 Coliving Model resulting in lower carbon footprint

CONCLUSION

The research is concluding with the facts and figures showing that the reduction observed in carbon footprint as in comparison of coliving to coliving and coliving to a non coliving space. Coliving model helps saving in electricity, sharing of resources and spaces, saving time and money in construction which overall results in reducing carbon footprint.

ACNOWLEDGEMENT

I would like to express my deep sense of gratitude to my guide Prof. Ashish Sakat for his valuable guidance, inspiration and encouragement. Also I would like to thank my college to provide me with such opportunities and continuous support in this research work which helped me to achieve this destination.

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GST and Indian Construction Industry

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Abstract : With the implementation of GST, there are mixed responses, arguments and opinions among the manufactures, traders, builders, construction managers and chartered accountants about the drastic change in the working environment of the construction industry. This paper aims to understand GST for Indian construction industry. The objectives include; knowing the basics of GST, tax slabs for various construction materials and understanding the key aspects of GST for the construction industry. It also discusses the deficiencies of the earlier taxation system, and concludes with benefits and drawbacks of GST. This study does not include any transaction details.

Key words: GST, Construction industry, Tax slabs, Deficiencies, Key aspects, Transaction

I. INTRODUCTION

1.1 Introduction-

Introduced on 1st July 2017, GST is one of the biggest changes in indirect taxation of India. By replacing almost all indirect taxes such as VAT, sales tax, service tax, excise duty, etc. GST has eliminated various difficulties of the earlier tax regime. By adopting the dual model of GST, the tax revenue of each transaction is shared by the centre as well as the state government. The impact made by GST has transformed the entire tax system in India. This has paved way for the unification of the entire country under "one nation, one tax and one market".

With the implementation of "One nation one Tax", there has been a drastic change in the working environment of the construction industry which has led to changing rates of laborers, construction materials, machinery pertaining to construction, technologies used construction, which has ultimately affected the cost of construction as well as the cost of buying and selling properties.

1.2 VAT and Service Tax regime-

Old Taxation system had three elements- Excise, CST, VAT and Service Tax.

- **Excise-** Excise duty was charged by the manufacturer on the manufacture of excisable goods.
- **CST-** On inter-state sale of goods, the dealer used to charge CST on value comprising of (basic value + excise duty charged by manufacturer + profit by dealer).
- **VAT-** On subsequent intra state sale of goods, the VAT dealer used to charge VAT on value comprising of (basic value + excise duty charged by manufacturer + CST + profit by dealer). Hence there was Cascading of taxes (Tax paid on tax)
- **Service Tax-** Service Tax was payable at 15% [Service Tax (14%) + Swachh Bharat Cess (0.5%) + Krishi Kalyan Cess (0.5%)] on services provided by various service providers.

This old system had several deficiencies like

- Multiple taxes.
- Multiple returns (forms)
- Restricted credits (Credits available only for VAT)
- Confusion between origin based and destination based tax.
- Cascading of taxes (Tax on tax)
- Non-Integration of VAT and Service Tax.
- Maintenance of data and records.
- Different tax laws in different states.

1.3 GST Regime-

GST tries to iron out all the wrinkles of the VAT and Service Tax regime. Introduction of GST has subsumed various central and state taxes. It will be levied on manufacture, sale and consumption of goods and services.

GST is categorized as

- CGST (Central Goods and Service Tax)
- SGST (State Goods and Service Tax)
- IGST (Integrated Goods and Service Tax)
- UTGST (Union Territory Goods and Service Tax)

Under GST, five tax slabs are proposed- 0%, 5%, 12%, 18%, 28%. GST will lead to creation of a

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unified market, which would facilitate seamless movement of goods across states and reduce the transaction cost of businesses. Under GST, manufacturers will get credits for all taxes paid earlier in the goods/ service chain, thus incentivizing firms to source from other registered dealers.

Table 1: Central and state taxes subsumed into GST

Central taxes subsumed	State taxes subsumed
Central Excise Duty	Sales Tax/ VAT
Service Tax	Luxury Tax
Excise duty under Medicinal and Toilet Preparation Act	Tax on lottery, betting and gambling
CVD & Special CVD (Additional duty of customs under section 3 of customs tariff Act, 1975)	Entry Tax (All Forms) and Purchase Tax
Central Sales Tax	Entertainment Tax
Surcharges and cesses which relate to supply of goods and services	State surcharges and cesses which relate to supply of goods and services
	Taxes on advertisement

II. MATERIAL AND METHODOLOGY

2.1 Literature Review-

Sabari Nath T V discusses about GST in their research paper titled "Implementation of Goods & Service Tax (GST) in India Emerging Opportunities & Challenges." He gives an overview of the earlier tax system. The author explains the core concept of GST and also compares non-GST regime to the GST regime and concludes that GST will help to eliminate the cascading of taxes at multiple level and will help to build a transparent corruption free tax administration.

Girish Garg sheds light on history of taxation system in India in the research paper titled "Basic Concepts and Features of Good and Service Tax in India." Mr. Garg explains objectives of GST. He summarizes various salient features and benefits of GST. He also describes impact of GST on various industries including the Housing and Construction Industry and concludes that GST will strengthen nation's economy and development.

A book published by The Institute of Company Secretaries of India (ICSI) titled "GST- A Simplified approach and Practical Guide for GST Accounts Assistants" gives the background of GST, how and why it was implemented. It provides clear explanation of the various sections of GST Act with simple examples. It also consists of various formats (Registration forms, Payment forms, practitioner forms, etc)

Dr. N VisalakshI and Dr. K. Kanaka Raju explain various concepts of GST in the research paper titled "An Overview of GST". The authors shed light on impact of GST on a consumer through a comparative study and conclude that implementation of GST has eradicated multiple taxes, problems and issues in the economy.

2.2 Methodology-

The methodology adopted for this research includes informal discussions with a chartered accountant. These informal discussions are vetted through questionnaire survey with tax practitioners and several other chartered accountants. A market survey was conducted to compare tax rates for various construction materials.

III. RESULTS AND TABLES

3.1 Key Aspects/ Important Features of GST-

a) One Nation, One Tax- GST law extends to the whole of India and it came into force on 1st July 2017.

b) No Cascading of taxes- Since, only value added at each stage is taxed under GST, there is no cascading of taxes (tax on tax) under GST.

c) Input Tax Credit- ITC is the backbone of GST. A registered person will be eligible to claim Input Tax Credit (ITC) for tax paid by them on purchases.

d) Destination based tax- GST is a destination based tax on supply of goods and services. It is a levy at all stages right from manufacture up to final consumption with credit of taxes paid at previous stages available as setoff.

e) Composition scheme- A person whose aggregate turnover is less than Rs. 1.5 Crores in the preceding financial year can opt for a simplified composition scheme. The person opting for composition scheme

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is liable to pay tax at a concessional rate on the turnover in the state without the benefit of ITC.

f) Classification of goods and services- HSN (Harmonised System of Nomenclature) code is used for classifying goods and services under GST.

g) Taxation on import and export- IGST will be levied on import of goods and services as it will be treated as inter-state supply. No tax will be payable on exports of goods and services as export is treated as zero rated supply.

h) Threshold- A taxable person is liable to pay tax when he crosses the turnover threshold of Rs. 40 lakhs (Rs. 20 lakhs for NE and special category states) except in certain specified cases where he is liable to pay tax even if he has not crossed the threshold limit.

i) GST Identification Number (GSTIN)- Unlike the previous indirect tax regime, where multiple registration numbers were present for different laws like Excise, Service Tax and VAT, it is a single registration number under GST- GSTIN.

3.2 Results from Questionnaire survey-

Following are the results from the questionnaire survey, which was targeted at the chartered accountants having at least 5 years experience and clientele of construction industry.

Figure 1: GST is simpler than earlier tax system

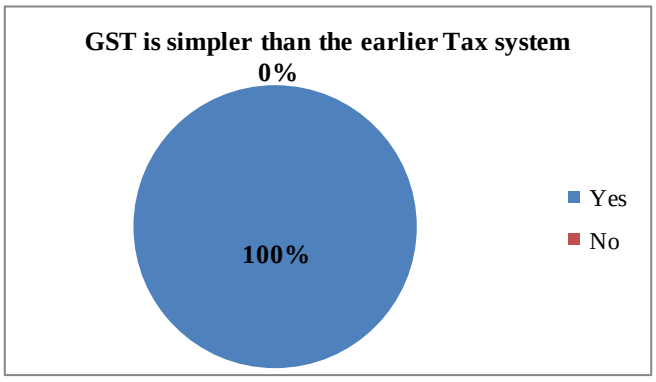


Figure 2: GST is simpler than earlier tax system

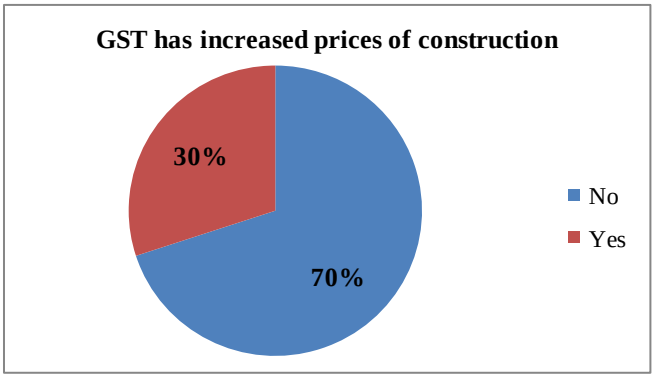


Figure 3: GST: Benefit or barrier

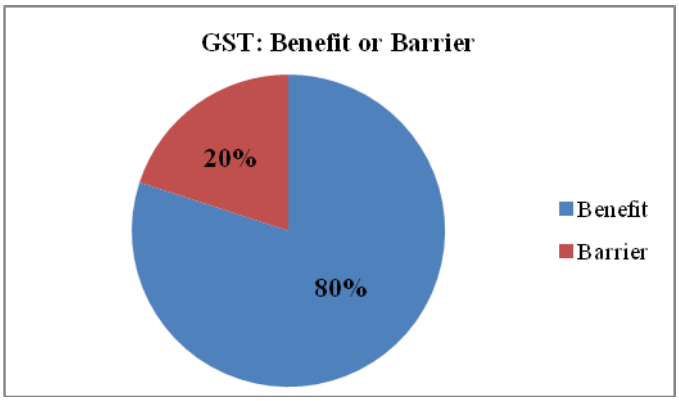
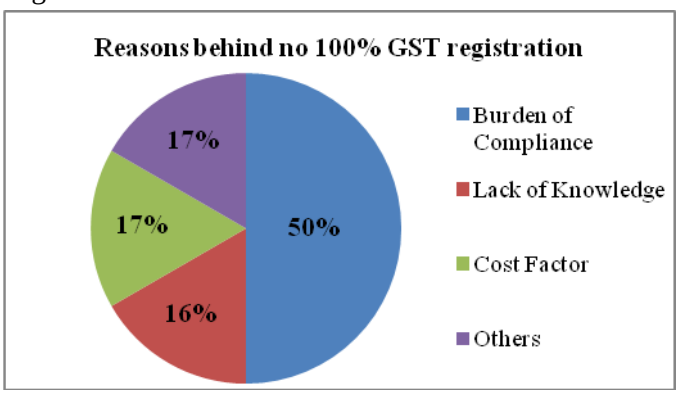


Figure 4: Reasons behind no 100% GST Registration



3.3 Results from Market Survey-

Table 2: Tax rate comparison for construction materials

Sr. No.	Material	Pre GST	Post GST	Difference
1	Cement	32%	28%	-4%
2	TMT Steel	23.5%	18%	-5.5%
3	Coarse Aggregate	6%	5%	-1%
4	River Sand	6%	5%	-1%
5	Bricks (locally manufactured without the	6%	5%	-1%

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	use of power)			
6	Floor & Dado Tiles	32%	18%	-14%
7	Plywood	30%	18%	-12%
8	Laminates	30%	18%	-12%
9	Wires and Cables	31%	18%	-13%
10	Glass	31%	18%	-13%
11	Paints & Varnish	32%	18%	-14%
12	Sanitary Fittings	32%	18%	-14%
13	Wooden Door & Window	30%	18%	-12%
14	Aluminum Window Sections	32%	18%	-14%
15	Marble and Granite	32%	18%	-14%
16	AAC Blocks	21.5%	5%	-16.5%
17	Waterproofing chemicals	32%	18%	-14%

Note- Pre GST rates include Excise Duty, CST, MVAT and other taxes. Green color indicates reduction in the tax rates.

3.4 Benefits

- One Nation, One tax.
- Single and simplified return filing.
- No Cascading effect.
- Duplication of work is avoided.
- Simple online procedure for filing returns.
- Input tax credit easily available.
- Less paperwork.
- Simplified registration process.

3.5 Drawbacks

- Heavy penalty for non-filing of returns on time.
- GST website problems.
- Rectification of mistakes is not possible.
- More frequency of returns.
- Frequent changes in tax rates.
- More compliance cost.

IV. CONCLUSION

From the results of questionnaire and market survey, it can be concluded that, GST is simpler and beneficial to the construction industry. As we are new entrants into this taxation system, the act has several drawbacks, which if rectified can surely be more beneficial to the construction industry.

ACKNOWLEDGEMENT

I am extremely grateful to my guide Mr. Sumesh Sawant for his valuable insight, discussions and support in completing this research. I would like to express my gratitude towards CA Sunil Ingale and Prof. Satyajeet Shah for their valuable time to explain various GST concepts.

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Daylighting in public areas of hospital building.

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ABSTRACT : ***Public areas in hospitals are accessible to people on any time of the day or night, the people who visit hospitals are not that emotionally stable which makes it different from other public areas like museum or malls. Use of artificial lights is provided in large hospitals without considering the comfort of people. While considering this aspect the focus of public areas include waiting areas, entrance and reception areas and main corridors. As people spare most of the time in waiting areas because of the patients. The cases of general hospitals in Pune region will be considered, analysis and comparison of these hospitals public areas would be taken into consideration with identification of problems if any. This research will help in studying different public areas that require or has natural light and its impacts on people that visit patients including family members, relatives, friends,staff etc. Outline of the research will have findings that prove the need for natural light in public areas of hospital building and in what way such hospitals can provide better environment for visitors.***

Keywords- public areas, natural light ,hospitals ,waiting areas , visitors.

INTRODUCTION

An efficient hospital design includes concern for human comfort, indoor environment & productivity. They are usually occupied 24 hours per day, all year round and careful control of their indoor environment is necessary. Natural light is critical aspect in hospitals as not all the hospitals incorporate natural light in buildings, use of artificial lights also serve their purpose.Daylight affects human beings psychologically. Several studies have documented the importance of light in reducing depression, decreasing fatigue, improving alertness, (1). Further, the presence of windows in the waiting areas and access to daylight have been linked with increased satisfaction with the physical environment.

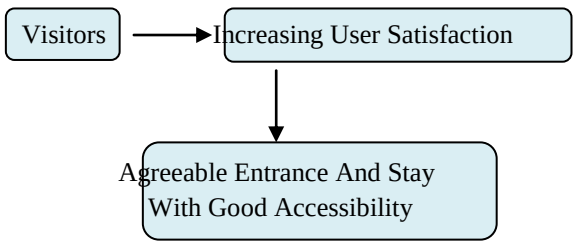
Reasons for maximizing daylight and views in public areas of healthcare building:

1. Helping users to orient themselves and find their way through the space : since healthcare facilities are often very large, with multiple floors, wings, and extensions, it's not always easy for users to determine where they are and find their way around. This can be the case in particular for new visitors, patients with cognitive impairment, or elderly people with reduced mobility or poor vision. Bright spaces and enhanced views to the outdoors, combined with a well-planned choice of colors, contribute to users correct orientation and ability to find points of reference. therefore seeing more and more atriums and patios that create areas of light inside these spaces.

2. Reassuring visitors: hospital environments are traditionally not seen as being very welcoming and can be a source of additional stress for visitors who are already anxious when they arrive. For example, the hallways of hospitals and emergency departments are often very compact and barely receive natural light. However, these spaces are the first areas of contact with patients and visitors! Psychologically, visitors tend to determine the quality of a service or a healthcare professional based on the quality of the waiting room,
including the lighting. Bringing natural light and views into these spaces as well is vital to improving the user's experience

3. Creating comfortable, welcoming, high-quality spaces, similar to those in the hospitality market: ambiances based on the optimization of light and views, this is true not only in the areas used for patients families, but also more generally in lobbies, waiting rooms, consulting rooms, and recovery areas.

4. Contributing to the facility's sustainable development: energy and environmental performance is also a key challenge in hospitals, and maximizing the use of natural light can contribute to reducing the use of electrical lighting and the building's carbon footprint.
Therefore the user is truly being repositioned at the heart of the architectural design for hospitals, whether that user is a visitor, family member, or staff member. In this context, natural light and outdoor views play a vital role.



There is much research on the impact of daylight on patients health recovering faster, but there is no

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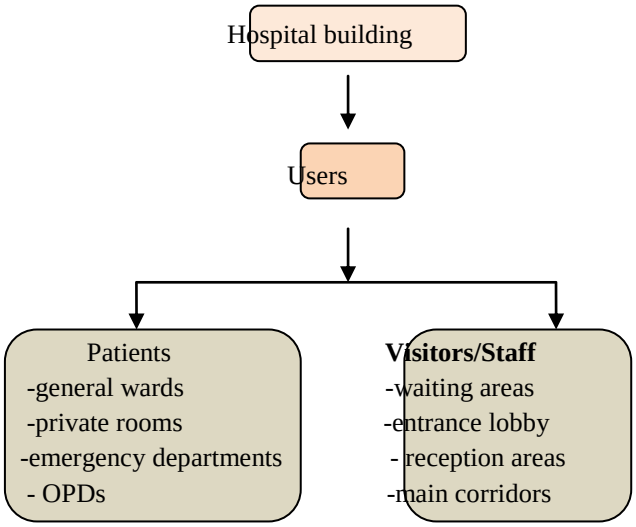
consideration for visitors which spares most of the time in the waiting areas and the public areas without their choice in the hospital because of the patient. As in general, for a single patient two or three family members have to be there in hospital for some or other need. So the public areas of hospitals needs to be focused upon.

Without access to daylight the human body-clock becomes disrupted –it needs recalibration on a daily basis and unless we receive adequate daylight overwhelming medical evidence suggests that humans become stressful and agitated. Any disruption to our circadian rhythm has highly negative consequences in terms of our health, happiness and wellbeing. A well designed daylighting will obviate the need for artificial lighting. The effort to reduce dependency on artificial lighting would directly contribute to the energy consumption of hospital buildings, subsequently assisting sustainability.

METHODOLOGY



In general, daylight has also been found to be a more effective form of environmental lighting than electric lighting in boosting alertness (2). Natural light provides high-intensity blue light (400–500 nm) in the morning. The wavelength smoothly transitions to orange-red light (600–700 nm) at sundown with minimal blue light intensity. Human physiology has evolved by responding to this phenomenon. An effective light wavelength for a circadian response is mainly between 460 and 500 nm (3). When indoor electric environmental lighting is not appropriate for our body's natural state, occupants will be trapped in "biological darkness"

All of the above qualitative and quantitative evidence is derived from the fields of human biology and environmental psychology.(4) Experiments undertaken between 1941 and 1944 demonstrated the extraordinary and remarkable effectiveness of daylight in killing the bacteria streptococci .The blue light in skylight was found to be particularly potent. The trials also examined the bactericidal effects of artificial light, which was found to have little value as a disinfecting agent.

Cases of general hospitals in Pune-

1. Case of Jahangir hospital, the courtyard space has been closed, and glass cubicle medical shop is situated there, the daylight entering the building is not used, which is making maximum use of artificial lights in entrance and reception area. The waiting areas of this hospital are always crowded, even though the waiting area is a huge space on ground floor itself, but it feels conjusted, as the windows provided are not enough to the size of waiting areas which are closed by curtains that doesnot get any outside view and all .artificial lights needs to be switched on even during daytime which doesnot give feeling of waiting for visitors.

Fig 1 (a) – closed courtyard space fig 1(b)- waiting areas

2. In Dinanath old Hospital building, it is designed in a manner having a central skylight dome. The natural light enters into the building but it doesnot reach sufficiently till ground floor. As we enter the building, it feels dark in central foyer and the visitors have feeling of anxiety, waiting areas are along the central foyer even passages on first floor do not get sufficient light in day time where most of the people have to sit and wait, which doesnot give a pleasant feeling sitting there.

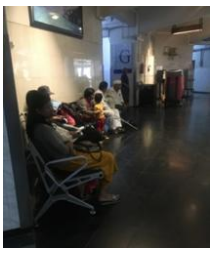


Fig 2(a)- ground floor waiting areas in darkness fig 2(b)- skylight dome

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3. In Dinanath new hospital building, windows of double height entrance and reception area is large and
proportionate, so there is no need of artificial lights in public space, circulation spaces in public areas are big and daylight is enough so that people may find their way inside, also entrance is of glass façade, which gives the feeling of welcome to patients and visitors, indoor canteen area is also provided with large windows for view so people coming in canteen will feel mentally relaxed but all windows are fixed, so canteen's foul smell comes in the public space which is a disturbing factor.

Fig 3(a) entrance, reception, waiting and canteen areas are properly daylighted

4. The design of Ruby Hospital, It has entrance from two sides. On both sides they have used the double height of ceiling in the foyer at the entrance in order to make the patient and visitor feel warm welcome with tinted glass façade used throughout the front façade of double height entrance lobby penetrating adequate daylight and to diminish the fear and frustration causing the worry to the patient and visitors during his visit to the hospital.

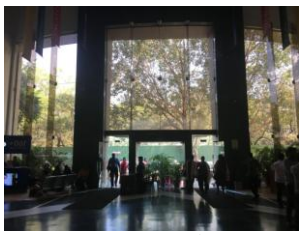
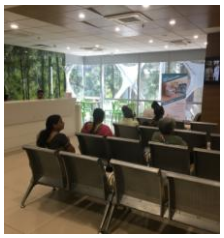


Fig 4(a)- tinted glass façade entrance

fig 4(b)- skylight in waiting area

The waiting areas of public is a courtyard like space having skylight in the center where people sit comfortably around it. The place is always full of people but waiting area feels open and daylighted as use of artificial light is less and there is enough seatings over there so people spend most of the time over there.
Apart from that the spaces inside the hospital also has a daylighted view on the above floors where waiting areas are designed for public, even though space is conditioned but people's comfort is considered.



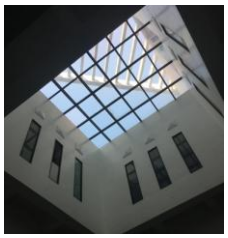


Fig 4(c)- daylight and skylight view for public to mentally relax

5. As for Poona Hospital, the waiting areas for public are provided on mid landing of every floor, which is why the natural light penetrates inside directly, as waiting areas are not inside. The windows in waiting areas are also large and throughtout the wall so it doesn't feel dark .The main passages of hospital are wide enough with circular large windows so passages doesnot need any artificial light and people sit over there also.The entrance and reception area of hospital is single storey but entrance has large openings for daylight so there is no need of artificial lights in daytime.

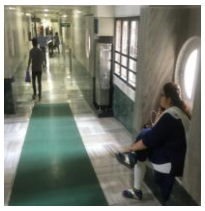


Fig 5(a) passages and with windows

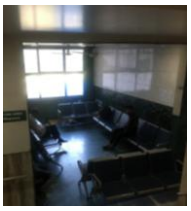


fig 5(b)- waiting areas

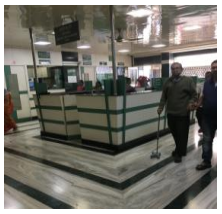


fig 5(c)-entrance reception area

6. In Sassoon hospital, the double height hall for the public space is not having adequate light and hygiene consideration so it doesnot feel to sit in the waiting areas inside, so the people also sit outside the hospital on the footpaths or shed which looks very disturbing when we enter. The reception areas are also not spacious, they are enclosed with small openings without proper lighting levels. Also it is a government hospital, not much care is taken on the ambiance and comfort of the public areas of hospital.

Fig 6(a)- entrance, reception and waiting area with no adequate light

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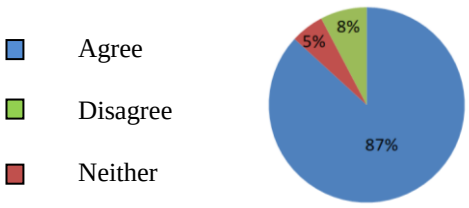
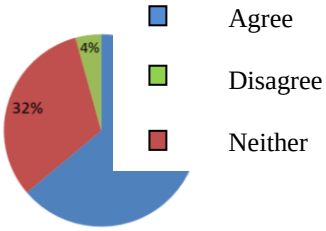
DISCUSSION

In this paper focus is on two groups, visitors and staff. Questionaires were asked in above hospitals visited, the people who were discharged were more answerable. Following verbal introduction to the nature and purpose of the survey and acquiring the background information, the subjects were then asked to rate their satisfaction with the following four questions.

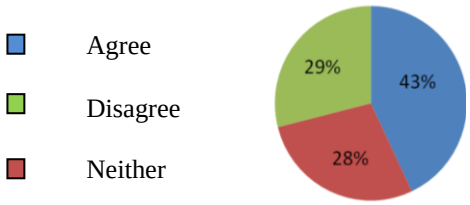
1. Do you think , waiting in daylighted area feels more comfortable and relaxed?



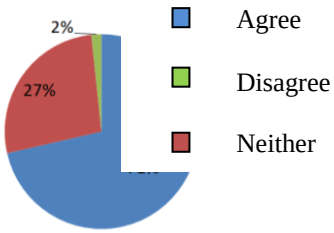
2. As soon as you enter this hospital do you have feeing of uneasy or nervousness apart from patients health



3. Will you be able to sit in artificial lights for long time?



4. Does it feel pleasant to work more in daylight hours? (helping desks, reception counters, security guards in public areas)



The above survey is done with sample size of 60 in seven different Hospitals .

FINDINGS

Hospital Area	Entrance	Reception	Waiting areas	Corridors/atrium
Recommen-ded lux levels	200 lux	300 lux	200 lux	100 lux
Jahangir	212	209.2	104	109
Dinanath old bldg	85.8	115.8	74.0	85
Dinanath new bldg	215	324.3	210.3	110
Ruby	228.3	281	250	-
Poona	199.6	204.5	222.3	150
Sassoon	118	100	89.2	90..46

The critical cases identified among these hospitals are Sassoon and Jahangir Hospitals. As in Sassoon hospital case public areas are not at all considered with respect to daylight or hygiene, it feels dark inside even in daytime. On the other hand in Jahangir hospital although artificial lights are used in the waiting areas it doesnot feel to sit in waiting areas as space allotted is compact with less windows without double height. The best compliance was with Ruby hospital and Dinanath new hospital building.

CONCLUSION

Major conclusions drawn from this study is there are identified gaps in the existing lighting standards in the Hospitals and the recommended lighting levels and standards in the public areas of Hospital. As per the analysis, where there are spacious daylighted areas or large windows for view people prefer sitting there for long time compared to dark or artificial lights areas. This has been stated in the study with the effect of daylight on psychology of people. The salient features of various guidelines and standards on lighting in the public areas of hospitals should be considered by Hospital Administrators and Medical Architects before planning a new healthcare setup. These lighting standards should be circulated in the environment for compliance thus this will have better environment for visitors or public.

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude from the bottom of my heart to my guide Dr. Parag Narkhede

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Sir for his valuable guidance, inspiration and encouragement. His keen and indefatigable indulgence in this work helped me to reach an irreproachable progress.

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Analyzing Energy Consumption Pattern and Compensating With Rooftop Solar PV for Chaitraban (Indra Nagar) Slum, Pune

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Abstract: India's Energy sector is one of the most critical component of an infrastructure that affects India's economic growth. In the present energy scenario, Smart grid technology plays a very productive role towards alternate sources of energy as compare to coal (which is already dominating the production of energy). This paper analyses energy consumption patterns & electricity costs of Pune Chaitraban slums & suggests recommendation for energy substitution with rooftop solar PV for reducing their electricity cost. The paper also recommends rooftop solar PV as a portable source of income for slum dwellers when linked to the grid supply for excess solar PV generation.

Key words – BAPV, Energy consumption, Conventional energy source, Energy cost, Rooftop solar PV.

INTRODUCTION

Established in 1975, the Chaitraban slum is located near the Pune upper indra nagar, Bibwewadi. It is a large residential slum with about 800 households. The slum covers an area of 1.6 hectares. Located in the outskirts of Pune city the slum has a gradual slope of 2m across the site. Increasing electricity costs is one of the major problems faced by the slum dwellers. In the year 2019, the charges for electricity consumption escalated from 3.00rs per unit to 3.05rs per unit. Slum dwellers and socially poorer segment are facing problems with the increasing cost of energy. As an alternative solution for increasing energy cost, suggestions and guidelines can be recommended to the residential sector to use solar energy, primarily due to easy installation, higher productivity, lower operating, maintenance costs, and incentives offered by India's government through various subsidies. BAPV (Building Applied Photovoltaics), an advancing renewable technology thus plays a vital role in leaning on conventional energy sources as well as being very effective at the moment for rapid climate change. To Slum dwellers, BAPV appears to be the best alternative option with the help of government subsidies.

METHODOLOGY

The Methodology is divided into two parts primary analysis and secondary analysis.

Primary analysis: -

- Climate analysis

Secondary analysis: -

- Field survey, Survey questionnaire, Taking random sampling
- Market survey for Solar PV (1kW Off-grid and 1 kW ON-grid
- Identify Government policies.

Furthermore, shadow analysis using Ecotect software have been done. Based on shadow analysis results there is a suggestion for preferable roof area for solar PV panels and their energy generation.

Data Collection

1. Field Data

Climate analysis: - Pune falls under moderate climate ranging from 20 to 28 ° C mean temperatures. Typical summer months are from mid-March to mid-June, with maximum temperature of 42 ° C. Average solar radiation in Pune is 1266.52 W/sqmt. Pune's warmest month is May. In May, there are strong dusty winds, with still high humidity. The monsoon lasts from June to October, with mild precipitation ranging from 22 to 28 ° C. Most of the city's annual 722 mm (28.43 in) precipitation falls between June and September, and July is the year's wettest month.

2. Site survey

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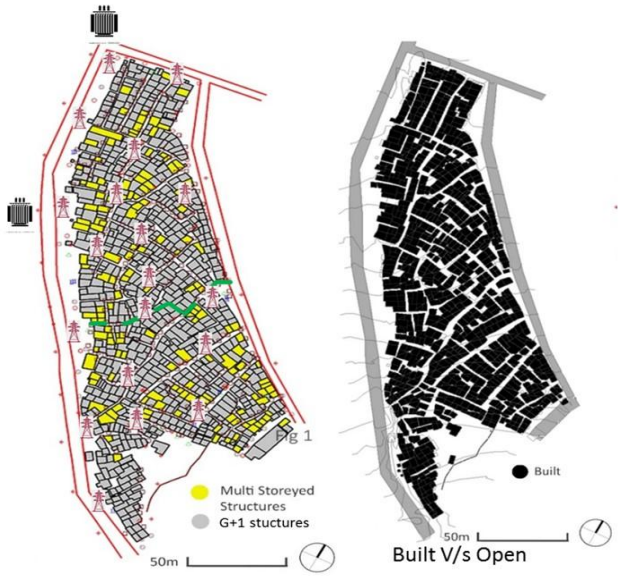

Figure 1 Site plan

Legend: -

Boundary of transformer distribution

Transformer – 11kV each (Nos. = 2) (400People/1 Transformer). Total 800people

Electrical poles (Nos. = 19)

Ward no. = 38
Total no. of houses = 800
Number of Pucca Houses= 680 (85%)
Number of Kuccha houses = 120 (15%)
Total approximate population of slum = 3500
Total area of the slum = 16000 sq. mt (1.6 Hectres)

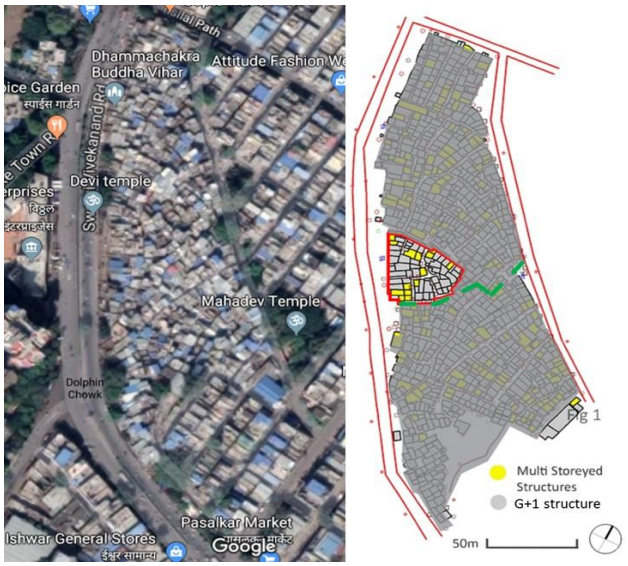

Figure 2 Demarcated sample size

3. Random sampling

Zone:-

- 37 Houses
- G, G+1 & G+2 structures.
- all 3 types i.e Kuccha(Tin roof and Tin walls), Semi-Pucca(Brick walls and Tin roof) and Puccha (Rcc roof and RCC Wall).

Taking random sampling and selecting 37 houses of various types (kuccha, semi Pucca, Pucca) and marking it as a zone for further survey. In this zone all types of houses are there i.e. G, G+1,G+2 and contains commercial(shops) also.

Figure 3 typology of houses

CONDUCTING SURVEY AND LOAD CALCULATIONS: -

All 37 samples are taken for survey and connected load calculation. 90% of the houses have 3-4 members in a family, having 3-4 electrical equipment's per house. All samples are grid connected. 90% of the houses have Floor area/house is around 25 sqmt. Connected Load calculations for each individual unit is carried out in the survey. The quality and life of equipment have also been examined.

	No. of storey	Type of equipment	Time of use	Pattern	Quantity	Total capacity in watts	Working hours	Energy consumption in kWh
House no. 2	G+1	TV	Day	Daily	1	50	7	0.35

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		Fridge	Day & night	Daily	1	250	8	2
		Tubelight	Evening & night	Daily	2	22	8	0.176
		Bulb	Evening & night	Daily	2	9	8	0.072
		Fan	Night	Daily	2	75	5	0.375
								2.973

Table 1 Connected load consumption

- Boundary of transformer distribution
- Transformer – 11kV each (Nos. = 2) (400People/1 Transformer). Total 800people
- Electrical poles (Nos. = 19)

MARKET SURVEY DATA COLLECTION FOR SOLAR PV

Loom solar 1 kw Grid connected AC Module (75,000 + installation charges) with 25 years' warranty.

Loom solar introduces 1 kW solar panel called Solar AC Module. A 1 kW solar system generates 5 units every day from morning 9 am to 5 pm which is sufficient to run 1 Refrigerator, Television, Fans and lights during the day from small 1-2 bhk home. It does not work when there is power failure. To convert solar energy to AC current (AC module is mounted in the back of the solar panel).

GOVERNMENT SCHEMES

- JNNSM (Jawahar Lal Nehru National Solar Mission) :-The Phase-II of Grid Connected Rooftop Solar Programme for achieving cumulative capacity of 40,000 MW from Rooftop Solar (RTS) Projects by the year 2022.
- MEDA (Maharashtra Energy Development Agency). :- MEDA Maharashtra rooftop solar policy complies with the subsidy available from the central government. Accordingly, the subsidy can be availed on installation of rooftop grid connected solar plants as either of the following- (MEDA, 2019)
  - 30% of the project cost (or)
  - 30% of the benchmark cost, whichever is lower.

Page 2

RESULTS

DATA ANALYSIS AND INFERENCES

Using 'Ecotect' software, yearly shadow analysis of the selected sample is done for 4 representative months i.e. for January, April, August and November.

As per the Solar radiation data, the horizontal radiation is 1266.52 watts/meter²/day. During Monsoons i.e Except July and august the radiations falling on the horizontal surface are 263 W/m²/day. During summers i.e from March to June the radiations are harsh i.e. 496 W/m²/day minimum to 735 W/m²/day maximum respectively.

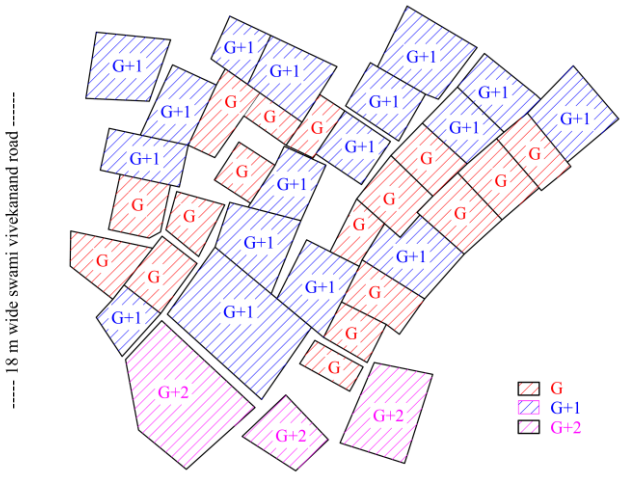

Figure 4 types of houses (G,G+1,G+2)

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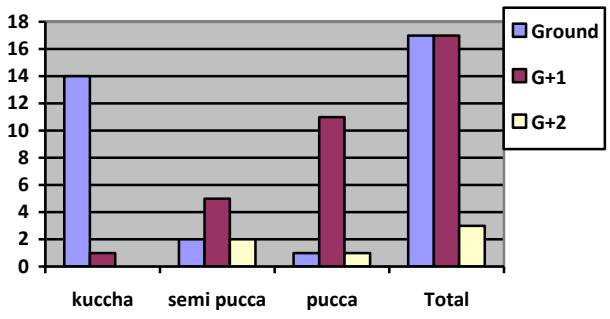

Chart 1 - Number of houses from selected zone

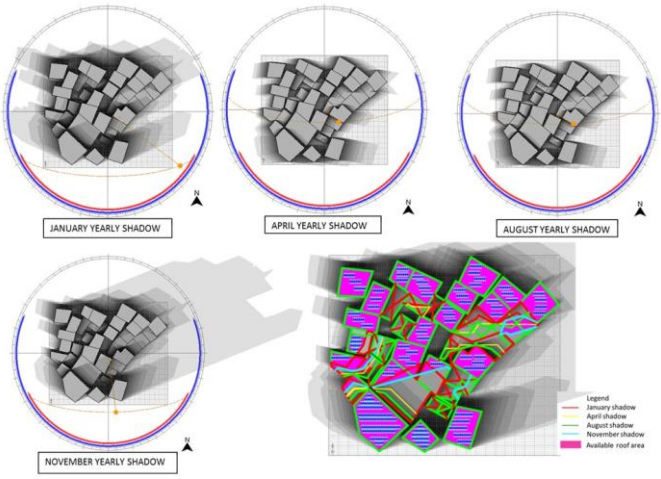

Figure 5 Yearly Shadow analysis using Ecotect Software for the month of January, April, August, November. Also showing Available roof area in magenta color with number of possible rooftop panels.

INFERENCE

The available yearly sun lit rooftop area (No shadow area) w.r.t the installation of solar PV. Available rooftop area = 202.52 Sqmt for 37 households.

- Depending upon the load a roof can take, Solar panels are placed accordingly.
- Total number of solar panel are = 528 panels, generating electricity of 528 x 0.35Kw = 184.8 Kw/day.
- Taking average Load Consumption per day of individual slum is = 4 Kw
- Number of houses getting solar electricity = 184.8Kw/day divided by 4Kw Load consumption = 36.96 houses (approx. 37 houses)
- Hence 37 houses are getting catered with 528 panels.

PV PANNEL SIZING

1 Kw Pannel generates = 1800 kwh per year & 1kwh = 1unit 1 Kw will generate in a day: -

1800/12 months = 150 kwh(approx..) per month.

150/30 days = 5 kwh(approx.) per day.

GUIDELINES

Installation

1 solar panel weight is 10-20 kg, which can be mounted on a sloping roof as well. The model includes a mild streel frame on which to install the solar panels. Because most of the slum has a tin roof with a mild steel frame, the installation of solar PV is optimistic.

Financial requirements:

Bank loan are also available for purchase of 1kW Rooftop Solar PV. And after payback period of 7 years it will be free energy for the slum dwellers.

Page 3

As per MNRE "All banks are advised to encourage the home loan/ home improvement loan seekers to install rooftop solar PVs and include the cost of such equipment in their home loan proposals just like non solar lighting, wiring and other such fittings"

Subsidy:

To initiate the project, 30% subsidy of benchmark cost will be very helpful to the slum dwellers.

RECOMMENDATIONS AND CONCLUSIONS

RECOMMENDATIONS: -

1 kW of panels on the roof need an area of 6 square meters. On grid (without battery) costs 80 thousand and off grid cost goes to 1 Lakh (with battery) for PV, including installation charges. Since both central government and state government subsidies exist, the Solar PV can be installed financially for slum dwellers. Since the On-Grid PV system connects to the main power supply grid, selecting the ON-Grid connected option for slum residents will be good enough, as it will provide opportunities to produce

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more energy and supply the network. Compared to the 25-year warranty from the solar PV firm manufacturer, the 12-year payback period seems to be financially favorable also to slum dwellers.

Houses	Pv panel per head cost	Total cost for 37 houses	Govt. Subsidy	Final cost of PV panel	Electric bill cost per consumer in Rs/month (approx.)	Permonth Electricity bill of whole slum	Payback (in months)	Payback in Year
37	80000	2960000	30%	888000	700	25900	34.2	2.8

Table 2 Payback for Whole (sample size) Slum (calculated Together)

From the table above, the Payback period calculated for the sample size (37 houses) is 2.86 years.

CONCLUSIONS

Energy consumption per day for Slum dwelling units with refrigerators is 5.6kWh and without refrigerators is 2.9kWh/day (i.e. almost 50% reduction). The study recommends that slum Payback period is 2.86 years hence reduction in electricity bill costs plus through net metering there is a potential source of income also.

ACKNOWLEDGEMENT

It is pleasure to thank many people who made this dissertation possible. I would like to express my gratitude to My guide, Ar. Aditi Lanke, for keeping me in the perspective and ensuring that the analysis and methodologies were logical.

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Quantifying Amount of Water Wasted From Showerheads, From Households in Pune, Having Central Solar Heating Systems

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ABSTRACT: World over, water as a resource, is sparse and expensive. Considering the growing population and rising number of residential buildings coming up, it is necessary to understand the need and urgency to pay attention to water conservation in the services provided in buildings by reducing both, wastage and consumption. Conserving water will help in making the overall building sustainable. The objective of this study is to test methods to quantify the amount of water wasted from showers while waiting for hot water in situations where water is heated using central solar heating systems, in order to compute actual quantities.

Key words: Solar heaters, water, showerheads, losses, Pune

1. INTRODUCTION

As per a study conducted across seven cities in India it is noted that bathing consumes the maximum amount of water, at 28 % of the total domestic consumption, roughly 55 litres per person per day [1]. Shower water wasted by individuals, has a cascading effect that amounts to huge loss of potable treated and heated water being lost while waiting for hot water to get to an optimum temperature, hot enough to bathe and this paper intends to find methods to compute these losses. As per Ministry of New and Renewable Energy (MNRE) reports, it aspires to cover 20 million sq metresof Solar Water Heating Systems (SWHS) tillthe 13th plan by the year 2022 [2]. As solar water heating comes under the purview of green building norms, builders today are particularly providing this facility to consumers and are expected to adhere with MNRE guidelines while providing so[3]. Yet the facility is unable to fulfil expectations of the consumers, both time and resource wastage is a problem. Due to its dependency on climatic conditionsand functional inconsistencies it is noted that the wait for hot water from solar heaters is the fairly long. For management professionals, the primary goal is to manage costs and resources and as architects' sustainability cannot anymore be an afterthought but needs to be woven in system design itself. The building Industry in India will eventually have to comply with the Sustainable Development Goals formulated by the United Nations Development Programme (UNDP) that mandates that development must balance socio-economic and environmental sustainability. The crisis that we currently face in terms of water scarcity not only directly affects urban consumers but has now become a potential deterrent in the development process itself as new building projects face the threat of being potentially stalled due to lack of resource. On June 28th 2019 The times of India, one of the premier newspapers carried the news announcing that the State of Karnataka, India was considering a 5 year ban on new construction activities due to water crisis [4]. Chennai city is one of the worst hit cities in India as far as the water crisis is concerned. The Chennai Metro Water Supply and Sewage Board, (CMWSSB), on worst days of the crisis could provide only 525 million litres of water to the city that has a requirement of 830 million litres a day[5].

Pune is considered as a city that demonstrates a gross overuse of water as pointed by Madhav Chitale, an expert on water issues and recipient of the Stockholm Water Prize, 1993. According to him, users in Pune consume almost double amount of water than the prescribed 100-135 litres per person per day consumption norms applicable for urban areas [6]. Currently the Pune Municipal Corporation cannot meet the current demand of the consumers and hence consumers have to purchase deficit amount.

2. NEED FOR RESEARCH

According to the Ministry of Water Resources, potable water is the second largest projected water demand in India, after the irrigation sector which shows the highest demand [7]. As per statistical data and surveys conducted by The Energy and Resources Institute, India(TERI), a **large demand for water and increased volume of wastewatergenerated thereby** both put a significant strain on costs of distribution and treatment both on regional level, as well as micro level, which is the individual user level [8]. Most of the municipalities like Pune Municipal Corporation cannot provide enough potable water to meet the requirement of the population due to variety of reasons like leakages and unaccounted water losses [9]. There is an urgent need to identify the reasons and sources of these leakages as well as the unaccounted water losses. In order to conserve this precious resource conducting audits and identifying problems will help to rectify grey areas. Losses from showerheads need to be quantified and hence there has to be an effective method to compute these losses.

3. LITERATURE REVIEW

"National Building Code of India (NBC)" [10] Part 11 covers approaches to sustainability and **section 3.7** talks about Integrated water management emphasising that efforts are needed to reduce the per capita water consumption in buildings. It emphasises that least anthropogenic water discharge should be a strategy implemented to achieve sustainable water management in buildings. Hence this literature elucidates that reduction of wastage will be possible by reduction of consumption which is directly linked to reduction of losses.

"Ministry of New and Renewable Energy (MNRE) report on Progressive achievements and plans" [3], this report presents the vision the ministry has in terms of implementing Solar Water Heating systems (SWHS) across India. The government aspires to cover upto 20 million sqmts of SWHS by the thirteenth plan by year

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2022[3]. Hence the objective of this paper, to focus on wastage from showerheads, stems from ministry'sintentions to scale up the system.This reference helps to form grounds thatsteps to preclude potential wastages need to be taken.

"Water Consumption Patterns in Domestic Households in Major Cities" [1] by Abdul Shaban, R.N Sharma throws light upon the plight of supply deprived Indian cities reeling under the scarcity of water. Seven Indian cities have been studied to examine consumption patterns in the domestic usage of water .The cities chosen are population and culture wise similar to Pune hence the findings are relatable to the context. The paper gives an insight into how showering is an activity that consumes maximum amount of water across all domestic uses and is as high as 28.2%. This is an important premise upon which this research is based so as highlight the importance of conservation of water in this activity by accounting for the losses first by quantifying them and then finding and employing mitigation methods.

4. MATERIAL AND METHODOLOGY

The objective of this study was to find methods to **quantify the amount of water wasted from showers.**Two methods have been devised to quantify the wastage. First method records data by using a 'metered method' and second by 'observation method'. Thesecomputations calculate losses that occur daily. When a shower is turned on there is a lot of time spent waiting until a steady stream of hot water starts to flow from the shower, which is a temperature comfortable for usage. The **water that the shower dispels before this point is the wastage that needs to be quantified**and this paper intends to structure methods for the computation.The methods tested were:

1. Metered method:

- A showerhead was fitted with a flow meter and the reading before starting the shower and after stopping was noted. Water was allowed to run till an optimum temperature was felt to touch which was adequately hot enough for taking a bath.
- A video recorded number of rotations of turbine to show how many cycles were completed and odometer indicated overall rotations. The needle moved from one point to the other in a cyclic manner and readings were noted at the start and the end of the cycle and noted as photographic data.
- By mathematical computation water wastageswere calculated in litres by incorporating the readings noted during the recording of data.
- Temperature was measured using a regular thermometer that gave the value in Fahrenheit degrees.
- It was possible to derive data to a fair degree of accuracy as no losses were incurred in collection of water

Figure 1: Installation of meter on the shower and meter

(Source: Author)

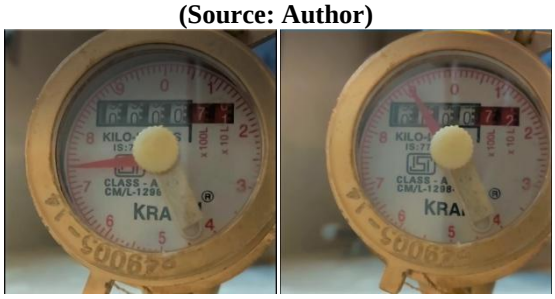

Figure 2: Meter readings showing start and end values (Source: Author)

The figure above indicates that the needle has completed one rotation and gone ahead. Calculation done is:

10 – 7.4 = 2.6 +9.1 = 11.7 litres

Hence 11.7 litres is the amount of wastage.

2. Observation method:

- A calibrated bucket was placed at a position where it would receive the shower water.
- The shower was started and adjustments were made to the hot and cold faucet till observer started receiving water that iswas comfortable to use.
- Once a steady flow of water,suited to the temperature requirement of the observer started flowing, the shower was turned off.
- Some water was collected at this point in a mug to record final temperature
- A picture of the bucket of wasted water and the thermometer was taken to document data.
- The wastage was measured in the calibrated bucket and amount was recorded in litres.
- Final temperature was also recorded in Fahrenheit degrees.

Figure 3: Recording of wastage by observation method (Source: Author)

The wastage of water recorded manually in the above figure was 11.8 litres. The results of both methods corroborate.

5. RESULTS AND INFERENCES

The quantum of water wasted, defers with respect to several variables like height of the building, temperature outside, the persons rank in the series of baths taken in the building,the floor on which the water is being consumed and the kind of heating system used to heat the water and the distance from heat source. This makes the quantification of shower wastage extremely challenging in terms of extracting authentic data.

While the metered method leaves a lower margin of error it is cumbersome to install, involves meter cost and installation cost and recording of readings is a difficult

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task as it is installed at the receiving end of the shower and hence at a height of over 7 feet.

The observation method is easy to conduct but as the data would be self supported the integrity and honesty of observer is very important. It can be noted that some losses occur due to improper positioning of the bucket and hence skills of the observer are also needed.

The observation method needs precise skills of observer so as to minimise the losses occurring if water is not collected completely in the bucket.

Observation method could be implemented for large scale data collection. It can be used in a mass survey, while metered method can be employed for a focus group or selected participants. The socio-economic, educational and cultural backgrounds of the participants are also key aspects to be considered in observation method while conducting a survey, as consumption pattern parity can be maintained while recording the readings.

6. CONCLUSION

Both the methods tested to extract quantitative data in this study proved to giveaccurate data and can be employed in computation of wastage.

7. IMPACT ASSESSMENT AND RECOMMENDATIONS

This wasted water is collected and used for other uses by consumers but it is still considered wastage as it is essentially a flaw in system design. If the plumbing design mitigates these losses in design itself the onus of conserving water is not solely placed on the consumer who, is in most cases,is not sensitised to the magnitude of the problem. Consumer attitude and behaviour is a larger and more complex issue to handle than finding economical, workable solutions in the plumbing design itself.Awareness campaigns that take statistics to people will help them grasp the gravity of the situation by looking at numbers.

Correctional plumbing design needs to be done to save these losses in buildings. A resource as precious as water, that is fast depleting cannot be forgone in favour ofimplementing a renewable energy system that need corrective measures to augment its efficacy. Considering MNRE's goal of covering 20 million square meters by 2022 corrective measure for this problem has to be addressed urgently to mitigate potential losses.The development in the coming years needs happen in such a manner that the gap between policy, design and implementation of the system are addressed with effective solutions

8. ACKNOWLEDGEMENT

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A Study of Agile Vs Traditional Project Management

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Abstract: The Indian construction industry is known to be inefficient and highly reluctant to accept change. Even with changing market and increasing competition, there are no obvious signs of comparable changes in methods of management and approach. Advancement in Project management tools and techniques, on the other hand, seems to offer what is needed to raise industry standards. The gap between an old view on managing projects and new way of actually conducting them creates uncertainty and anxiousness within the business and its employees. So,use of an Agile methodology helps to address such weaknesses associated with traditional methodologies. Study aims to compare APM method with TPMinconstruction projects with the help of a questionnaire survey based on agile values.

KEYWORDS:
Traditional Project Management, Agile Project Management, ConstructionProjects, Change Management, Flexibility.

ABBREVIATION
TPM – Traditional Project Management
APM – Agile Project Management

I.INTRODUCTION

To avoid or overcome with failure in construction projects is difficult task, most of the countries within the world are experiencing problem in managing failure in construction projects, Where nearly two-third of the development projects in the world are suffered by significant problems as a rise within the cost, delay within the specified duration for execution, and discontinuing of the projects. In this conservative industry, still the old method like the traditional waterfall method is used for managing the projects, This method follows linear processes and practices in which detailed, upfront planning is done at once by project managers and team members. That is an analysis of the project is done very early in the process, meaning stakeholders and customers must identify their desired outcome in an early stage. However, it can be hard to determine all the requirements and outcomes without seeing the project in progress especially early in the design phase. Once a phase is completed, there is no way to go back and change the outcome without repeating the entire process from the beginning. It is both time-consuming and costly to allow room for change within this process, making it difficult for teams to maintain strict timelines if not everything goes as planned. In this project, clients are hardly involved in decision making.Project communications with the client are extremely limited being either at the beginning or at the end of the development. [1]

Good communication is crucial to delivering a successful construction project. When communication among stakeholders breaks down or is mishandled, it can lead to delays, accidents, costly rework, and unhappy clients. Keeping everyone up to date on changes to the work or schedule goes a long way in preventing major problems. The flow of communication affects the flow of a construction project. Problems and delays occur when people stop communicating or responding to inquiries. Projects run smoother and get completed on time and within budget when everyone is communicating and collaborating effectively. [2]

Therefore it becomes necessary to look into new methods of managing projects which overcomes these problems and ensure its success.

Finding the optimal way of managing, control and coordinate projects is a constant challenge. Adjusting working methods, clarifying roles, simplifying project reporting or visualising the project-status through new user-friendly management tools are examples of how this challenge can be met. Project management
today often concerns the entire organisation whether it is a small private company or a larger public business.[3]

Project teams are using agile approaches in a variety of industries beyond software development. Organisations realize that expansions has created a need for a common language ,open mindset, and willingness to be flexible in how projects are delivered to the market. InAddition, there are broad range of tools and techniques ,and frameworks ,teams have choices for approaches and practices that fit their project and the organizational culture in order to achieve the desired outcome.[4]

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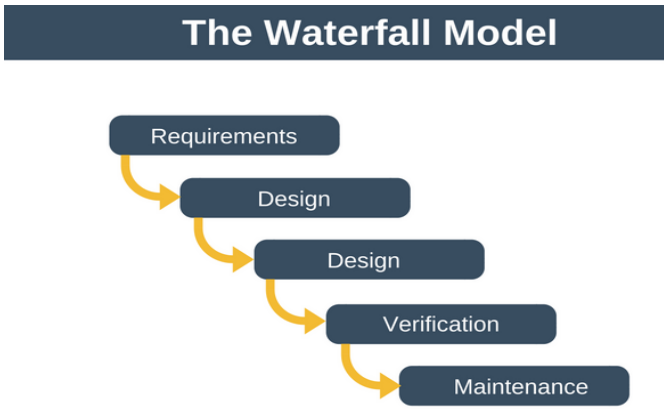
Although the agile movement was the "brain child" of the software development and IT world, it has grown and evolved over the past several years. There is no question that today agile project management can be, and has been, applied successfully to a broad range of projects. Users and stakeholders have benefited from the agile project management approach one in which the end user and the project team are partnered in a collaborative effort focused on the project vision and the end result. [5]

What is Traditional project management?

Traditional project management involves very disciplined and deliberate planning and control methods. With this approach, distinct project life cycle phases are easily recognisable. Tasks are completed one after another in an orderly sequence, requiring a significant part of the project to be planned up front. For example, in a construction project, the team needs to determine requirements, design and plan for the entire building, and not just incremental components, in order to understand the full scope of the effort.[6]Traditional project management assumes that events affecting the project are predictable and that tools and activities are well understood. In addition, with traditional project management, once a phase is complete, it is assumed that it will not be revisited. The strengths of this approach are that it lays out the steps for development and stresses the importance of requirements. The limitations are that projects rarely follow the sequential flow, and clients usually find it difficult to completely state all requirements early in the project. This model is often viewed as a waterfall.[7]Flow chart -1.



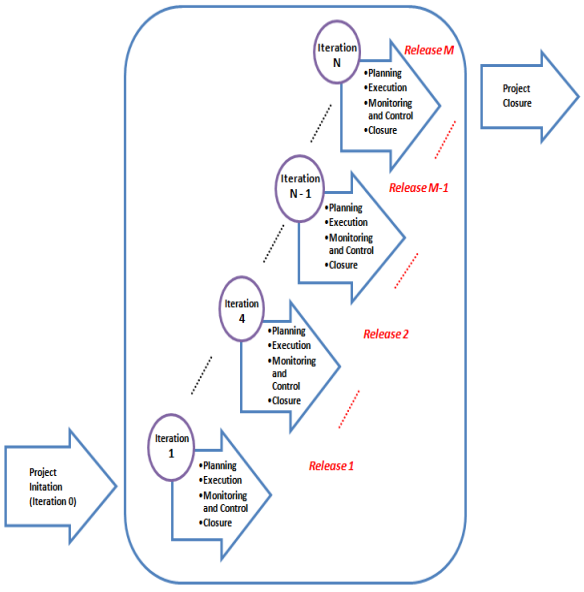
Flow chart -1 Water fall model

(source-www.expertprogrammanagement.com)

According to a Gartner report "The End of the Waterfall as We Know It" by Matthew Hotle and Nathan Wilson): *"Quite simply, Waterfall methods, when used in the traditional, project-based manner, are inconsistent and risky. Since there are other choices available that have the potential to be more consistent and less risky, it's time to begin the transition to these methods."*

What Is Agile Project Management?

Agile project management is an iterative development methodology that values human communication and feedback, adapting to change, and producing working results.[8]Agile is iterative, meaning that it is done in pieces (sprints), with each sprint building and improving off the lessons from the previous sprint.(Flow chart-2)This is where that term Scrum comes into play. Scrum methodology is a workflow framework made up of sprints and reviews used to promote Agile project management. Unlike Scrum, which can be distilled to a step-by-step process, Agile is an approach and a mindset. Agile methods are based on the central to see the actors' innate ability to learn from experience, to find creative solutions, and to spontaneously seek to derive mutual benefit from each other. "The agile methods are therefore directed to create situations where players are able to communicate very informally and can govern themselves"-Tomas Jansson, PhD & Professor of Project Management at Karlstad University



Flow chart-2Agile Project Management process.[9]

Agile methods are used when these conditions are present: project value is clear; the customer actively participates throughout the project; the customer, designers, and developers are co-located; incremental feature-driven development is possible; and visual documentation (cards on the wall vs. formal documentation) is acceptable.The Agile approach consists of many rapid iterative planning and development cycles, allowing a project team to constantly evaluate the evolving product and obtain immediate feedback from users or stakeholders. The team learns and improves the product, as well as their working

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methods, from each successive cycle. After a streamlined planning, requirements definition and solution design phase is completed to get the project underway, iterations of more detailed planning, requirements, design, build and test take place in waves. This approach allows for immediate modifications of the product as requirements come into view. APM requires a dedicated full-time project team that includes a customer or end user, where team members work from the same location.[7]

The Agile Manifesto is a proclamation that articulates four key values and 12 principles.

1. Individuals and interactions over processes and tools:
2.Working software over comprehensive documentation:
3.Customer collaboration over contract negotiation; and
4.Responding to change over following a plan.

In agile refers values on left more.

The twelve clarifying principles flowed from these values are as follows:

1.Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2.Welocme changing requirements, even in late development. Agile processes harness change for the customer's competitive advantage.
3.Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4.Business peopleand developers must work together daily throughout the project.
5.Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done.
6.The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7.Working software is the primary measure of progress.
8.Agile processes promote sustainable development. The sponsors,developers,and users should be able to maintain a constant pace indefinitely.
9.Continuous attention to technical excellence and good design enhances agility.
10.Simplicity-the art of maximizing the amount of work not done-is essential.
11.The best architectures,requirements,and designs emerge from self-organizing teams.
12.At regular intervals, the team reflects on how to become more effective, then tunes and adjust its behaviour accordingly.

Although originating in the software industry,these principles have since spread to many other industries. This embodiment of mindset, values and principles defines what constitutes an agile approach. The various agile approaches in use today share common roots with the agile mindset,valve,and principles. The relationship is shown in Figure 3below.

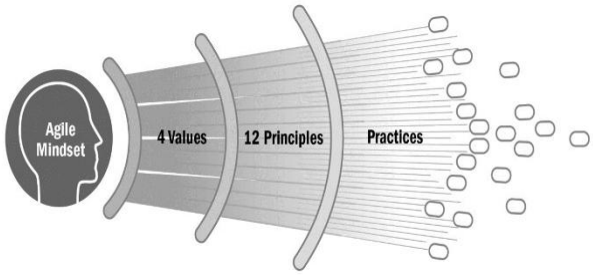

Figure 3The Relationship between the Agile Manifesto values,principles,andcommon practices.(source-PMI Agile Practice Guide)

As shown in the above Figure 3 the model articulates agile as a mindset defined by the agile manifesto values, guided by the agile manifesto principles, and enabled by various prctices.it is worth noting that while the term "agile' becomes popularized after the Manifesto approaches and techniques being used by project teams today existed before the agile manifesto by many years and in some cases, decades.[4]

II METHODOLOGY

The quantitative approach was chosen to gain understanding Depending on the theoretical study of the agile project management, this research examines the applicability of the agile project management on 4 values, which itself compares with traditional management in the construction industry.

For this purpose, the closed questionnaire technique for a group of professional from construction industry was conducted.The questionnaire survey form was for targeted group of people only,Professional who are working in construction project and having knowledge about project management were the main target group. Mainly the technical persons (like project managers, contractor, Team members, architects, client, etc.) were considered for better responses. Since this methodology is not much familiar and well known in Indian construction Industry, Questions were designed based on 4 values of agile project managementidentified through theoretical study. Then, the questionnaire was sent to Research guide and some of the professional experts for evaluation the questions of the questionnaire, the final form of the questionnaire included the General Information about the Respondent and Applying of Agile projects management values in construction projects.

III DATA COLLECTION

The questionnaire was sent to 30 respondents. From which, 23 people read the questionnaire, but only 20 people have actually completed the questionnaire form. Therefore, the total number of respondents is 20, resulting

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in a good response rate of 66.66 % Out of those 20 successful respondents, their roles in projects were, 7 wereProject managers, 7Architects,3 Contractor, 2Clients, and 1structural engineer who had more than 20 years of experience in working with the main parties involved in the construction project.

The respondents were also asked for their experience in construction filed, work sector, organisation details, cost of the project on which they are working.etc. ReferTable 1

Table 1: General information of the study sample

General information		Project Manager	Contractor	Architect	Client	Other Consultants
Total no of experts		**7**	**3**	**7**	**2**	**1**
Professional expereinece	More than 20 years	1	1	2	0	1
	16 to 20 years	1	1	0	0	0
	11 to 15 years	4	1	4	2	0
	6 to 10 years	1	0	1	0	0
Work sector /company	Public	1	1	1	0	0
	Private	6	2	6	2	1
No. of empolyees in an organisation	1 to 9	1	1	4	0	1
	10 to 50	1	0	0	0	0
	51 to 200	1	1	0	1	0
	More than 200	4	1	3	1	0
Project cost	10 lacs to 50 lacs	1	0	2	0	0
	51 lacs to 1 cr	0	0	0	0	0
	1 cr to 2.5 cr	1	1	1	0	1
	More than 2.5 cr	5	2	4	2	0

Table 1General Information of the Study sample.

IVANALYSIS ON FOUR VALUE BASED FACTORS:

Analysis is done through detailed information collected through the questionnaire responses. The objective of this section is to check the possibility of implementing the Agile project management values in the construction projectsby a set of questions related to each value. Respondents had the freedom to choose their opinions about this survey. Specifically, this question focused on their perception about these factors and respondents had to choose one option for each factor. The scale ranged from 1 to 5 wherein, 1 indicates 'Strongly disagree' and 5 indicates 'Strongly agree. The outcome of the survey would highlight perspectives of individuals regarding the kind of environment the project team would like to work within. Along with that, it would also hint on the satisfactory levels of the respondents regarding the agile project management or want to improvise/ suggest changes in the existing management approach. According to the result of this survey, the responses were positive which might lead these people to adopt agile approach and negative ones are for still following the existing waterfall project management approach.

Below are the results of responses for 1st value of APM:

1.Individuals And Interactions Over Processes And Tools.

Valuing people more highly than processes or tools is easy to understand because it is the people who respond to business needs and drive the development process. If the process or the tools drive development, the team is less responsive to change and less likely to meet customer needs. Communication is an example of the difference between valuing individuals versus process. In the case of individuals, communication is fluid and happens when a need arises. In the case of process, communication is scheduled and requires specific content.[1]

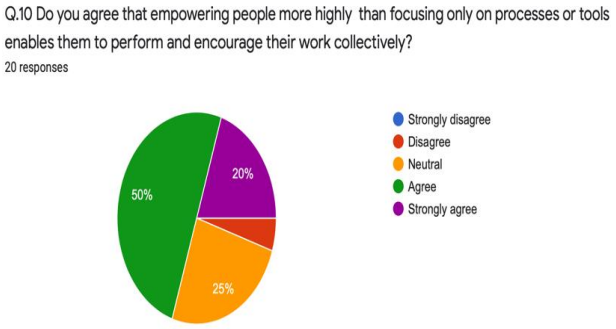

Figure 4Individuals and interactions over Processes and Tools.

The first value of Agile project management values can be applied in the construction projects at a high level as 50 % respondents have agreed and 20 % have strongly agreed ,it means 70 % respondents think that communication within team is very important while working on any project. AsCommunications makes people to think and observe more.25% given neutral (don't know)as their response, only one respondent is not agreeing with this it means that they might be following TPM. In traditional project management approach communication within team in terms of construction is less because they are bound by project managers to work accordingly. Also importance to processes is given more than the outcome.

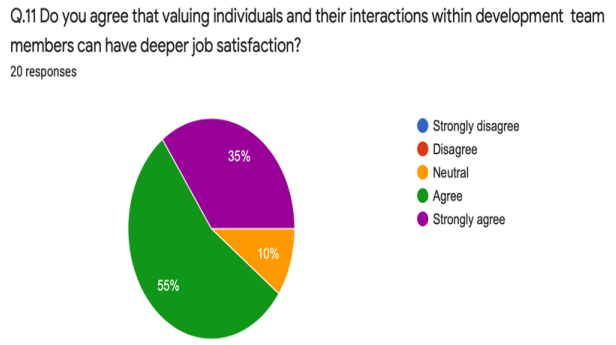

Figure 5 Valuing Individuals

55% respondent agree and 35% respondent strongly agree that the job satisfaction is also more due to valuing individuals and their interactions within the team. No matter how well-researched your process and high-tech your tools are, it's the team you work with and the way you work together that determines success. Your team and their ability to communicate effectively and efficiently is

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more valuable than the processes they follow or the tools you use.

The results of responses for 2nd value of APM

2.Working Software Over Comprehensive Documentation

Enormous amounts of time were spent on documenting the project requirements for development and ultimate delivery. Technical specifications, technical requirements, technical prospectus, interface design documents, test plans, documentation plans, and approvals required for each. The list was extensive and was a cause for the long delays in development. Agile does not eliminate documentation, but it streamlines it in a form that gives the developer what is needed to do the work without getting bogged down in minutiae. Agile documents requirements as user stories, which are sufficient for a software developer to begin the task of building a new function.[1]Useful project outcome over comprehensive documentation" and this makes it easier to understand what it would mean in construction industries. The meaning of this part of the manifesto is to throughout the project deliver smaller useful results, instead of setting up a goal to deliver the result of the entire project at one point somewhere in the far future. The process is divided into short cycles and at the beginning of each cycle there is an opportunity to both review the past cycle but also thoroughly plan the upcoming cycle. At the end of each cycle a useful part of result is presented. How early in a project these parts actually become useful depends on the type of project. By actually closing each cycle and review what has been produced, there are throughout the project possibilities to decide whether the project has been completed or if it needs to be cancelled before completion because of various factors. It becomes a tool of monitoring the progress of the project that naturally includes opportunities for decision-making.[3]

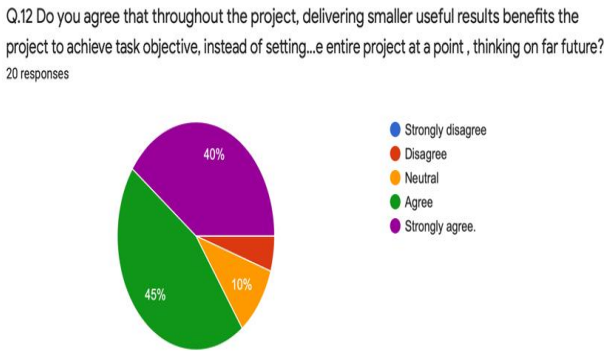

Figure 6 working software over comprehensive documentation.

As per survey resultsFigure 6shows 45% and 40% respondent agree and strongly agree ,together 85% of respondent agree for adapting agile management second value.

The results of responses for 3rd value of APM:

3.Customer Collaboration Over Contract Negotiation

Throughout the history of project management it has been a well-known fact that a good relationship between the client and the supplier is of the essence for a successful project. The thing is that before the Agile management approach methods one did not really know how to achieve a good relationship. Since the process is divided into smaller parts, in Agile, with review and presentation between each of them the client has (and should take) the opportunity to see, discuss and decide whether the present plan should continue or if something should be changed. These presentations are held with, at the most, a month's interval, which makes it possible for theclient to be involved throughout the project and make changes, if necessary, before the issues get too large.At the end of each cycle of an Agileproject, the client is involved to bring forward opinions and thoughts about the project.

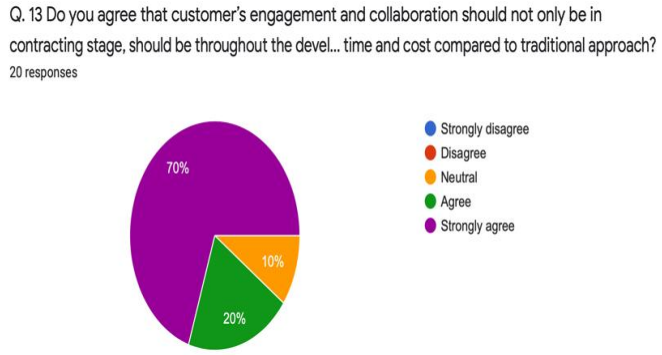

Figure 7Customer collaboration over contract negotiation

As per Figure 790% respondent strongly agree this means that the client collaboration is core to bring the project towards success. The customer gets involved throughout the completely Agile project process by reviewing, discussing and deciding at the end of each cycle.

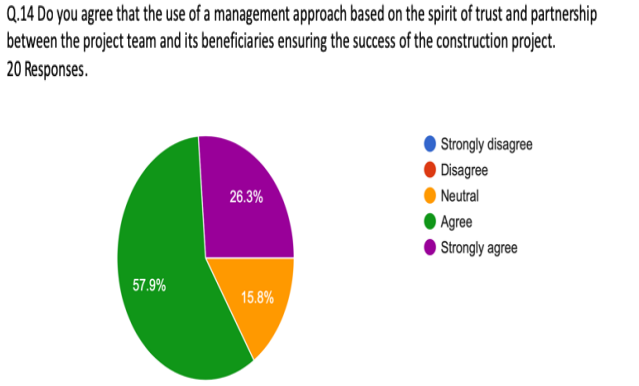

Figure 8Trust and partnership between project team and client.

As per survey results 57.9% and 26.3% respondent agree and strongly agree ,together 84.2% of respondent agree for adapting agile management approach based on the spirit and partnership between the project team and its

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beneficiaries ensuring the success of the construction project.

4: Responding To Change Over Following A Plan

The Agile Manifesto states that changes are welcomed in agile projects. The reason for this is that Agile projects do not believe in "predicting the future" by planning for every detail in advance. The plans should instead be dynamic and Agile teams should realize that projects are prone to change.

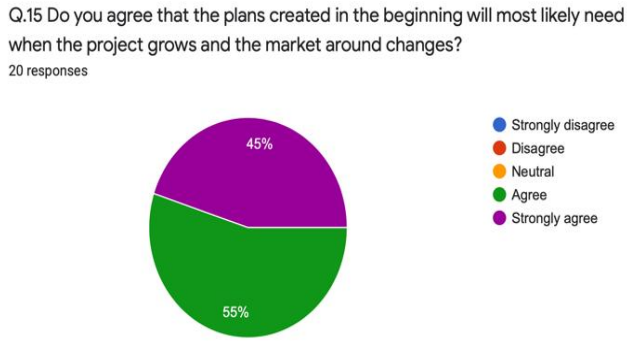

Figure 9Responding to change over Following a plan.

As per survey results 55% and 45% respondent agree and strongly agree respectively, so it means 100 % of respondent positively agree to it that the plans which were created at the beginning will most likely need to be adjusted when projects grows and the market around changes.

V.CONCLUSION:

The major advantage of implementing agile project management in construction projects is to increase communication within development team.Agile approaches are effective and allow the project management process to be a vivid and continuously updated depending on how much information has been disclosed as well as how many different scenarios have been run. Agile project management provides project managers with methods, tools and approaches to aid both the project manager and project client to engage in a more efficient manner, allowing for more open communication, feedback sessions and the notion of pursuing a shared goal towards successful project management. Implementing agile project management will also result in client's satisfaction in the end of the project. As the chosen research topic is mainly focused on agile values, further research can be done on 12 agile principles and its implementation in construction industry.

VI.RECOMMENDATIONS:

Construction companies should provide, conduct the seminars and training courses to raise awareness among the decision-makers and all the team members of the project to adopt these values in the construction projects.

VII.ACKNOWLEDGEMENT:

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Morphological Analysis of 'Shilpashastra' and a Comparison with Contemporary Urban Morphologies : A Case of Madurai

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Abstract: ***Planned historic settlements based on agama texts [Shilpashastra] in India are a unique morphology, physical embodiment of the agama philosophy & practice-ritual systems in these cultural landscapes. These settlements, characteristic to the SE Asian region have remained absent from the global city-planning dialog. The agama texts prescribed city-structure guidelines for urban form. However, there is a large deviation between the prescribed and on ground model. This paper intends to carry out a morphological analysis of Shilpashastra and understand it in relevance to the contemporary city. The process shall help identify the deviations from texts as well as evolutionary developments.***

Keywords: Shilpashastra, cultural landscapes, agama-based city model, planned Indian cities, morphological analysis, Madurai.

Introduction: Planning and conservation practice in India, today, is still a reflection of Western philosophies & ideologies[i]. The knowledge systems embedded within our philosophy are disregarded on the grounds of superstition.

The 'Agama philosophy' has been the basis for the conception of Pre-Mughal historic culturallandscapes in India, especially temple towns. Some of the oldest towns have been functioning for more than 2000 years. Shilpashastra provides guidelines for the architecture and planning of the towns, a system whose history might go deeper than we know.

The engineering of such unique morphological systems, composed by successive layering of geometrical patterns over metaphysical diagrams dictated by social norms and shaped by mathematical proportions, based on the agama texts or the Shilpa-Shastra, exist even today in some of the temple-towns in India.

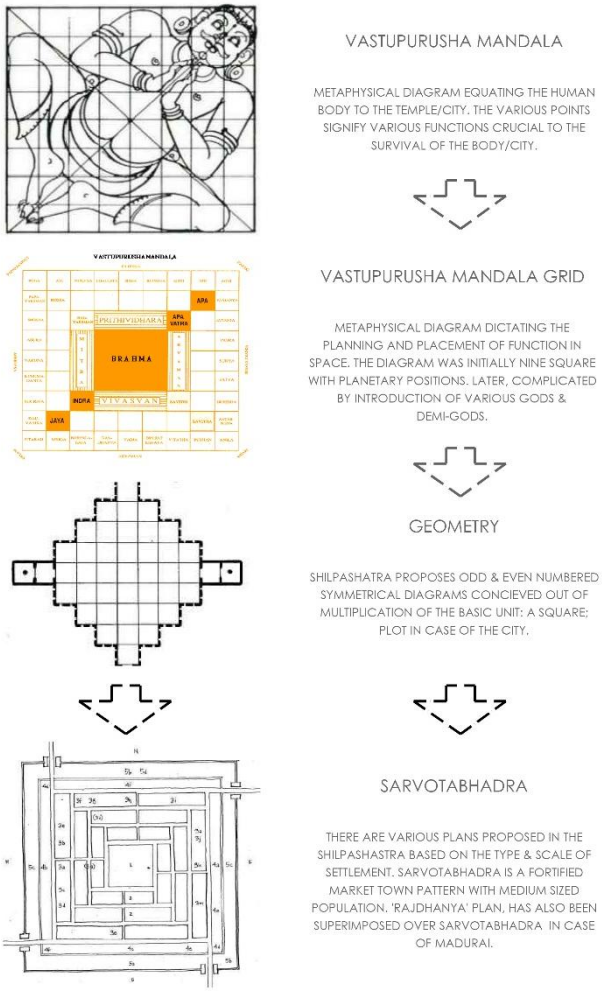

Fig 1: Layering of various diagrams constituting the city-plan
Source: Author

These living cities bear physical witness to the evolutionary processes that the city's urban form has undergone through time, successive cultures, changing politico-administrative structures and ever dynamic 'people's agency'. The lens of 'cultural and religious value' to the system and its central role in these landscapes is pivotal to their survival and continuity. Such a culture of pilgrim towns form a network of connected landscapes at a macro-level and an integrated interdependent local system at a micro-level.

Hence, these norms operated to create interconnected systems of morphology and syntax intertwined at various

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levels. City-building science and cities have been in existence since ages. In the global context, the 'agama-city model' isn't acknowledged as a working model under the alibi of its metaphysical base. This paper intends to explore the city-planning aspect of the Shilpashastra beyond the metaphysical aspect and understand its implication and meaning in the contemporary times.
With recent awakening for the 'need for a different outlook' in the SE Asian context, many more such unique 'agama-based' morphologies are being discovered in the region [loosely referred to as the historic 'Greater India'].

Fig 2: Various cities across SE Asian context conjectured to have an agama-base
Base map Source: Google

There are large deviations in the cities prescribed under the Shilpashastra versus the actual city in existence. This is one of the major reasons that these city models lay buried for centuries undiscovered. Another major issue with studying city models is that archaeological remains of old cities and intact city forms of historic cities can be identified and studied with greater ease than the living continuous cities with evolutionary and executional deviation in the case of the agama-cities in the Indian context.

These models were also governed by socio-cultural and politico-administrative stands and economic statuses at a city hierarchy level. The contemporary forms display strands of such hierarchical systems in their composition. The impact and adaptative-modification of this composition due to time-factor and successive cultures in the timeline[1]. The transformation can also be looked upon as a transition from a utilitarian city-model with centralised administrative control [Madurai] to a decentralised model [Jaipur] and finally a capitalist aesthetic city-model in contemporary times that branch out from these agama-historic cores.

Fig 3: [top to bottom] Jaipur, Srirangam and Madurai; various grids and patterns of the planned historic cores; Base map source: Google

Literature Review: The various arguments of the origin of the schemes and plans prescribed under Shilpashastra have essentially stemmed because of these very deviations. Kramrisch [ii] started the argument of the metaphysical base to the diagrams[2], thereby associating the '**Vastupurushamandala**' to the plans. From this argument stemmed the connotation of **Mandala city plan** addressing the agama-based cities. Adam Hardy [iii] decoded the temple plan and form and drew patterns of extrapolation and projection of plan into 3D form. Bafna [iv] argues that the annotation of Mandala city plan is not fully justifiable in itself and although the Vastupurusha diagram might be considered as an underlying aspect to it, Yantra, the geometrical diagram is the predominant base. BB Dutt [v] is an important contributor to the translation of Shilpashastra and reproducing it nearly close to city-planning guidelines.

Mayamatam helps us understand that the city-form in itself is a product of not only the overlap of Vastupurushamandala [metaphysical] and the pada-vinyasa schemes [geometry], but essentially also mathematical proportions [volumetric proportion of the city's built-form and its hierarchy].

Methodology: Morphological analysis of the agama-texts [Shilpa-shastra] and comparison with contemporary urban-form, forms the core of the research of this thesis.

A basket of methods- both qualitative and quantitative have been used to assimilate the study. Morphological analysis has been used as a method to decode the evolution in the urban form of the planned city of Madurai and understand the agents of change. Along with this, phenomenology and historico-geographic methods have been used as supplementary methods.

[1] Centralised administrative power in Madurai and Srirangam to decentralisation in Jaipur

[2] The interpretation was primarily for the plan-diagrams for the temples

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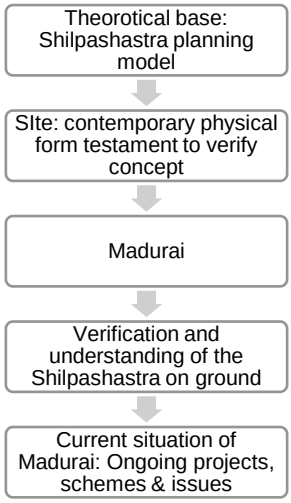
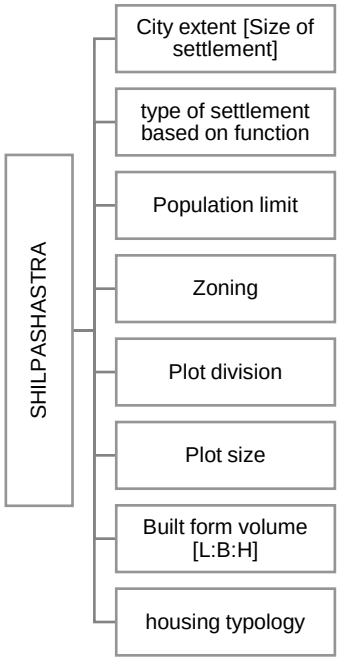
The Mayamatam[3] book, compendium of architectural, city-building and engineering practices based on the Hindu philosophy had been taken as the theoretical base from where the study started. The area of interest was to find planning models existing in the Indian landscape since ages.



Flowchart 1: Methodology

Results and Inferences: The differences between the prescribed form and existing/executed raise the question of level of stringent implementation of the agama guidelines. They may have served merely as a framework subject to interpretation with respect to each individual site.



Flowchart 2: Various guideline categories provided under Shilpashastra

Criteria	Prescribed	Deviation in contemporary form : madurai
Size of settlement	300-8000 poles[4]	800 m x 900 m[5]
Type of settlement	Rajdhanya	Rajdhanya+Nandyavarta+sthaniya
Plot size	121 blocks[6]	
Volume	L:B:H= B+2:B: 1 to 2B	Contemporary: B: H= B: 3 TO 4B[7]

Table 1 : Prescribed versus deviation [Shilpashastra]

The probable causes for deviation between the prescribed and the ground model could be:

- Scale of the city being humungous as compared to the machine scale: the human.
- Technological limitations to execute the desired layout
- Mode of execution being manual and on ground; limitation of capacity
- Discrepancy of various overlapping criterion, each generating individual layouts: the resultant city form is a mixture of all the layouts and unidentifiable with any one particular layout.

The reason for undistinguishable submerged state of the contemporary city form of Madurai:

- Adaptive-evolutionary changes
- Different politico-administrative structures
- Changing economic base through time
- Changing people's aspiration

Madurai happens to be an overlap of three mapping categories prescribed in the agama – Rajdhanya [capital city] which largely impacts the zoning and hierarchy, Sarvotabhadra layout which regulates the street layout, blocks and accommodates its fort-city capacity. Madurai also being a major economic center, in places displays zoning pertaining to the market in Shilpashastra.

The current form of the city exhibits a crooked concentricity as compared to Srirangam, which displays

[3] Later version of ManasaraShilpashastra

[4] 1 pole= 5.02 m

[5] UptoMasiveedi

[6] Sarvotabhadra town is prescribed to have 121 blocks; whether these blocks are same as plots is ambiguous.

[7] The paper notes observable patterns of change in deviations

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concentricity to the maximum and deviation to the minimum. Madurai as a model in the timeline of city-building in the Indian context is considered to be a part of learning and working process, hence is given the leeway for its deviant form.

The ring roads- *Aadi veedi*[8], *Chittiraiveedi, Avvani Moola veedi, Masiveedi and Veliveedi*[9]*;* follow their ceremonial function of processions even today. The central temple has been prescribed to be the highest [point] and largest [block] in the city's cultural landscape, followed by the palace and the rest of the landscape. In the contemporary landscape, the temple still fairly remains the highest and largest point, even amidst the new development.

The plot division and sizes as prescribed in the Shilpashastra provided a regulation for capacity of land to supply and sustain. There are a few areas of old vernacular building stock that display uniformity or hierarchy in the form along with regulated volume and capacity.

Category	Element	Use/function	Value
Street system	Ring roads-concentric	Procession	R C H
	Axis roads	Avenue and axis to the temple	R C H I
	Outcrop roads leading to outside of the core	Transit lines	C H I
Central foci	Meenakshi Amman Temple	Congregation, religious space	R C H I
Tanks	Perumal Theppam	Subordinate shrine	R C H I E

Table 2: Charting the elements to their corresponding function and value. [basic primary elements as observed in Madurai] R: Religious value, C: Cultural value and H: Heritage/historic value, I: Contemporary value, E: Ecological

Although the entire prescribed form is not projected onto ground in case of the agama-planned cities, the Shilpashastra acts as a guiding framework, right from the location of the city at macro-scale to the Vastushastra operating at an individual house level at a micro-scale.

Conclusion: The topic of agama-based city is to be further studied. It becomes critical to address all the aspects of the morphology prescribed in the agama as well as those that are a product of evolutionary adaptation in order to atleast balance out the contemporary action if not improve the situation.

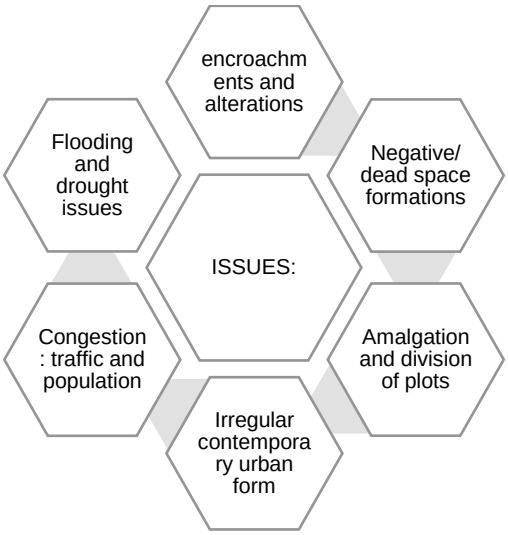

Fig 4: Critical issues of the contemporary urban form

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[8]Veedi meaning street
9 Veliveedi being a later addition during colonial times for city expansion

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Analyzing The Rehabilitation Of Landslide Affected Village By Application Of Sustainability Indicators

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Abstract: The focus of paper was on landslide disaster rehabilitation in rural region, as these areas lack infrastructural development due to inaccessibility and are in much need of innovation and aid. Existing literature suggests that the rehabilitation housing projects lack cultural appropriateness and considerations of local needs of disaster victims. Aim of the research was to analyze current impacts of rehabilitation housing project on people and environment, using sustainability indicators such as Social appropriation, infrastructure, construction materials, future risk minimization and low impact on environment. The methodology of research included, background study of landslide disasters in Maharashtra and current disaster mitigation system, as this state, specifically Western Ghats come under moderate to high risk of landslides. It presents the findings of a live case study at Malin village located near Pune in Maharashtra. Analysis of rehabilitation housing project was done on basis of survey and interviews of villagers rehabilitated and further issues faced by them. The research concludes with issues of current rehabilitation process and gives future direction to make rehabilitation process more sustainable, so that further impact on already affected village can be minimized.

KEYWORDS : Disaster, Vulnerability, Landslide, Rehabilitation, Sustainable Indicators, Housing

1. INTRODUCTION

India is advancing towards the future, where disaster such as floods, earthquakes, landslides, cyclones, tsunami's, heat strokes etc are becoming more and more frequent (International Disaster Database - EM DAT). The major cause behind this is climate change caused by global warming and pollution (Alexander, 2019). This paper explores various impacts of landslide disaster on different aspects of society and surroundings. The factors such as social, economical, infrastructure and environment are under study. The focus is on disaster in rural region, as such areas are generally less accessible from well developed infrastructure.

Existing literature suggests that the rehabilitation housing projects lack socio-cultural appropriateness, considerations of needs of local disaster victims and effect of such rehabilitation on surrounding environment (Barenstein, 2008). Sustainability factors play an important role in having long term positive impact on wellbeing of rehabilitated people. This research analyses such positive and negative impacts of rehabilitation housing project in terms of sustainability indicators. The research concludes with issues of current rehabilitation process and provides recommendations in order to minimize negative impacts. Following section reviews various concepts related to the study.

1.1 Hazard, Vulnerability And Disaster

When we talk about disaster, it is the combination of two factors, i.e., Hazard, which is defined as, '*an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural losses, damage to the environment, interruption of business, or other types of harm or loss*' and Vulnerability, which is defined as '*The degree to which a person, system or unit is likely to experience harm due to exposure to perturbations or stresses* (Vijayalakshmi Viswanathan, 2019).*'*

In general, disaster involves many factors, both natural and man-made. In case of landslide, natural factors such as soil type, weather, rain are involved with manmade factors such as, deforestation, farming and construction development on slope, soil extraction etc.

1.2 Landslide and it's impacts

Landslide near human development can create impacts on many aspects of environment, which can become hazardous to local residents. These can be categorised as social, economic and environmental impacts (Highland, 2009).

Social impacts include loss of livelihood, heritage and social structures, weakened social structure etc. (Highland, 2009). Environmental Impacts include, changed surface topography, groundwater flow alterations and poor water quality, destruction of vegetative cover and natural habitat (Gouagna, 2012).

Economic Impacts include destruction of farmlands, Soil contamination leading to barren lands, Physical assets destruction giving major economic setback to villagers (E. N. C. Perera, 2018).

1.3 Landslide Vulnerability profile of India

NDMA (National Disaster Management Authority) has published report on disaster vulnerability of India. It depicts the landslide sensitive zones all over in India. It

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can be observed that northern regions including Himalayas, northeast regions of Assam and south western region of Maharashtra and Karnataka including ranges of Western Ghat are major landslide prone areas. The landslide prone areas are located prominently in geologically active zones of India. (NDMA, 2018)

The National Disaster Response Force (NDRF) has been established to provide immediate response to disaster. NDRF is further subdivided till regional and local levels for more efficient response to disaster event as well as keeping up to date records of disaster activities throughout India.

1.4 Rehabilitation aspects and norms for landslide affected village

In general, ideal rehabilitation should include physical, economic and social aspects as well as psychological upliftment of the livelihood in the disaster affected region. Hence following aspects are considered while planning rehabilitation.

Social rehabilitation

Considering the vulnerable sections of society like elderly, orphans, single women and young children would need special social support to survive the impact of disasters.

The rehabilitation process should be sensitive about the fact that victims may have already gone through much of social strain, as many people in their neighbourhood may have heavily suffered in disaster.

Psychological rehabilitation

Dealing with victim's psychology is a very sensitive issue and must be handled with care. Thus, counselling for stress management should form a continuous part of a disaster rehabilitation.

Economic rehabilitation

To economically sustain rehabilitation, analysis of existing livelihood and economical opportunities is to be done by planners. Rehabilitation should be economically feasible for Vulnerable families, as to stabilise and grow stronger. There should be some business opportunities at local level or alternative income jobs and commerce.

1.5 Sustainable rehabilitation

Sustainable development is concept of livelihood security. Sustainable development will create long term positive impacts on every aspect of rehabilitants lives (Adams, 2002). Following major aspects are included in this development -

- **Increasing awareness** of people to offset risk, absorb shocks and Training them to avoid any further disaster i.e., Disaster preparedness.
- **Including affected villagers** in decision making and construction process and planning of rehabilitation project. Keeping check on rehabilitation process by continuous assessment of such project with expert supervision and technical help, Which will strengthen the overall future of rehabilitation.
- Designing and planning of rehabilitation project with consideration towards rehabilitants actual needs and requirements.
- **Proper and well maintained services** are very important for functioning of rehabilitation project. supply of electricity, water, waste management are much important factor for better livelihood of villagers
- **The aim of rehabilitation project should be** to make rehabilitant economically independent and integrated with the host population; to re-establish true home.

1.6 Advantages of people centric approach to rehabilitation-

- It is more cost effective as **owner knows exactly what he wants and don't want** in house.
- Building may be **used for occupancy** already before the house is fully finished.
- Active participation by rehabilitant will increase joint community feeling which is essential for long term rehabilitation.
- Construction activities keep people occupied and gainfully employed**.** which helps in stabilizing economical state of people.
- Due to participation of rehabilitant, attachment is formed between owner and house. Which is essential as that person maintains the house increasing lifespan of project.
- Increased social involvement creates and heals the social bond, and helps in re-establishing cultural heritage and identity.

2. METHODOLOGY OF RESEARCH

Methodology included following steps -

- live case study of disaster rehabilitation project is done to understand the current methods applied by government for disaster rehabilitation.
- Through field study on rehabilitation project, Primary data was gathered by using structured questionnaire from residents of the affected regions; the questionnaire data gives detail information about the livelihoods and issues at the household level.
- Before data collection, a pilot survey was conducted on disaster site for creating baseline/ framework of detailed survey, and the questionnaire was revised according to the responses.

3. LIVE CASE STUDY OF MALIN VILLAGE

The case study was selected after the background search of disaster incidents in Maharashtra state. As the focus of the research was assessment of rehabilitation of disaster

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affected people at village level, The incidents were selected on criteria of following -

- Accessibility - As the aim of the research is to assess the rehabilitation project in remote level and with lower accessibility.
- Location - The village should be situated in Western Ghats region as, this region is considered to be under moderate to high threat of landslide disaster.
- Time period - The incidents of landslides from 3-4 years back are selected, as research requires case study of fully rehabilitated village, So that after effects of such rehabilitation can be studied.

3.1 Background of landslide disaster

Malin village is the northern part of Western Ghat of Deccan Trap and is located on the one end of the reservoir of Dimbhe dam, situated on Ghod river, a tributary of Bhima river in the Ambegaon Tehsil of Pune district in Maharashtra, India. It is located about 40 km from the famous Bhimashankar temple and about 150 km from Pune.

The incident of landslide happened early in morning of 30 July 2014, more than 134 people from Malin village died and many more become injured. almost 70 percent village got buried under mud, destroying households and land. Following are the causes of landslide -

- The major cause of landslide can be considered as cutting down the trees on slopes of downhill, for expanding farmlands.
- due to which soil which has low holding capacity became unstable.
- due to heavy rain soil became saturated and muddy.
- Which lead to sliding of entire soil cover downhill and causing disaster.

3.2 Temporary rehabilitation

The Temporary Structures for landslide affected villagers of Malin were built in nearby school compound. The sheds needed to built as fast as possible hence the construction is done with corrugated metal sheets put over steel frame work.

- The Basic unit size is 12 ft x 15 ft. The unit is simple rectangular structure, without any internal partition (as shown in Figure 1).
- There are Window for ventilation on back side of each room measuring 75 cm x 90 cm in size.
- There are 2 Tube lights and no fans in Room.

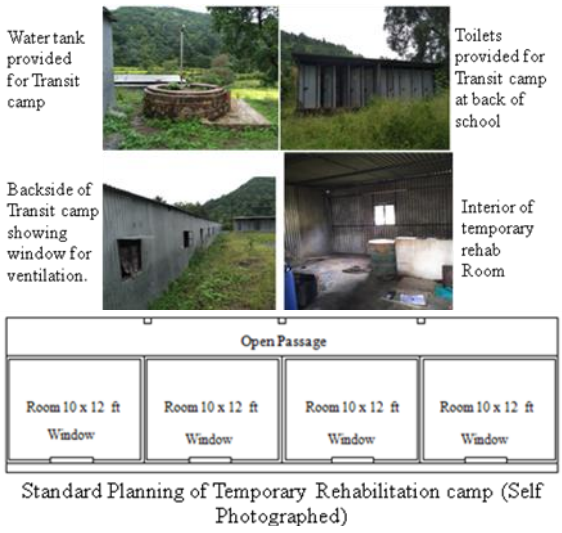

Figure 1 - Temporary Rehabilitation (Source - photograph by Author¹)

3.3 Permanent Rehabilitation

Rehabilitation project was planned on land of nearby village of Ambade.

- It took six month for selection of site that is Ambade village near the Malin .
- Total area **about 8.5 acre** has been allotted.
- **One unit of two houses** is costing **15 lakh**.
- The newly-built 67 houses are **earthquake-resistant.**

- Each house, made up of steel and concrete, has the carpet area of **450 sq feet**. Apart from houses, a school, a Gram panchayat office, a public health centre, public toilets and a boundary wall for the village too were constructed.
- The amenities provided here are school, hospital, Gram panchyat, internal roads, and proper drains.

Figure 2 - Permanent Rehabilitation project plan (Source - photograph by Author¹)

Rehabilitation of housing -

- Generally aluminium formwork used for **high rise building and** it is not economical to use in small residential project.
- COSMOS companies aluminium formwork has been used for fast construction (precession engineered

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formwork fabricated in aluminium). So it was possible to construct **67 houses with 2 years**.

- These forms are **strong and sturdy, fabricated with accuracy and easy to handle.**

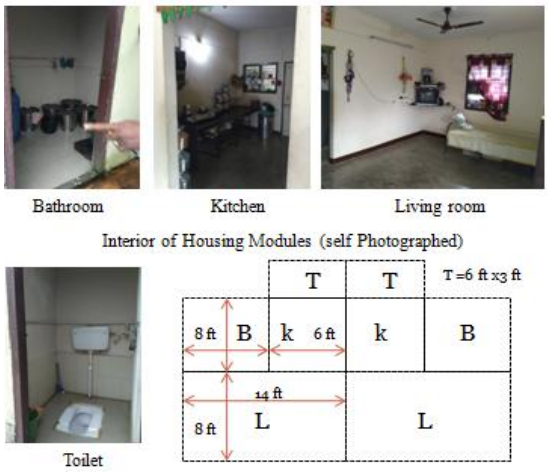

Figure 3 - Permanent rehabilitation housing module (Source - photograph by Author[1])

4. OBSERVATIONS

Infrastructure issues –

- Due to shifting of unstable soil under foundation, roads started to show the Fissure and cracks. Sewage lines getting cracked due to shifting soil pressure and use of low quality plastic pipelines.
- The amenities provided in the village are such as healthcare clinic, community hall, community cattle shed are in general inefficient.
- no convenience shop or market in village.
- Basic amenities such as water and electricity are in irregular supply. The drinking water is supplied from neighbour village, Adivare, once every alternate day for 1-2 hours.
- unsatisfactory size of housing modules, as per feedback of villagers.

Economical Issues –

- The major economical issue is lack of any business opportunity in village.
- Other issue is the location of village, which is quite remote due to formation of reservoir lake of Dimbhe dam.
- Some people have secondary income by cattle farming. But major issue with this is, the rehabilitation is far from original village, due to which people have to take their cattle far for grazing.

Social issues –

- In rehabilitation, the majority of resident belong to Mahadev koli cast. After disaster of landslide the local temple in village got destroyed.
- Under reconstruction and rehabilitation policy, Government has rebuilt the temple in the original place at Malin village. But there is no temple built at the rehabilitation project as till date of survey of this research. There is a community centre in the rehabilitation project, but it is rarely used by people.
- The other issue is that housing provided to families is not proportionate to family size, as each family got an house of fixed size. also there is no concern for neighbourhood system, which was previously present in old village.
- Also people are not attached to the housing module, as they were not involved in decision making process of housing construction. Hence may people find their houses.

5. INFERENCES

Following inferences can be drawn from the case study of Malin village rehabilitation project -

- It is inferred that, major cause behind low success of the Malin rehabilitation project is **lack of future planning** and no concern given to villagers livelihood. Due to which majority of villagers have to relocate to other places for jobs or other income.
- The location of rehabilitation is not an ideal location for project as it repeats **the same mistake of rehabilitating in existing village conditions**, due to which similar treat of landslide still hangs over villagers, even though disaster proofing is done with building retaining walls around rehabilitation.
- The rehabilitation project is sufficiently equipped with amenities at planning stage. But in reality working force or administration behind the village is not efficient. Also the capacity of these amenities and services are not enough for village. This is due to various causes such as -
- Remoteness of village
- Lower number of permanent villagers.
- No job opportunities at local level due to which working class has to shift to nearby town for jobs.
- Low level of farming opportunities due to sensitive land and soil.
- Amenities are not maintained regularly, due to lack of workforce. Hence the rehabilitation slowly leads to failure. The better connectivity and opportunities are required to maintain base population in rehabilitation.
- The rehabilitation is done without any concern for Individual needs of villagers, hence many villagers are modifying the housing modules according to their need. also housing is distributed in villagers as 1 module per family, without any concern for size of family.
- Site selected for rehabilitation was low vegetative grassland with few trees. rehabilitation is done without cutting single tree on site. hence it can be said that environmental concern was there while planning the rehabilitation.

6. CONCLUSIONS

- The disaster management system in India is structured over all stages of society, I.e. from national stage to rural stage. This makes the application of norms and disaster prevention at lowest scale much efficient.

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- It is concluded from case study above that, in Maharashtra state disaster rehabilitation is not done with aspect of sustainable indicators regarding social, economical, environmental.
- The rehabilitation is not all inclusive in terms of decision making and planning. In Maharashtra state, people in disaster affected villages have their own specific needs of livelihood and these needs are to be considered in at design stage only, while planning the rehabilitation.
- The balance between sustainable factors is interdependent and delicate, hence decision makers and planners have to study the rehabilitant area carefully and to consider effects of all aspects and their impacts on livelihood of rehabilitated people, for successful rehabilitation.

7. ACKNOWLEDGEMENT

I would like to express my gratitude to my guide – Prof. Archana Gaikawad for her constant guidance, encouragement and support without which the paper would not have been possible. I would also like to thank Prof. Priya Bangle and Prof. Aditi Lanke for their valuable inputs and feedback throughout the duration of the project.
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Exploration of Bamboo as a Construction Material to Adapt to Parametric Forms

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Abstract ***When the term 'Parametricism' gathered fame, there was a commencement of exploration in the field of architecture. Softwares are used as tools for form finding. Designs are based on various systems and computational scripts based on specific logics and parameters. which can also be termed as a reincarnation of Architecture. Along with the advancements in technology, development of a co-relation between tradition and trending needs to be established for a better India. This paper will aim at discussing the scenarios where Bamboo, a traditional and an eco-friendly source, can be used as a Parametric Material. It is the construction material which beats steel, when ratios of stiffness to strength of both the materials are compared. Bamboo is a fast growing commodity which will be used in future construction industry as one of the sustainable and multipurpose materials. This paper aims to explore the different forms and systems, where bamboo is used as the core material. This study has a case study approach. The possibility of using the computer aided forms with bamboo will be studied making it a potential parametric construction material.***

Keywords – Bamboo Construction, Computational Designs, Parametric Architecture. Form finding, Rhino, Grasshopper, Sustainability, Aesthetics.

INTRODUCTION

The digital era is here and like many other professions, architecture is also under transitional phase. Parametric and Computational design has taken the center stage in architecture and now this culture is fast evolving. By computational design, we relate to the design created with the help of the computer. Design decisions are taken with the help of logic which is set using computer code or a script. It encourages the strategies which would trounce the shortcomings and mundane aesthetics of contemporary building materials, styles and techniques. "Parametricism" (Patrick Schumacher, 2008) is the current movement happening in architecture and is accepted globally as the latest emerging style. It has the cutting edge as the aesthetics is supported by the right construction and functional blueprint. In this way new shapes and forms can be explored and implemented. Among the materials used to achieve the desired geometry, the qualities which are necessary for them to cater are – Sustainability, Affordability, Flexibility, Light weight, Eco-friendly – **S.A.F.L.E.** model. Bamboo is one of the few materials which succeed in having all the above characteristics (Sharma P., et al, 2014). So this paper will aim at studying and exploring new parametric forms which can be achieved using bamboo.

Every month, there is a new construction material is introduced in the market. Many experiments are made in the field of architecture since the commencement of "Parametricism". With the changing trends, one must not forget the traditions. Bamboo is a high potential material having the ability to replace many present day counterparts which are having considerable environmental impact. Maharashtra Bamboo Development Board has a vision of replacing timber with bamboo. It is observed that, there is an unofficial taboo over bamboo being used as a construction material in India. Bamboo is looked at as a material which is used mostly as scaffoldings and supports for a temporary structure (Pandals). This is because people have widely seen bamboo being broken or decompose due to natural forces. The performance and lifespan of bamboo as a construction material largely depends on the age of the bamboo when it is cut, and the treatment it has undergone after it is cut. Treatment of bamboo makes it lose starch. The presence of starch in the untreated bamboo makes it vulnerable to insect attacks and decomposition. There is a need for the study of bamboo as a parametric material and its behavioral traits when it is bent. It is the need of the hour for the people to be aware about the potential of this "Green Gold" to make more eco-friendly structures in the future

Mankind has been using bamboo since a long time. Bamboo stays with human right from the cradle to the grave. Over one billion people worldwide stay in bamboo housing and 2.5 billion people depend on bamboo for a living (Maxim Lobovikov, et al, 2007). When bamboo is compared to steel, concrete and timber it is found that bamboo is more sustainable (Van Der Lugt et al., 2003). Hence it can be an excellent resource in terms of affordable housing. So it is necessary to conduct more exploration of bamboo as a construction material. This

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paper will aim at using bamboo as a construction material which can adapt to different parametric shapes and will have a case study approach

AIM AND OBJECTIVES

Aim - To study different computational forms that can be achieved using bamboo as the core construction material.

Objectives - 1. To understand Bamboo as a sustainable construction material.

2. To understand use of bamboo to adapt to different parametric forms.

CASE STUDY

Location – Bamboo Structures in Bali, Indonesia

The island of Bali in Indonesia is very famous for the bamboo structures. 'Sharma Springs' is by far the tallest structure made in Bali, belongs to an Indian family named Sharma (ibuku.com). The building has six levels consisting of four bedrooms and a spacious living room overlooking the river. The highlight of the structure is that, it is constructed wholly with bamboo. The construction was completed in 12 months. 'Sharma Springs' is designed and built by firm named IBUKU. They tend to use bamboo because of its carbon sequestration capacity. They also claim that bamboo is the most environmentally conscientious building material conceivable. The researcher paid a visit to the Green Village and Eco village in Bali, Indonesia to study in detail the new vocabulary in architecture that Balinese architects are developing. People there are not hesitant to use bamboo as the structural, paneling, flooring, roofing material. Even the furniture is made up of bamboo. Balinese people believe that being surrounded by bamboo enhances their quality of life. When the researcher interviewed the local architects in Bali, it was found that they develop the idea of the form of the structures by sketching as shown in figure 1. Minimal use of tools like (AutoCAD and Sketch Up) is being done for

Figure 1 Sketches made by architect before making the physical model (Courtesy- Chikoliving)

form -finding. The form of the structures though is inspired by product design, making it dynamic. When the sketch is finalized, the design is further worked out by making a physical model of the design. The material used for model is strip of bamboo cut in diminished scale. Using bamboo strip as the material for model gives a perfect idea to the designer as it tends to show the same behavioral traits as the bamboo in its true scale. The model made is so precise that even the number of bamboos used in the real construction stay the same. Figure 2 shows some of the examples of the models.

Figure 2. Models made by the architect (Courtesy-Chikoliving)

Thus the forms are executed to perfection using bamboo as the core structural material. The researcher then visited the ongoing bamboo construction site to study the details of construction and explore the further possibilities of form findings with bamboo. After having the hands-on experience of construction, it was observed that bamboo is a high potential parametric material. After interviewing local architects it was observed that the time of harvesting the bamboo and the treatment it undergoes after that plays a very crucial part that determines the life span of the structure. The structures can last for more than 30 years, with maintenance period after every 3 years. When the structures are studied, use of traditional joinery details can be seen. The possibility of using unorthodox joineries can pave way for more complicated forms

Figure 3. Site Visit – Sundari Village, Bali

METHODOLOGY

Bamboo is a flexible material and may be curved or flattened by the application of heat and pressure (modlar.com). This property of bamboo can be used to adapt to parametric shapes and forms. For analyzing role of bamboo in parametric design solutions, some forms are taken into consideration. The tools used were 'Rhino' and 'Grasshopper'. The shapes/forms were regenerated with bamboo material to understand its behavior as a material.

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The experiment was started with some basic forms and then the complexity was gradually increased.

Singly Curved Surfaces – A curve was first created then extruded in X direction to create a simple 'Barrel vault'. Bamboo of two different diameters can be used to achieve the form as shown in figure 4. **Main Frame** – B. Bambos (B stands for Bambusa) – Hollow, 20m, 100mm Dia, 12 Mm Wall Thickness. **Supporting Members** – B. Wamin (Buddha Belly) – Hollow, 6m, 60mm Dia, 15 Mm Wall Thickness

Figure 4 Bamboo adapting to the shape of singly curved surface Barrel Vault (Courtesy - author)

Then the complexity of the surface was increased by changing the diameter of the outer curve. Two bamboos were used at the edge for stability. **Main Frame** – B. Bambos – Hollow, 20m, 100mm Dia, 12 Mm Wall Thickness. **Supporting Members** – D. Strictus (D stands for Dendrocalamus) – Almost Solid, 12m, 50mm Dia.

Figure 5 Bamboo adapting to the shape of singly curved surface Barrel Vault (Courtesy - author)

Doubly Curved Surface – The form was changed to doubly curved surfaces. The bending quality of bamboo helps to achieve the desired shape. The shapes taken into consideration are Elliptical Paraboloid (figure 6), Hyperbolic Paraboloid (figure 7 and 8), and shell inspired form (figure 9). 'Kangaroo', a physics engine plugin was used for form finding.

Figure 6. Bamboo adapting to the shape of doubly curved surface Elliptical Paraboloid (Courtesy - author)

Figure 7 Bamboo adapting to the shape of doubly curved surface Hyperbolic Paraboloid (Courtesy - author)

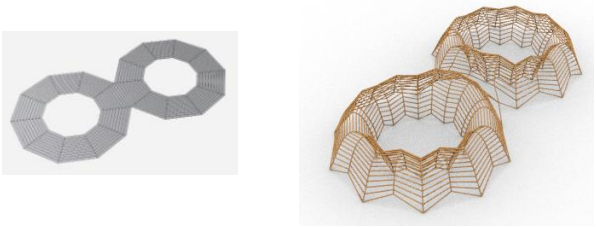

Figure 8 Bamboo adapting to the shape of doubly curved surface shell inspired (Courtesy - author)

Frame used for both Figure 6,7, and 8- Guadua– Semi-Solid, 25m, 75 Mm Dia, 15 Mm Wall Thickness . The nature of Guadua (Semi-solid) makes the structure stable despite the tension that is applied over structural bamboos.

Figure 9 Bamboo adapting to the shape of doubly curved surface Hyperbolic Paraboloid (Courtesy - author)

Main Frame – B. Bambos – Hollow, 20m, 100mm Dia, 12 Mm Wall Thickness **Supporting Members** – D. Strictus – Almost Solid, 12m, 50mm Dia.

Considering the tensile nature of bamboo, it was compared to tensile roofs as shown in figure 10. Bamboo can achieve the shape provided the edge supports or framing is strong.

Figure 10 Tensile roof (Left), Bamboo imitation of form (Right)

Main Frame – B. Bambos – Hollow, 20m, 100mm Dia, 12 Mm Wall Thickness **Supporting Members** – D. Strictus – Almost Solid, 12m, 50mm Dia.

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CONCLUSION

In the present research, the application of bamboo as a parametric material has been studied. The implemented designs of bamboo structures in Bali, Indonesia advocated Bamboo as an excellent structural as well as a parametric material. The bamboo is used to achieve the form of singly and doubly curved surfaces according to the computational study that was carried out.

Promoting bamboo construction is the key to a better future. There are very few structural consultants available for bamboo construction. Skill development programmes for the bamboo contractors and workers need to be conducted. There should be awareness programmes about the benefits of bamboo for the people. So for envisioning a green India in near future, there should be more research and implementation of this "Green Gold".

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Efficient Water Utilization In Mid-Rise Residential Apartments in Pune

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ABSTRACT: ***The water consumption in residential buildings is predicted to rise by 11% by the year 2050. It is of vital importance to develop water efficiency guidelines to limit the current trends of the ever escalating water demand in residential sector. Fresh water availability is decreasing and untreated domestic waste water generation is increasing which requires to efficiently use the resource by minimizing wastage, reusing or recycling to the highest level possible. The study attempts to find the efficient water utilization and concludes that use of water efficient plumbing fixtures, alternative water sources and recycling has significant reduction in fresh water consumption.***

Key words – Water efficiency, recycling, reuse, plumbing fixtures, alternative water sources, residential building, zero discharge systems

INTRODUCTION

Water scenario of India:
The country's total water resources are 690 Billion Cubic Meters from surface waters and 447 BCM from groundwater resources. The urban population of India is expected to reach 600 million by 2030, and it will be a major challenge to meet its water needs and is estimated that the demand-supply gap for the domestic sector will be ~50 BCM by 2030, with demand expected to double by then (Composite water management index, 2019). Through 2015, India had treated just 30% of the country's produced wastewater. Thus, wastewater treatment can provide additional water resources and can help to reduce the supply-demand gap that is likely to occur in the future.

Water scenario of Maharashtra:
During the three year duration of the composite water management index, Maharashtra registered a decline in performance, is a medium-performing state with a score of 41 in 2017-18, and is also one of the largest urban waste water producing state with over 50% waste water treatment capacity. (Composite water management index, 2019)

Selection of residential sector for study:
According to the URDPFI guidelines, "maximum percentage of land is allotted to residential areas across urban centres." The water consumption in residential buildings is predicted to rise by 11% by the year 2050. This will approximately double the per capita consumption from 89 litres per day now to 167 litres per day by 2050. (Composite water management index, 2019)
As per Central Public Health and Environmental Engineering Organization estimates, about 70-80% of total water supplied for domestic use gets generated as wastewater. Thus, a recovery based close loop system is the need of the hour.

City Selection -Pune:
Pune is a classic case of over-consumption i.e. the average per capita supply is around 194 litres per capita per day in Pune (Pune Municipal Corporation). The sewage generated by the city's 3.7 million inhabitants is 756 Million Litres Per Day, 33 percent of which is untreated and mixes with treated sewage before entering in the river, also percolating into aquifers (Pune Municipal Corporation). The total geographical area of Pune city is 450.69 sq. km. Out of the total area, 38.6% is residential area, 1.8% is commercial area, 9.5% is defence area, 11% is industrial area and 9.7% is recreational area. As the growing trend of mid rise residential developments as seen till Dec 2018 i.e. total new supply:2600 developments in 2018, out of which mid rise residential apartments-95%, plots-5%,villas-3%.

Need for study:
In present scenario, to address the problem of water scarcity, no guidelines exist for recycling or zero discharge from the residential site. Domestic,

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industrial and agriculture are water intensive sectors and due to the increasing population growth and rise in mid rise residential apartments led to the idea of this research which is to study and analyze efficient water utilization in order to render appropriate guidelines for a new construction of residential projects.

METHOD OF STUDY:

Literature study is done to identify the current scenario of water utilization in residential buildings to find research gap, data collection and analysis has been done through primary study (2 live case studies) and secondary study to fulfil the following objectives:

- To study water consumption pattern in India.
- To study water usage breakup in residential activities.
- To study water efficiency aspects by green building rating systems.
- To identify water efficiency parameters at all levels.

The data is analysed on the identified water efficiency parameters to render appropriate guidelines at all scales for a new mid-rise residential project.

STUDY AND ANALYSIS:

The secondary data has been collected from reference and relevant research papers, journals and books.

Domestic water requirements:

Use of water for	*Consumption in litres per head per day*
Drinking	5
Cooking	5
Bathing	75
Washing of clothes	25
Washing of utensils	15
Washing and cleaning of houses and residences	15
Lawn watering and gardening	15
Flushing of water closets, etc.	45
Total	200

Figure 1:Average domestic water consumption in Indian cities with full flushing system (Source: IS: 172-1993)

The market for domestic water consists mainly of drinking water, cooking, bathing, washing, toilet flushing, toilet and floor cleaning, gardening, swimming pool etc. Domestic water demand is determined primarily by the total no. of people in a region and their daily water requirement.

According to Figure 2, most water is utilized in bathing and secondly in flushing followed by washing and gardening. Water consumption in these activities can be reduced by using water efficient fixtures and treated waste water can be used in flushing to reduce potable water demand and further supported by native species which require less water.

Water Balance Chart:

A water balance is a no. of the volume of water entering and leaving a site. Detailed information on the amount of water used by each system should be given in a water balance sheet. Water balance is one of the key tool for recognizing and controlling water flows throughout the facility, locating water saving equipments and detecting leaks.

Water efficiency aspects by Green Building Rating Systems:

Green building rating system like IGBC and GRIHA systems in India are gaining popularity and success in construction industry. Therefore understanding their practical approach towards water consumption and resource conservation is of utmost importance. Water efficiency aspect is being discussed considering two Indian green building rating systems i.e. GRIHA and IGBC and one international, which is USGBC LEED.

No.	Requirements	Description
1	Reduce building water use	Indoor use through efficient plumbing fixtures, appliances and in outdoor use through efficient irrigation systems in landscaping.
2	Water efficient plumbing fixtures and fittings	To reduce potable water consumption through low flow and flush fixtures.
3	Water efficient landscaping/irrigation	Elimination of potable water for landscaping and minimizing load on municipal water supply.
4	Waste water treatment and reuse	To reduce load on municipal sewer lines and reuse the treated waste water for non potable water applications
5	Rain water harvesting or storm water management	After water treatment can be used to fulfil potable water demands or else can be used to recharge the aquifer.
6	Water quality	To ensure that potable and non potable water conform to BIS standards and the discharge water from STP should meet CPCB norms.
7	Water monitoring,	Reduce water wastage through

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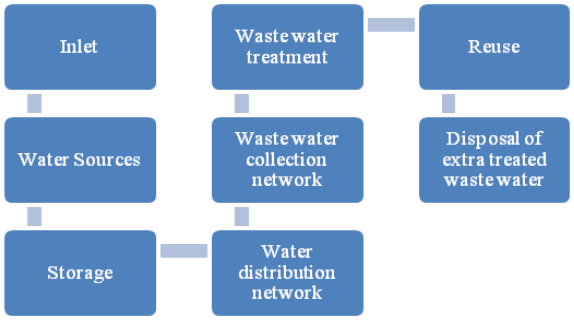
	leak detection and prevention	leaks, overflows etc.
8	Water metering	To measure the water consumption at different end uses and can also be provided for individual houses

Table 1 **Error! Bookmark not defined.**: Identification of water efficiency aspects by Green Building Rating Systems

Efficient Water Utilization:



Stages in Water Utilization

Water can be conserved at each above mentioned level through efficient utilization such as source for non-potable water can be reclaimed water, treated grey water, rain water etc. Dual plumbing systems can be used at distribution level for supplying treated grey water for flushing. Efficient plumbing fixtures i.e. low flow and flush fixtures can be used. Automatic water level controllers can be used for storage tanks to avoid overflowing. Various techniques is specified in the following sections at each level to utilize water efficiently.

RESULTS AND DISCUSSION:

Analysis from literature study:

Parameter	Problem/issue	Efficiency measures
At source level		
Reduce fresh water demand	Using fresh municipal supply for non potable applications	Use of alternative water sources for non potable applications
	Overexploitation of fresh water for landscaping	Drip irrigation for lawns and sprinkler for shrub and tree areas Ground moisture sensors. Limiting lawn areas Hydro zoning Native trees should be planted.
Water metering	Over consumption of water	Building sub metering at various sources like municipal water source, bore wells, treated water etc. Individual household metering.
Water Quality	No discharge of waste water in municipal mains according to Central Pollution Control Board norms.	Regular testing of treated waste water from STP.
At storage level		
Water monitoring	Overflow	Automatic water level controllers.
	Maintenance (Cleaning)	Two independent cells in water storage tank of 50% capacity of total tank volume so that one can be cleaned at a time without any water supply shut off.
	Location of overhead tank	The elevation difference between outlet pipe and highest fixture at topmost floor should be min. 2m to maintain the required pressure.
At Distribution level		
Efficient distribution	Maintaining desired pressure at all levels	Pressure sensors which provide water at efficient pressures at all levels. Pressure reduction valves
	Drain of running water to achieve correct temperature.	Lag pipe work to reduce heat loss/heat gain so as to avoid the practice of running water to drain until it achieves correct temperature.
Monitoring of leaks	Loss of non revenue water	Leak detection systems. Flow meters to measure velocity of water near water intake/head works, transfer mains, storage tanks/reservoirs, distribution network like branch/main/sub lines.
Plumbing fixtures	High flow and flush rates leads to wastage	Use of low flow plumbing fixtures
		Reducing flow rate of fixtures at individual household through aerators, atomisers and pulsators
Waste water management		
Waste water treatment and reuse	No separate collection of black and grey water.	Two pipe drainage system. Dual plumbing system for reuse of

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		treated waste water.
	Cross connection problem	Treated waste water lines should be color coded.

Table 2**Error! Bookmark not defined.**: Water efficiency measures at different levels

Analysis from field case studies:
Two live case studies are done to understand the water utilization and water savings through efficiency parameters implemented by them.

➢ Case Study 1:
Total no. of flats=240
Avg. occupants considered per flat=4
Total occupants=960
So, the total water consumption per capita per day is 163 lpcd(157000/960=163)
Fresh water demand i.e. 163lpcd has been reduced to 120lpcd through treated waste water for flushing and landscaping.

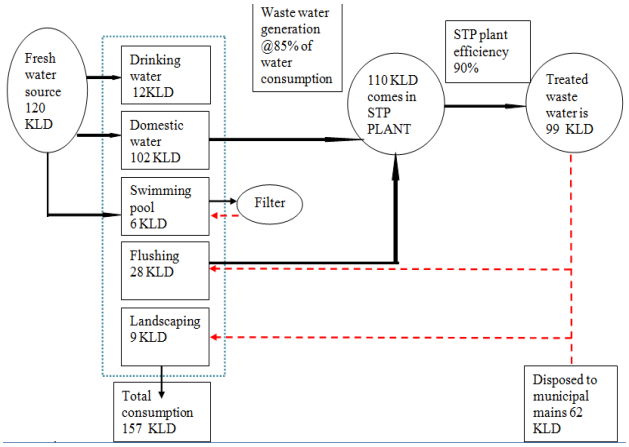

Figure 2:Daily water consumption balance chart

Water Efficiency Interventions and Water Savings:

- Reuse of treated waste water:

Used for flushing and landscaping. Waste water is treated through phytorid technology.
Quantity of water saved(KL/annum) -
For flushing:10,220KL(28X365=10,220)
For landscaping:2187KL(9X243=2187, excluding four months of rainy season).

- Ground water recharging through harvested storm water:

Total 14 recharging pits.
Quantity of water saved(KL/annum)=6149KL
Hardscape area:12010m²
Annual mean rainfall:0.8m
Run-off coefficient:0.8
Evaporation loss:0.8
Volume(cum/yr):12010x0.8x0.8x0.8=6149cum.

- Rain water storage tanks:

Rain water harvesting through roof areas.
Quantity of water saved(KL/annum)=2040KL
Roof area:3543m²
Annual mean rainfall:0.8m
Run-off coefficient:0.9
Evaporation loss:0.8
Volume(cum/yr):12010x0.8x0.9x0.8=2040cum.

➢ Case Study 2:
Total no. of flats=388
Avg. occupants considered per flat=5
Total occupants=1940
So, the total water consumption per capita per day is 132lpcd(257000/1940=132)
Fresh water demand i.e. 132lpcd has been reduced to 87lpcd through treated waste water for flushing and landscaping.

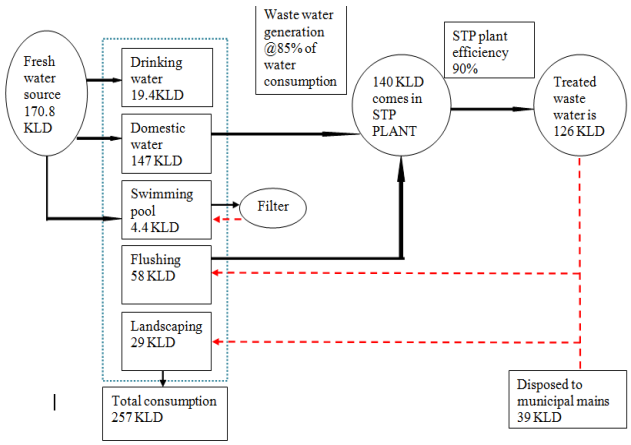

Figure 3:Daily water consumption balance chart

Water Efficiency Interventions and Water Savings:

- Reuse of treated waste water:

Can be used for flushing and landscaping.Waste water is treated through Moving Bed Biofilm Reactor technology.
Quantity of water saved(KL/annum)
For flushing:21,170KL(58X365=21,170)
For landscaping:7047KL(29X243=7047, excluding four months of rainy season).

- Ground water recharging through harvested storm water:

Total 4 recharging pits of 10m depth and diameter 0.15m each.

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Quantity of water saved(KL/annum)=2857KL
Hardscape area:5954m²
Annual mean rainfall:0.8m
Run-off coefficient:0.75
Evaporation loss:0.8
Volume(cum/yr):5954x0.75x0.8x0.8=2857cum.

Analysis from study:

➢ Water saved in KL/annum in non-potable applications
Considering 150lpcd of water demand in metro cities like Pune.

- Activity- Flushing

Per capita per day consumption:30lpcd
Base Case: Through municipal water source
Design Case: Through treated waste water

- Activity- Landscaping

Per capita per day consumption:15lpcd
Base Case: Through municipal water source
Design Case: Through treated waste water
Potable water saving for both activities:45lpcd potable water saving. Fresh water demand reduced to 105lpcd.
Potable water saved (KL/annum):16,425KL (45X365=16,425) saved per person per annum.

Thus, there is a huge potential of using treated water for non potable water applications like flushing, landscaping, car washing etc. which will help to reduce high water consumption of fresh water for non potable applications.

➢ Potable water saved through water efficient fixtures
Considering for 1 person
Considering two star efficient fixtures for design case and National Building Code recommended flow and flush volumes as base case.

- Fixture- Showers

Estimated daily uses per person:1
Duration:8min.
Base Case(litre/min):10lpm
Total daily water use(litres):80
Design Case(litre/min):7.5lpm
Total daily water use(litres):60
Savings:20litre/min saving (25% saving)

- Fixture- Lavatory faucet

Estimated daily uses per person:4
Duration:0.25min.
Base Case(litre/min):8lpm
Total daily water use(litres):8
Design Case(litre/min):5.7 lpm
Total daily water use(litres): 5.7
Savings:2.3litre/min saving (28.75% saving)

- Fixture- Kitchen faucet

Estimated daily uses per person:1
Duration:4min.
Base Case(litre/min):8lpm
Total daily water use(litres):32
Design Case(litre/min):5.7lpm
Total daily water use (litres):22.8
Savings:9.2litre/min saving(28.75% saving)

- Fixture- Showers

Estimated daily uses per person:4
Duration:1 flush
Base Case(litre/flush):6 l/flush
Total daily water use(litres):24
Design Case(litre/flush):4.8 l/flush (full flush)
Total daily water use(litres):19.2
Savings:4.8litre/min saving (20% saving)

Inferences: Reduction in water usage at end uses is achieved through water efficient fixtures as the water savings can be seen as 20% to 28% in all of the above cases.

RESULTS AND GUIDELINES:

Guidelines at Site level: Reduce fresh water demand

➢ Potable water should not be used for non-potable applications like landscaping, flushing and car washing.
➢ Explore the alternative sources of supply that can be rain water, treated waste water, storm water.
➢ Water metering at different sources help to measure the overall water consumption.
➢ Reduce landscaping water demand through planting native species, limiting lawn areas, hydrozoning, using drip irrigation for trees, shrub area and sprinkler irrigation for turf areas.

Guidelines at Building level: Efficient distribution

➢ Maintain the desired pressure at all floors through pressure reducing valves and pressurized systems used for water distribution at desired pressures.

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- Splitting the floors into zones of water distribution of 4-5 floor per zone.
- Combined gravity pressurized systems and hydropneumatic systems are mostly used for efficient distribution of water at all floors.
- Two pipe system to be used for separate collection of grey water and black water and dual plumbing for reuse of treated water.
- Ensure valves and overflows are visible for early detection of water loss and easy to access for maintenance.

Guidelines at Component scale: Efficient Plumbing Fixtures

- Water efficient plumbing fixtures to be used which accounts for overall reduction in water consumption.
- Reduce the risk of uncontrolled water use in community halls by using sensor faucets.
- Use of flow limiters such as aerators and flow regulators.

CONCLUSION

The study conducted shows that using star - rated labeled plumbing fixtures, flow limiters and regulators are presently most effective in minimizing water wastage at component level and reducing water demand at source i.e. using alternative water sources for non potable water applications at all scales of the building.

ACKNOWLEDGEMENT

It is an immense pleasure to thank all the people who made this study possible. I would like to express my deep gratitude to my guide – Associate Professor Aditi Lanke for her constant guidance, encouragement and support in a definite direction. Without her, this study would not have been possible.

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Feasibility study of 'Electronic Toilets' in Pune Municipal Corporation

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Abstract : Public sanitation is one of the basic needs of any developing city. There are several 'Electronic Toilet' units being set up by Pune Municipal Corporation under Sanitation goals. The study is done to evaluate the working efficiency of 'Electronic Toilets'. The functionality of the toilets, in terms of Design, Resources, Operation & Maintenance, are the main issues addressed.A field study was done on selected sites and analyzed as per the parametersderived from the case studies, codes, standards. Issues related to the inefficient working are identified and solutions are provided for the same from case studies and product design studies.

Keyword: Smart toilets, Sanitation economy, Electronic toilets, PMC jurisdiction, Design, resources, Operation & Maintenance

Introduction

Access to basic sanitation is one of the fundamental rights of any human being.

One of the targets for sanitation under 'Sustainable Development Goals 2030' is as follows: Sustainable Development Goal 6:

'By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations' (Sustainable-development-goals: Goal-6-clean-water-and-sanitation:Targets)

Government of India is following the Sustainable Development Goals and is taking actions accordingly. Civic bodies are implementing various initiatives from a national level to ward level to deal with the sanitation issue. When observed at a city level, the rapid urbanization of cities is making the role of the Urban Local Bodies (ULBs) more difficult. There is no efficient planning and sufficient infrastructure to meet the existing demands of the city. Secondly, the rate of growth & development of the city is not matching the speed of the services being offered. There is no even distribution of services and facilities provided throughout the city. The other part is the cultural habits, usage patterns, the income and characteristics of the population to be served, that are equally important, which is true for almost all the cities in India.

For the economic development of any city, employment generation is to be done to create jobs in various parts of the city, which requires people to travel long distances for work. Lack ofsufficient sanitation health facilities along or near the work route might pose health problems.Open public spaces like gardens, parks, plazas, etc attracting a huge amount of crowd lack the necessary infrastructure to provide sanitation facilities.A city-wide, inclusive, safe and maintained sanitation facility is necessary to be provided at the public spaces for able, disabled, children, adult, aged population.The area selected for this study is the Pune Municipal Corporation (PMC) jurisdiction area.This research provides an overview of the 'E Toilets',a study of individual units, analysis of each issue and probable solution for it. The intent is the create awareness in policymakers & designers, regarding the various issues related to design & maintenance of 'E toilet' and its probable solutions.

The scope of the research includes issues arising from usage patternsand solutions (modifications or changes) on a micro-scale are provided, which can be effectivelyimplemented by the ULBs

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Methodology

The overall methodology of the study consists of identifying& evaluating the parameters on which the 'E toilets' are designed as per the relevant codes & standards. Guidelines are suggested for individual cases as well as comprehensivesolutions.

The E Toilets were shortlisted based on the secondary data received from Pune Municipal Corporation.'E toilets' from J.M. road, Model colony, Sinhagad road and Hirvae Garden were selected for the research. The parameters for the studyof 'E toilets' were derived from various National and international codes and standards and field studies were conducted based on the parameters and its subsets.

For design guidelines and comprehensive suggestions, statistical data from Pune Municipal Corporationand relevant codes and standards were followed. Case studies for failures and success stories to identify and apply design parameters were done before developing the 'E Toilet' guidelines.

DESIGN CONSIDERATIONS

- Toilet cubicle size: 900 mm x 1200 mm
- Location: At a convenient walkable distance, safe, visible, provided with access and ramp.
- Signage, Access, Aesthetics
- Contact area: Overall minimum contact area
- Caretaker
- Energy supply: 24 x 7 necessary
- Lighting & Ventilation
- Accessories
- SanPro: Provision & disposal facilities
- O&M: List of equipment, schedules, etc

UNIVERSAL DESIGN

- Access: Avoid grating, manholes near entrance
- WC, WHB sizes & locations
- Taps & Faucets,Sensors, Alarm
- Maneuvering space: 900 mm x 900 mm
- Tactile & Visual information
- Children section: 1 Urinal at a lower height
- Lights: Automatic light systems without timers, minimum illumination 200 lux
- Flooring: Anti-slip, anti-glare, firm

The results from the case studies were individually analyzed and further compared to develop guidelines and suggest effective design and maintenance solutions.

Two types of 'ELECTRONIC TOILETS' approved by PMC were studied (Smart She Toilets – ERAM scientific, E-toilet – ERAM scientific)

Various codes followed were studied to list the parameters for analysis

The following important inferences were derived from various codes & reference manuals.

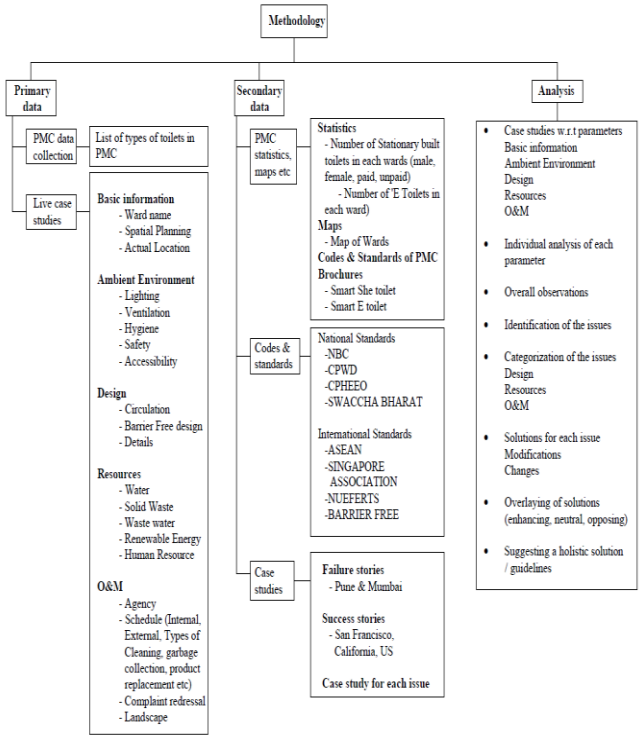

Figure 1: Showing Overall methodology of the research

PARAMETERS FOR SELF SUFFICIENT DESIGN

Following are some of the additional inferences, from the International guides (The Association Of South East Asian Nations & Restroom Association, Singapore)

- Looscaping: Using plants that can be easily maintained inside and outside the toilets

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- Energy conservation
- Products: Use of low VOC products and finishes
- Indoor air quality

Results

Following is the study for J.M. road. One sample aspect from the subset is listed below. Similar study was carried out for the other 3 sites and a comparative analysis was done. Based on the findings, the solutions were suggested and guidelines were formulated.

- Feedback/suggestion box
- Emergency lighting
- User education, Audit

(Bureau of Indian Standards, 2016)

Figure 2: Showing images of 'E Toilet' at J.M.Road

Figure 3: Showing a Curb ramp

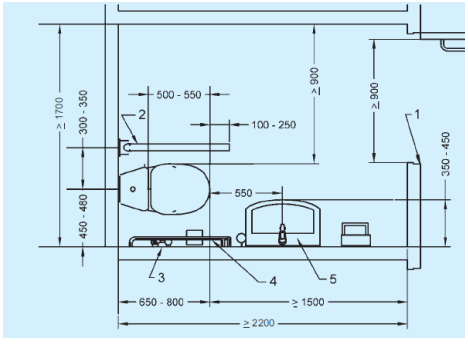

Figure 4: Showing a typical layout for handicapped people

Figure 5: Showing colour contrast between the floor, walls & fittings and grab bars

Figure 6: Showing universally accepted signage related to Public toilet usages

Conclusion

The study resulted in some additional suggestions to enhance the working, operation and maintenance of the Electronic Toilets. The recommended guidelines /suggestions were given on: General surroundings / ambient environment, Design, Resources and Operation & Maintenance

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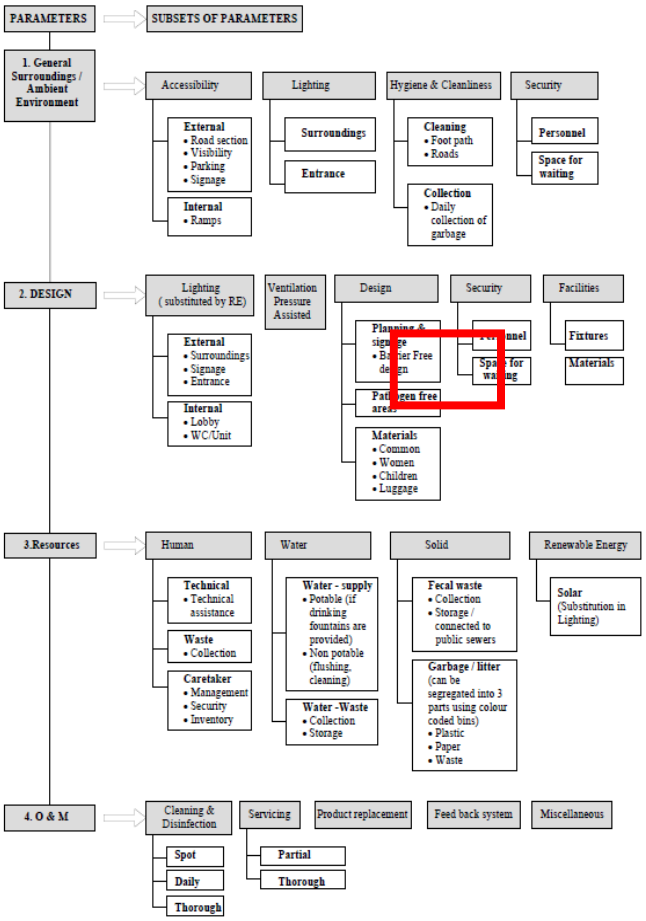

Figure 7: Showing Comprehensive suggestions for all the parameters

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BARRIER FREE DESIGN			
AMBULATORY HANDICAPPED			
CRITERIA	IMPORTANCE	J.M. ROAD	OBSERVATIONS
Ramp provision	Provision of ramp for children in carriers, disabled people, etc	The slope on road is away, bollards at the end of the toilet.	**Only providing a ramp is not sufficient**. A ramp should be provided to allow a handicapped person to reach the plinth of the toilet **with a minimum travelling distance and in minimal efforts**. Here some redesigning of road section might be required **(DESIGN, IMPLEMENTATION – ISSUE)**
Height of door handle /bar	' reach heights'	No handle at a specified height	The push bars are not present **(DESIGN-ISSUE)**
Width of passage	Width of the passage should be sufficient to turn the wheelchair conveniently	Not sufficient	The width is not sufficient **(DESIGN-ISSUE)**
Turning radius for a wheelchair near the entrance		Not sufficient	Difficult for a handicapped person to directly turn the wheelchair, as there is minimum landing after the ramp **(DESIGN-ISSUE)**
Turning radius for wheelchair inside WC, Bath		Not sufficient	The disabled-friendly toilets are rendered useless if they are not able to maneuver inside **(DESIGN-ISSUE)**
Provision of 'Grating'	For passing over grooves &level difference	Not accessible	The disabled-friendly toilets are rendered useless if they are not able to cross the level difference with ease **(DESIGN-ISSUE)**
Range of reach – entrance doors, coin box, grab bars, health faucets, handles	The fixture and fittings should be provided at a height and position convenient to use in a wheelchair /crutches	Not provided	The position to insert the coins, in on the slope of the ramp which makes it impossible for the disabled to stop their wheelchair on the slope and insert a coin, unless accompanied by another person. **(DESIGN-ISSUE)**
VISUALLY HANDICAPPED			
Guiding blocks near the entrance	The enable the visually impaired to find their way without any help	Not provided	There being a difference in the road sections for each toilet, the disabled have to spend time to find the entrance of the disabled-friendly toilet **((DESIGN, IMPLEMENTATION-ISSUE)**
Guiding blocks inside the toilet		Not provided	There are no guiding blocks inside the toilet which causes inconvenience while using. **(DESIGN-ISSUE)**
Audible signages with sensors	To aid in wayfinding (General & emergency)	Not provided	There are no audible signals inside the toilet which causes inconvenience while using. **(DESIGN-ISSUE)**
Colour contrast signages /doors/furniture	For ease of identification for colour blind people	Not provided	Blue, Pink & SS finish are used, which are not contrasting **(DESIGN-ISSUE)**
Information in Braille	Aid in wayfinding	Not provided	There is no information in Braille, inside and outside the toilet which causes inconvenience while using. **(DESIGN-ISSUE)**

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Fire Safety Analysis of High-Rise Residential Buildings In And Around Pune

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Abstract : High rises are vulnerable to fire hazard due to their complex nature. Pune is rapidly expanding with high-rise residential buildings making Fire safety a matter of concern. It is achieved by collaborative efforts of all the stakeholders of the project and the fire department throughout the lifecycle of the building. This paper aims to study and analyse already built as well as under construction high rise residential buildings, provisions in law and preparedness of fire department to understand current state of fire safety. It is concluded that the city needs some retrofitting measures to make it more fire safe.

Key words- Fire safety, High rise, Residential buildings, Pune, project phases ,Fire department, stakeholder's awareness.

INTRODUCTION

Fire is like a silent demon in every house. Fire can start anywhere when fire triangle gets completed and hence the concern of fire safety holds true for every building of any height. But effects or losses differ with the height and occupancy type. Industrial as well as commercial sectors are very anxious about the fire safety as the loss of business is the biggest threat to them. But in residential apartments, fire safety is neglected as everyone feels that there are less chances of fire outbreak . Pune is a rapidly developing city due to its importance in industries, I.T. parks , institutions, defence activities etc. It has been estimated that population will hit 5.6 million by 2031. PMC has amended its development control rules in 2017 by removing height limitation of 100m. One can observe a common pattern of development in residential sector in and around Pune like single towers, residential complexes and residential complexes with consumer shopping on ground floors on building frontage. With changing outlook of Pune city, high rises and luxury towers are getting preference of homebuyers to live in. Punekars are following the footsteps of Mumbaikars, who have already considered skyscrapers as a testament to their success and status in society, apart from the other inherent benefits. But there are many news headlines in local papers about fire outbreaks in Mumbai's high-rise residential towers. Pune, though is in development phase with high rises , is witnessing fire incidences in 1000s every year in residential area. High rise buildings show unique behaviour towards fire safety due to their complex nature. The analysis of behaviour of high rises and issues arise or may arise due to fast development is necessary to forecast the issues in fire safety. Fire safety is achieved on different levels

- By using fireproof or retardant materials in and outside the building to control the outbreak of fire and to contain the fire.
- By implementing safe evacuation plans in case of emergency
- By installing fire suppressing apparatus to control the spread of fire.
- By involving fire department in the fire safety plan for ensuring the easy access of fire brigade in case of emergency.

Fire has been identified as a risk in disaster management plan of the city. Also, the fire safety of high rises has been given a prime importance in development control rules of the city. Maharashtra fire prevention and Life safety act has imposed legal binding on all the developers to adhere to fire safety parameters. The analysis of these regulations with case studies is important to identify the problem areas. Fire department plays important role in fire safety of the city. Fire safety is achieved by taking relevant steps in designing and construction phase and maintaining the facilities in occupation phase. Thus, Fire safety analysis of high-rise residential buildings under construction as well as already built has done to get knowledge of current situation of Pune and make stakeholders aware of their responsibility towards fire safety.

LITERATURE REVIEW

There are varied news article reporting actual incidences, questioning administrators about fire safety, elaborating administrative viewpoint and giving the idea of changing situation of Pune city and its fire safety.

National building code 2016 ,in its dedicated chapter, has given utmost importance to safety of life by covering fire safety in three parts (a) Fire prevention- Covering aspects pertaining to design and construction of buildings (b) Life

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safety- Covering life safety provisions in the event of fire and similar emergencies, that are necessary to minimise danger to life from fire, smoke, fumes or panic; (c) Fire protection - Covering the significant appurtenances and their related components and guidelines for selecting the correct type of equipment and installation meant for fire protection of the building, depending upon the classification and type of the building. It defines the high-rise buildings as buildings with more than 15 m height and elaborates special requirements irrespective of the occupancy of the building.

Maharashtra Fire Prevention and Life Safety Measures Act, 2006, is enforced with the objective of making more effective implementation of the fire prevention and life safety measures in various types of buildings in different areas in the State of Maharashtra . Development control rules of Pune municipal corporation, PMRDA and PCMC also address fire safety issues separately for high rises giving weightage on implementation of life safety measures mentioned in NBC and Safety act.

'Pune Municipal Corporation ,Fire Hazards Response And Mitigation Plan' February 2011- Pune Fire Brigade Pune

This document throws light on the Pune's exposure of Fire risk and its preparedness against fire hazard. Also, it elaborates on causes of fire , the data of man and machine number, working in and for fire rescue, Pune's development and statistics of fire incidences.

'A Review of Pune's Fire Safety in Light of its Smart City Aspirations' Secondary Study by Shashank Pareek. This paper talks about the relation of fire safety and smart city development. its importance while preparing the plans for Smart city. Also, it talks about the fire department of Pune city. **Fire Safety in High Rise Apartment Buildings-By Ken Richardson** This lecture discuss peculiarities of high rises with reference to fire safety and strategies required to be taken to deal with fire hazard in such cases**. Fire Accidents in Buildings – Case Studies**, Mrs. Lilly grace murali. P, Dr . M.M. Vijayalakshmi. This paper has analysed fire incidences and given the solutions.

METHODOLOGY

Study of high-rise buildings with fire safety perspective, analysis of development pattern of Pune city in residential sector, analysis of rules and regulations is done through this literature study. The role of fire department, their preparedness is understood through interview and reports. Live case studies of under construction as well as completed buildings are done in various parts of Pune city and around to understand the gravity of the fire safety issues. Case studies are analysed based on adherence to norms as well as awareness of the users. Based on the findings the conclusions are drawn.

PECULIARITIES OF HIGH-RISE BUILDINGS

High rise buildings need special attention to address fire hazard for the following reasons-

Egress Systems- Overcrowding and slow movement can happen due to a greater number of storeys. Staircase shafts can become the means of smoke rise. Hence the Egress system must provide enough time for the occupants to reach to safe place.

Fire department access-The fire department can reach up to 6-7 floors with modern equipment also. This requires more time for rescue. The fire fighters must use the stairs with the hose reels to fight internal fires at upper floors. Thus, this increase the need of unobstructed fire shafts.

The forces of nature-Stack effect and wind plays an important role in smoke movement in high rise buildings. With increase in height, stack effect increases which helps in fire spread.

Increased density of occupants and fuel loads-By adding number of floors, the occupant and fuel density increases for the given footprint of the building. Fire tends to travel upward rather than horizontal adding more fuel.

Complex vertical utility services-A complex series of conduits for electrical, pipes, cables, ducts run vertically in high rise buildings. This increase the possibility of fire as well as fire spread Fire suppressing as well as detection systems also run vertically through the shafts and ducts. This imposes additional trouble in protecting these services in case of fire to be utilised in emergency.

Zoning of firefighting system –Zoning of firefighting systems to meet functional requirements of hydraulic pressure and flow must be done. This adds to the complexity of the firefighting systems.

ROLE OF FIRE DEPARTMENT IN FIRE SAFETY

There are separate fire brigades working for Pune and surrounding areas such as Pune fire brigade, PCMC Fire brigade, PMRDA fire brigade, MIDC fire brigade and Cantonment fire brigade (Pune, Kirki, Dehuroad).They work together in harmony and help each other in case of emergency. **Maharashtra Fire Prevention and Life Safety Measures Act, 2006** has laid the powers to the fire department to control the fire safety of the city . Thus , any high-rise building needs no objection certificates at construction stage and at occupancy stage. The plans are scrutinised by fire officers, trained in fire safety and give recommendations of fire safety installations in provisional fire NOC. The building is checked after completion and

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fire NOC is furbished for occupancy certificate. The half yearly audit report is compulsory ,after occupancy ,to be submitted to fire department. They can issue 15 days' notice for non-compliance and have the power of cutting light and water connections of the society till they do the rectifications as asked. But due to lack of automation and man power shortage , the record keeping has become tedious job for the fire department. The builder, the chairman and secretary (if society is formed) , all residents (if society is not formed) are responsible for the maintenance of firefighting installations to keep their building fire safe as per Laws. The department constantly upgrades the machinery and currently they are ready for rescue operation of the fire hazard in more than 100 floors also. Presently, there are 14 working fire brigade stations and few in the progress, making total count of 21. Fire brigade stations are located within 10 km aerial distance throughout the expanse of the city to make response time as 5 min. Fire department showed the concern that they have more control over the building till occupancy phase than later. Fire suppressing measures are made mandatory as minimum requirement to increase the time for the fire tenders to reach the spot . But the common experience of the fire officers is that the losses have increased due to failure of these systems because of ill maintenance. But at least due to implementation of the act all the developers have installed the fire suppressing measures in place.Fire department maintains the call record amongst 20 different categories. Only 6 types are considered which are related to fire hazard. From the data generated ,on an average, for last 8 years ,fire department is getting almost 2950 calls out of which 90 % are the calls from residential area including high rise development. The common causes of fire are kitchen fires ,mobile blast, fires caught by cars in basement, electric short-circuit etc. From the numbers it is evident that fire hazard needs attention of all the stakeholders to minimise the losses.

CASE STUDIES

The live case study was made of the building where the fire outbroke in January 2020. The building was done in phases. The single apartment tower (P+10 storeyed) was added with shopping complex of two floors with basement for parking on the front face making entry to the main housing through side lane. The shopping area has not been given with firefighting installations and also the uncontrolled modifications are made in the shopping adding more and more problems to the housing tower. On the day of incidence, the chimney of restaurant in shopping area ,caught fire and the residents and the hotel owner struggled to control the situation due to following points.-

1. There are no firefighting installations in the shopping area.
2. The fire tank in housing was empty as the residents have closed the tank to avoid contamination of water due to drainage leakage in the water tank.
3. Fire alarm system was not working.
4. The chimney fell by blocking the access way of the residents and fire tender as unthoughtful change in the access of the building was made while adding the shops.
5. Though there are no casualties the residents were very shocked by the incidence.

Actual photographs of the spot

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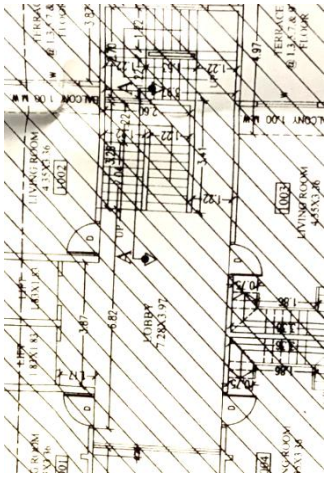


No staircase is enclosed as fire staircase and both are abutting in such way that they cannot be used easily in case of emergencies.

Important aspects derived from literature study considered for analysis of case studies are as follows-

In Pune majority buildings are constructed in R.C.C. frame structure with brick, concrete blocks or concrete walls by using different formwork technology as infill walls. But actual fire resistance of the bricks, blocks and concrete never gets checked prior to construction. Generally concrete/bricks show adequate fire resistance. So, passive measures in planning and active measures as suppression and detection systems are considered for analysis .

Three case studies are analysed under **construction phase**. The parameters for analysis which are applicable to construction phase under sub heads of Fire prevention and protection and life safety are only considered. Findings are-

1. Fire prevention measures are installed in 2 of 3 sites during construction.
2. Electrical shafts are enclosed but stops are not used at slab level.
3. Fire exit staircases are enclosed with fire doors and in 2/3 sites are pressurised. Location of fire staircase is of concern in one of the cases.
4. Fire hydrant piping should be done in separate shaft called as fire shaft. But in 2 /3 cases it is of concern. In one of them fire shaft is not enclosed with walls and in second case it is located inside the fire stair.
5. All fire suppression measures are planned and installed as required.
6. Sprinkler system in flats is also given a thought to reduce the possibility of sprinkler heads being hidden inside the false ceiling in later date.

Five Case studies of already **completed** building are analysed and comparative chart of case studies of **occupied buildings** is prepared. The weightage given is as follows-

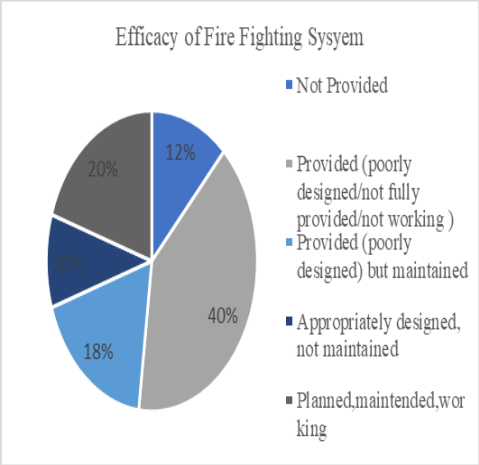
1-Not Provided

2-Provided (poorly designed/not fully provided/not working)

3-Provided (poorly designed) but maintained

4- Appropriately designed, not maintained

5-Planned,maintended,working



FINDINGS

1. Pie chart of analysis of 5 case studies show that in most of the cases the firefighting system was provided as per law but either not designed precisely or not working.
2. Installations of fire suppression and detection measures is mandatory by law to make building safe till fire brigade reach the site. But in the discussion with fire personnel they mentioned that in most of the case these installed systems are not working so the residents have suffered with more losses.
3. From the past fire case studies, it was clear that loss of life is more due to blockage in escape routes and smoke accumulation. But in case studies the thought of these issues found missing.
4. Location of fire shaft, fire staircase needs special attention to use safely in case of hazard.
5. In most of the cases the users are unaware of the fire hazard hence they are not taking part in the fire safety maintenance of the building.
6. Piped gas is popular feature in housing complexes now-a –days. It may turn as source of ignition if not properly provided. Gas leak detectors and heat detectors should be provided.

CONCLUSIONS

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High rise residential buildings are lacking in fire safety due to unawareness of the stakeholders. Hence this paper strongly recommends the need of fire risk assessment of the residential buildings , study of user's behavioural issues while providing for fire safety and working collectively by the stakeholders of the project.

Acknowledgement

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Micro-Climate Analysis of Bhopal through Bioclimatic Chart, Radiation Square, Wind Rose and Sun Path Diagram to Evaluate Passive Design Strategies

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Abstract: The concept is to develop climate-appropriate design to make building climate responsive and increase the human comfort level of indoor spaces. This research paper will provide suitable data to analyze the micro-climate of Bhopal to evaluate different design strategies. The average pattern of variation in elements such as temperature, humidity, solar radiation and wind over long periods of time will be measured. The use of Bioclimatic Chart is to identify human comfort and design strategies. Radiation Square provide hourly radiation data to design solar system and facade material. Wind rose provides direction, speed and frequency of wind for different seasons. Sun path diagram will show the path of sun in the sky-dome as projected on to a horizontal surface and to design shading devices. These manual techniques will be interrelated to each other for appropriate passive design strategies and climate responsive buildings.

Key Words: Bioclimatic chart, radiation square, wind rose, sun path diagram, passive design strategies, micro-climate analysis.

I. Introduction

Today's building are more focused on adapting glass construction style without considering the geo-location, micro-climate and surrounding context of proposed site which leads to high energy consumption in various seasons. Buildings are responsible for the 40% of world energy consumption (Serghides, 2014). Therefore, energy conservation is a fundamental concern nowadays. To reduce the energy consumption architects, engineers, public and private sector must have the understanding to make buildings climate responsive which will escalate indoor and outdoor environment quality for humans, animals and living organisms. The goal is to make building climate responsive, initial step will be to study the micro-climate of proposed site so to understand the impact of nature on building throughout the year. And also to achieve good human comfort condition in indoor spaces and evaluate proper design strategies that can help in improving the energy performance of new and existing buildings.

The main aim of this research paper is to use bioclimatic chart, radiation square, wind rose and sun path diagram in order to determine the appropriate technique and strategies to achieve climate responsive building at Bhopal. The climatic data of Bhopal is referred from India Meteorological Department (1971-2000). The data is plotted on quantitative and qualitative bioclimatic chart to identify most critical month in terms of human comfort level. The hourly solar radiation (W/m2) is considered on horizontal roof and differently orientated walls to suggest photovoltaic and hot water solar system to increase energy performance of building. The wind rose helps to design the position and size of inlet and outlet of fresh air. Sun path diagram helps to design shading devices for critical month and to understand percentage of sunlight penetrating from non-opaque surfaces.

According to climatic conditions in which people are bioclimatically comfortable condition consists of: relative humidity between 20% and 75%, temperature between 20°C and 27°C and wind speed up to 5m/s.

Climatic Parameters

Bhopal lies on 523m height above mean sea level. The latitude is 23°17' and longitude is 77°21'. The climate type of Bhopal city comes under composite according to Bureau of Energy Efficiency - Energy Conservation Building Code 2017.Bhopal experience 5 and half months of winter mid-September to February, 3 and half months of summer March to mid-June, 3 months of monsoon mid-July to mid-September. The Dry Bulb Temperature ranges from 14.5°C-38.5°C throughout the year. The lowest temperature 10.5°C in January and highest temperature 40.7°C in May month. The relative humidity ranges from 20% to 88% throughout the year. Lowest relative humidity experienced by May month ranges from 20%-37% and highest in August month

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ranges from 78%-88%. In monsoon maximum rainfall received in July and August ranges from 371.6mm and 402.6mm respectively. Wind speed throughout the year ranges from 6.1 kmph to 16.1 kmph. From this data critical month is identified which is January, May and August in terms of human comfort. The average sky clearance factor is 57.80%. Only monsoon season experiences 85%-95% of cloud cover and remaining months have 25%-30% of cloud cover (CLIMATOLOGICAL NORMALS 1971 - 2000).**II. Methodology**

Description of Bioclimatic Chart

Bioclimatic Chart, when plotted with monthly temperature and relative humidity, identifies potential passive solar heating and cooling strategies appropriate for the building's climate.

On the bioclimatic chat, plot two points: first, the average minimum temperature for one month by the maximum relative humidity; second, maximum temperature by minimum relative humidity. Connect these points with a straight line and repeat the process for each month of the year. Each line represents the change in temperature and relative humidity over an average day. The bioclimatic chart is subdivided into zones that define passive solar heating and cooling strategies. The zones crossed by the lines plotted indicate strategies that may be appropriate for the climate.

There are five cooling strategies represented by the five somewhat overlapping zones above the comfort zones:

1) natural ventilation, which depends solely on air movement to cool occupants; 2) large thermal mass, which depends on the building material to store heat during the day and reradiate it at night; 3) large thermal mass combined with night ventilation, which relies on mass heat storage during the day and ventilation at night to cool the mass; and two types of evaporative cooling, 4) direct, 5) indirect. Direct evaporative cooling raises the humidity and lowers the temperature of indoor space. Indirect evaporative cooling, such as the cooling of the outside of a roof or wall by evaporating water on its surface, lower the temperature of a building element, which then becomes a heat sink for the adjacent space. (DeKay, 2001)

Description of Radiation Square

Solar radiation square is already determined for Bhopal. The hourly solar radiation of horizontal and vertical surface will be used along with temperature, relative humidity and wind speed on bioclimatic chart to determine the potential for human comfort at a particular time and date. Sun path diagram is used to plot radiation levels at different times of the day and month.

Description of Wind Rose

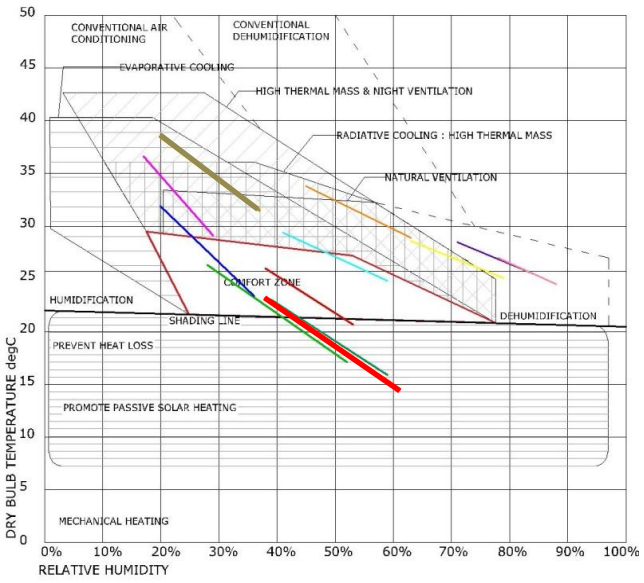
Wind rose gives detailed information on wind speed and direction for a month or a whole year**.** It is prepared from IMD data.

Description of Sun path Diagram

The heavy lines running from east to west represent path of sun on 21st day of each month of the year. Heavy lines running perpendicular to the sun path line indicate hours of the day. The lines radiating from the centre indicate the sun's azimuth. The concentric lines indicate the sun's altitude. Determine the sun's position in terms of altitude and azimuth for any hour of the day and any day of the year. (S.L.Koihatkar)

III. Results and Tables

Qualitative Bioclimatic Chart for Bhopal



Month (Daytime minimum relative humidity, maximum temperature – nighttime maximum relative humidity, minimum temperature)

Legend:

Jan (38%, 23.1°C - 61%, 14.5°C)
Feb (28%, 26.3°C -52%, 17.1°C)
Mar (20%, 31.9°C - 36%, 23.4°C)
Apr (17%, 36.6°C -29%, 29.1°C)
May (20%, 38.5°C -37%, 31.5°C)
Jun (45%, 33.8°C -63%, 28.9°C)
Jul (71%, 28.5°C -84%, 25.5°C)
Aug (78%, 27.0°C -88%, 24.5°C)
Sep (63%, 28.6°C -79%, 25.1°C)
Oct (41%, 29.4°C -59%, 24.8°C)
Nov (38%, 26.0°C -53%, 20.7°C)
Dec (39%, 23.0°C -59%, 15.9°C)

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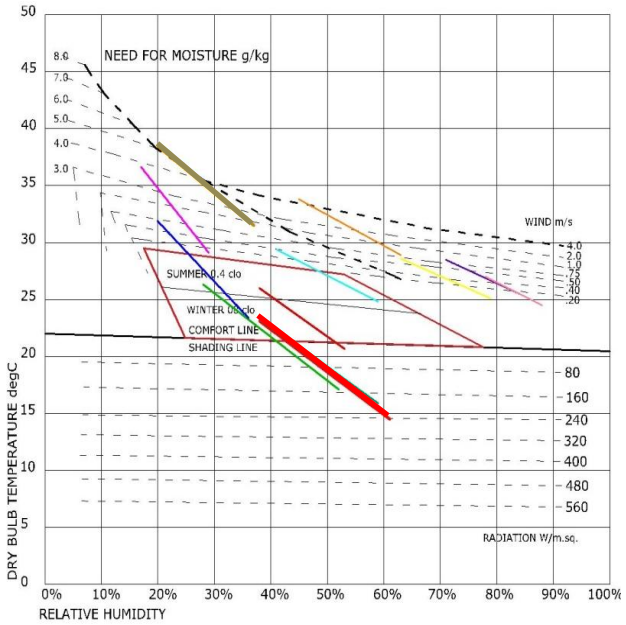
Quantitative Bioclimatic Chart for Bhopal



Qualitative Bioclimatic Chart of Bhopal

The most critical month in terms of human comfort is May and January which is in bbrown and red line respectively. In May month, the relative humidity is 20 - 37% and temperature is 38.5°C - 31.5°C which leads to dryness in the air and creates hot winds. To achieve human comfort in May, evaporative cooling and radiative cooling: high thermal mass design strategy suggested by qualitative bioclimatic chart.

In January month, the relative humidity is 38 - 61% and temperature is 23.1°C -14.5°C which leads to coldness in the air. To attain human comfort in January, prevent heat loss from indoor spaces. Remaining monsoon and summer months will be designed for natural ventilation. Good insulation is required in winter month to avoid heat loss from indoor spaces. This data provides designer to understand the required building treatments to make building climate responsive.

Table 2. Horizontal Solar Radiation Speed of Bhopal

MONTHS	REQUIRED SOLAR RADIATION (W/m.sq.)	REQUIRED SHADING (%)	REQUIRED WIND SPEED (m/s)
JAN	80-240	20	-
FEB	80-160	53	-
MAR	-	100	0-0.5
APR	-	100	1-3
MAY	-	100	2-4
JUN	-	100	0.75-4
JUL	-	100	0.2-0.75
AUG	-	100	0.2-0.5
SEP	-	100	0.2-0.75
OCT	-	100	0-0.4
NOV	0-80	90	-
DEC	80-160	23	-

Quantitative Bioclimatic Chart of Bhopal

This chart provides quantitative data which is used further to accomplish strategies from qualitative bioclimatic chart. For critical May month, solar radiation speed is 3-5 m/s and for January, 80-320 W/sq.m solar radiation required. Mostly all month requires shading devices. This data gives the idea about required solar radiation, shading and wind speed to make building more efficient.

Table 1. Passive needs from Quantitative Bioclimatic chart for Bhopal

Radiation Square for Bhopal

The total radiation received from the sun, of a horizontal surface at the level of the ground for a serene day, is the sum of the direct and diffused radiations. For Bhopal, solar radiations for horizontal surface are considered. Color scheme depicts various intensities. Higher the solar radiation value indicates high intensity and bright color. Lower the solar radiation value, lower is the intensity and darker color. The solar radiation square is designed from 6am to 6pm hourly radiation annually. Low radiation is coded as 260 W/sq.m and high as over 700 W/sq.m.

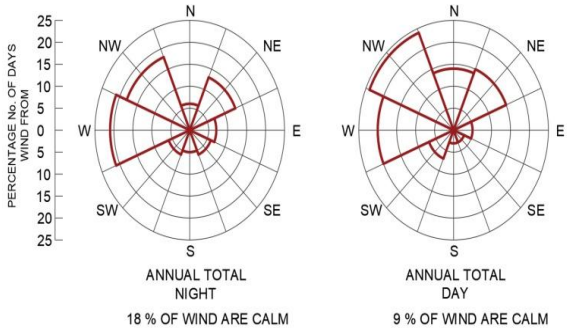


Figure 1. Annual Wind Rose

The critical May month, has higher solar radiation intensity which can lead to higher heat gain from the roof or horizontal surface. To avoid heat gain from horizontal surface appropriate insulation is to be designed with correct U-values. This solar radiation square value is used to design photovoltaic system and hot water system to increase the energy performance of the structure. While designing the solar system other factors also to be considered such as temperature, sun angle, shade, and shadow and panel efficiency. This data will simultaneously use with other design tools.

Wind Rose for Bhopal

Figure 1 indicates primary wind direction and percentage of wind coming from west and northwest. The annual wind speed is 2.88 m/s. Openings of the buildings should be designed on windward direction and outlet should be faced towards leeward direction. Factors considered while designing an opening are surrounding noise level, privacy,

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view, dusty, cold and hot winds. Wind rose is made for critical month May and January. Studying wind rose will help building more contextual to their site.

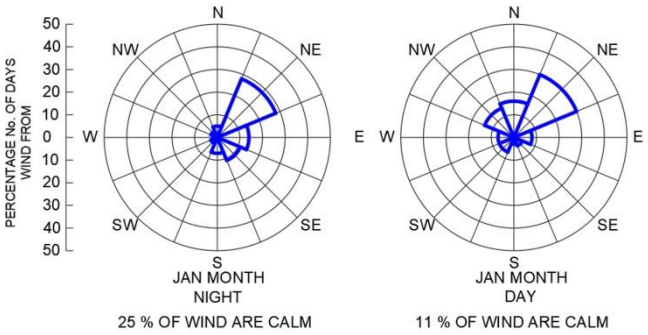

Figure 2. Wind Rose of January

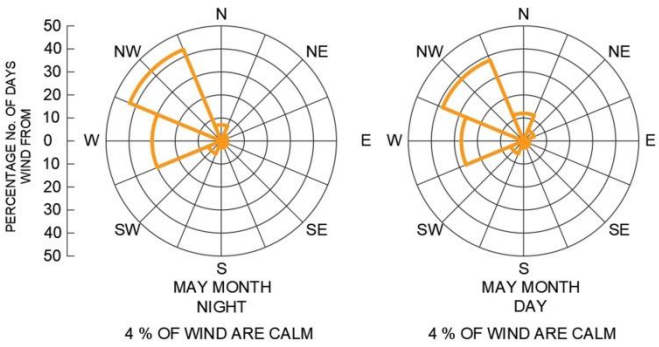

Figure 3. Wind Rose of May

Wind direction throughout the winter is from northeast. In the month of January, cold winds are experienced due to low dry bulb temperature 14.5 °C at night. To avoid heat loss from structure trees plantation can be act as a buffer zone but it should not be blocking the sunlight at daytime. Mean wind speed in January is 2 m/s.

Wind direction throughout the summer is from northwest and west. In the month of May, hot winds are experienced due to high dry bulb temperature 38.5 °C at daytime. To avoid heat gain from surrounding atmosphere the opening should be designed in such a way that warm air must be cooled, then supply to the indoor spaces. Mean wind speed in May is 4.08 m/s. Wind rose helps to design openings orientation and size.

LOCATION - BHOPAL		LAT - 23°17' LONG – 77°21'		M.S.L – 523 m
TIME	SUMMER MONTH - MAY		WINTER MONTH - JANUARY	
	Azimuth(Az)	Altitude(Al)	Azimuth(Az)	Altitude(Al)
6 A.M	73°	9°		
7 A.M	78°	21°	113°	7°
8 A.M	82°	35°	121°	19°
9 A.M	88°	48°	131°	29°
10 A.M	93°	62°	144°	38°
11 A.M	104°	75°	160°	44°
12 NOON	180°	85°	180°	46°
1 P.M	256°	75°	200°	44°
2 P.M	267°	62°	216°	38°
3 P.M	272°	48°	229°	29°
4 P.M	278°	35°	239°	19°
5 P.M	282°	21°	247°	7°
6 P.M	287°	9°		

Table 3. Sun Chart of Bhopal

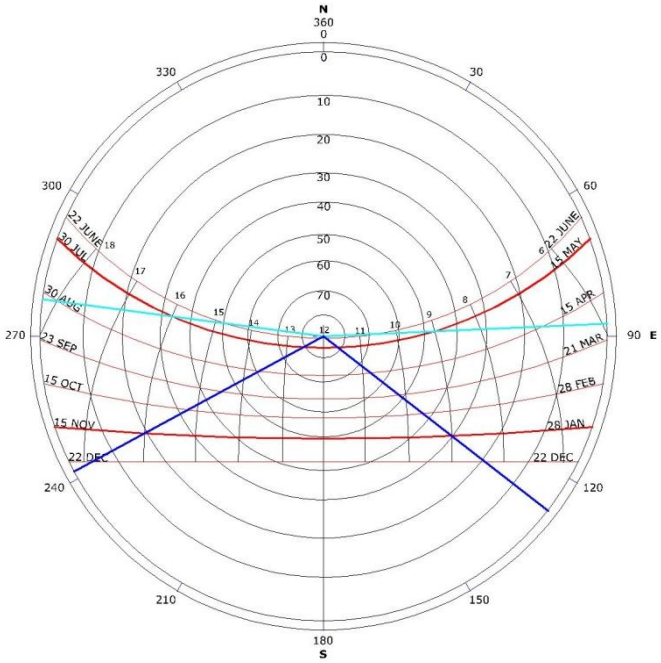

Figure 4. Sun path diagram of Latitude 23°17' Bhopal

Sun Path Diagram

In Figure 4, critical months May and January are marked. The sun's azimuth and altitude are listed down in table 3.

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The sun path diagram helps to design shading devices for critical months. The shading devices will be designed for 9am, 12 noon and 4pm from sun path diagram. The shading devices will cut off the sun wherever it's needed. Horizontal and vertical shading devices are designed with the help of sun path diagram. For horizontal devices, sun altitude angle and vertical devices azimuth angle is needed which is collected from figure 4. The solar altitude, and the solar azimuth, can be read directly for any date of the year and any hour of the day from the solar charts or sun path diagrams. It gives the liberty to understand sun position to plan and design site and building respectively.

Conclusion

Climate is an important context which greatly influences the amount of energy; a building would use and therefore, need to be analyzed accurately. Climate responsive buildings will be designed by using these set of tools. These tools are used to develop passive design techniques at the initial stage of building design in Bhopal to improve human comfort level and energy performance of the building. These data will produce design solutions that are eco-sensitive, energy efficient, climate responsive, user friendly and cost effective too.

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HORIZONTAL												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
6:00 AM	0	0	0	0	0	31	0	0	0	0	0	0
7:00 AM	0	0	99	113	111	123	24	18	52	0	0	0
8:00 AM	66	83	249	284	278	184	61	44	131	82	75	66
9:00 AM	232	290	398	454	445	246	97	71	209	286	261	230
10:00 AM	432	538	547	624	612	307	133	98	288	532	486	428
11:00 AM	531	662	696	794	780	338	169	124	366	654	598	527
12:00 PM	598	745	746	851	835	368	182	133	393	736	672	592
1:00 PM	531	662	696	794	780	338	169	124	366	654	598	527
2:00 PM	432	538	547	624	612	307	133	98	288	532	486	428
3:00 PM	232	290	398	454	445	246	97	71	209	286	261	230
4:00 PM	66	83	249	284	278	184	61	44	131	82	75	230
5:00 PM	0	0	99	113	111	123	24	18	52	0	0	0
6:00 PM	0	0	0	0	0	31	0	0	0	0	0	0
	427	532	576	656	644	307	140	103	303	526	480	423

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A Study on Improvement of Existing Daylight Level in Studio at D Y Patil College, Ambi, Pune

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Abstract: Construction industry being the foremost consumer of energy resources has great prospect to develop innovative energy saving techniques. Optimum use of natural daylight is one of most important aspect to reduce operational energy and maintenance cost in any building. Educational building where daylight is an essential need, however more specific to the working studio where natural daylight factor plays a very significant role. Intention of this paper is to study effective available daylight in the existing DYPSOA Ambi, more specifically for classrooms where manual drafting work has to be produced. The research investigates the problematic areas which are recipient of insufficient or improper daylight with the help of measurement of actual lux levels and analytical methods. Intention of this rigorous study is to improve the daylight factor with the help of combination of various strategies like light shelves, innovative material and solar tracking system with solar light tube. Intention of providing solution through passive means and complies with National lighting code (SP 72: 2010).

Key words: Daylight factor, IESNA method, Solar light tube, solar tracking system, light shelves.

1. INTRODUCTION

Daylight can be an important energy saving feature of any building by displacing electric lighting demands [i].However it is very difficult to provide even day lighting throughout the enclosed room. To study day light class room cum studio of D Y Patil college of Architectural has been chosen. Selection criteria to choose class room where there is minimum day light and maximum depth is observed. Window is located at the width of room which is external side of the structure, however there are two doors and one window at north side of which opens in the covered atrium but day light intercity from north side negligible. As per the 2.5 m rule of thumb day light is sufficient till the first column from the window side which is enough for the reading purpose. As per the National lighting code (SP 72: 2010) class room lux level should be 300 lux. [iii].

IMPORTANCE OF DAYLIGHT

- Studies show that improper use of day lighting can reduce productivity and increase employee absenteeism [iv].
- Daylight has physiological and psychological benefits for teachers and students. Physiological benefits due to daylight on students are less dental decay (cavities), improved eyesight, and improved immune system [iv].
- A school with insufficient light can also reduce a student's ability to learn due to the effect lighting has on physiology. Poor spectral light can create strain on students' eyes, leading to a decrease in information processing and learning ability, causing higher stress levels (Liberman 1991) [iv].

2. METHODOLOGY

Three methods could have been adopted for this study, the first of which is an actual field survey for readings and feedback of users, while the second could be based on techniques of simulation through computer-generated models, and third could be analytical or calculation based method. Since the case studies are of existing buildings in active use and, correct observations and users' feedback could be obtained, the first method was adopted and other methods are supportive or could be used as verification.

2.1 ACTUAL FIELD SURVEY

North side (Covered atrium) South side

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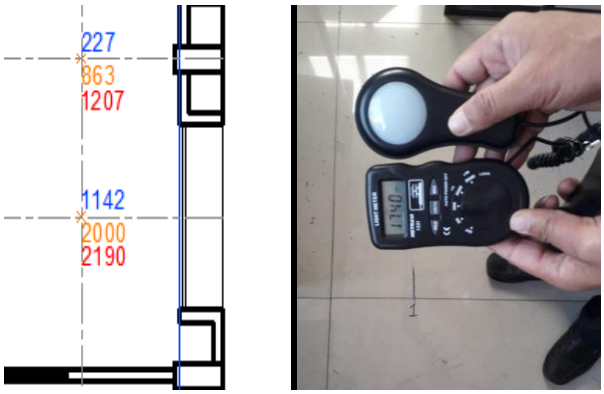

Figure – 1 Actual field survey

- Actual measurements of light has been noted for three different time period of the day that is 9.00 am , 12.00 noon and 3.00 pm and it is indicated in plan with Blue, Orange & Red respectively.
- Actual reading has been taken with the help of Lux meter.
- As the analytical method comprises of IESNA [i] method in which five point / location has been selected to take day light reading at 10,30,50,70,90 percentage respectively from the window centre. Hence for the fair comparison with IESNA method five point reading has been taken in actual measurement.
- Measurements also taken at the centre of two windows.

2.2 TECHNICAL SIMULATION

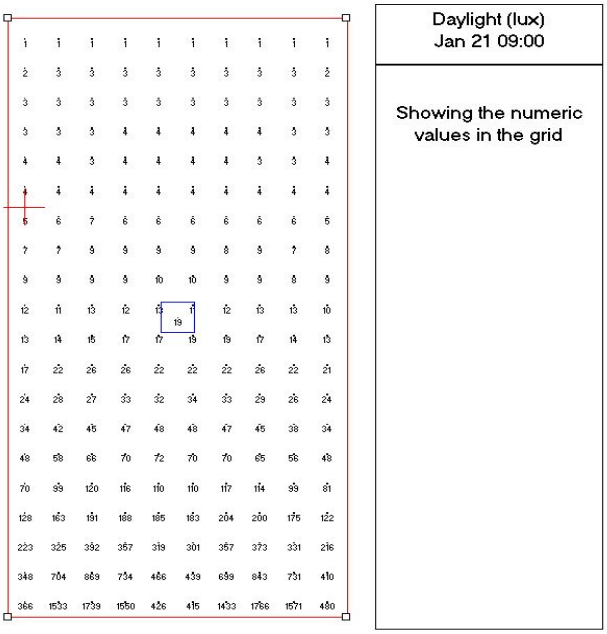

Figure – 2 IES simulation at 9.00 am on 21 Jan. 2020

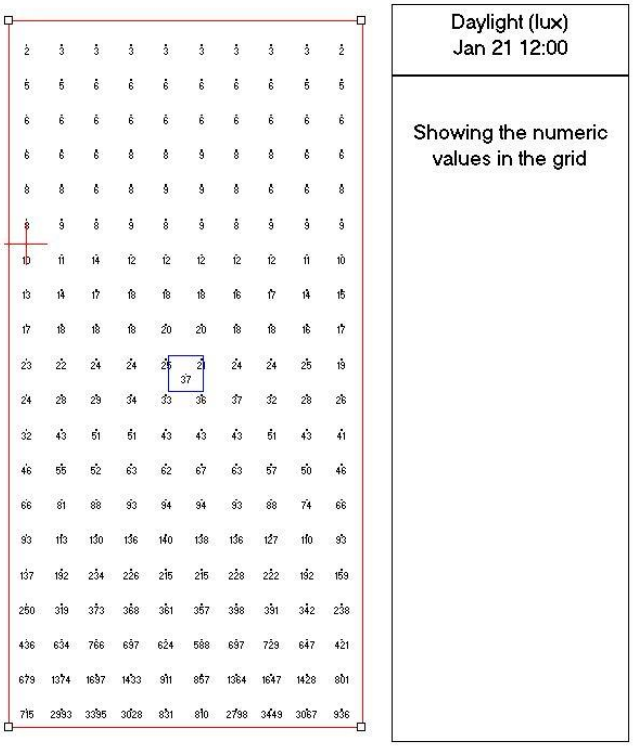

Figure – 3 IES simulation at 12.00 pm on 21 Jan. 2020

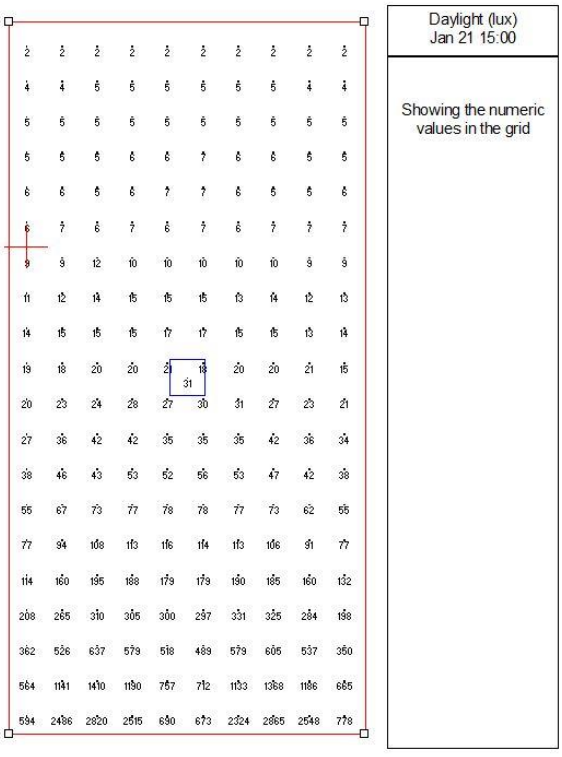

Figure – 4 IES simulation at 3.00 pm on 21 Jan. 2020

2.3 ANALYTICAL METHOD

IESNA [Illumination Engineers Society of North America] developed the lumen method for calculating daylight availability (published as RP-23-89,

Recommended Practice for the Lumen Method of Daylight Calculations) [i].

The IESNA method is probably the most flexible manual technique available. [i].
The method is usable in only one mode; that is, given location and full dimensional data, day lighting can be calculated.
GIVEN:
Location: Pune, Maharashtra
Latitude: 18^0 3' N
Room: 10.10 m width, 20.20 m deep, with a 3.40 m ceiling
Window: 2.35 m above a 1.05 m working plane, total length 3.00 m
Transmittance: 85%, net glass area 92% (assumed)
Ground Reflectance: not previously specified. Assume an extensive area of mixed grass and concrete walkways, with an average overall reflectance of 20%. See Table Below:
Calculation: Illuminance *Ei* will be found at the five points shown in Fig. A-1 for a summer day and a winter day at 09:00 A.M. and 3:00 P.M. Assume that the sky is overcast so that a direct comparison with other methods can be made. Reflectance are assumed to be 70% for the ceiling, 50% for the wall, and 30% for the floor to correspond to the IESNA method standard conditions.
STEP 1: *Determine the vertical and horizontal illuminance on the exterior of the window.*
Using the solar altitude for the summer and winter day (solar data), the vertical and horizontal illuminances can be found from Fig. A-1.

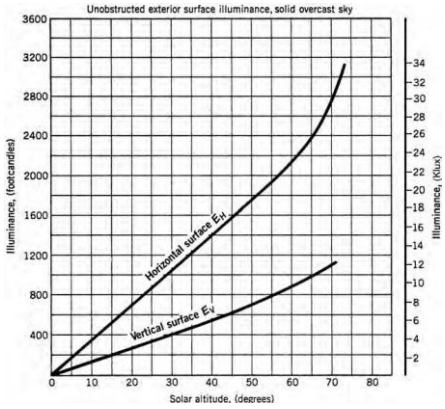

Fig. A-1 Curves giving unobstructed exterior surface illuminance directly from an overcast sky. (Data based on U.S. Weather Service observations; courtesy of Libbey-Owens-Ford.)
Calculate *Exhk*, the half-sky illuminance (a vertical window seasonally half of the sky). The results are compiled in Table below:

Solar Altitude	Vertical Window Illumination Exvk	Horizontal Illumination from full sky ExHk	Horizontal Illuminance from half sky Exhk
May,(Az82)Ver.,(Al-48)Hor.	8,000 lux	18,500 lux	9250 lux
Jan,(Az132)Ver.,(Al-29)Hor.	4, 250 lux	11, 000 lux	5,500 lux

Vertical illuminance from the ground is
$E_{xvg} = RF_g \times (E_{xHk}) / 2 = 0.2 \times 18{,}500 = 9250$ lux for May 21
$E_{xvg} = RF_g \times (E_{xHk}) / 2 = 0.2 \times (11{,}000) = 5{,}500$ lux for Hanuary 21-(E1)
STEP 2: STEP 2. *Determine net transmittance of the window*.
Glass transmittance is 85% ,light loss factor is 0.9 and the net glass area is given as 92%. The net transmittance (τ) of the window is a product of these factors:
$\tau = (0.85)\ (0.9)\ (0.92) = 0.70$
Source - IES Recommended Practice for the Lumen Method of Day-light Calculations, RP-23-1989
STEP 3.*Select coefficients of utilization for* the five calculation locations (10%, 30%, 50%, 70%, and90%) on the basis of room dimensions and the portion of the sky seen by the window. The SC seen by the window is determined by the ratio of vertical to horizontal illuminance at the window.
SC *E*xvk /*E*xhk:
May. 21: 8000 / 9250 = 0.86 (Table C.21)
Jan. 21: 4250 / 5500 = 0.72

The *E*xvk /*E*xhk = 0.86 and 0.72 values correspond most closely to the *E*xvk /*E*xhk = 0.75 value of Table C.21. Use the following values to find the coefficients of utilization, *CUk*:
Room Depth / Window Height = 20.20 / 2.35 = 8.59, use 8.0 (from first column variable)
Window Length / Window Height = 3.00 / 2.35 = 1.27, use 1.0
The ground component vertical illuminance (*E*xvg)is the product of the ground reflectance (Table -T3)and half of the horizontal illuminance (Equation -E1).The sky and ground component values are compiled in Table-T4 for each of the five reference locations.
STEP 4.*Calculate the illuminances for each of the five reference locations*.
(Table -T5: tabulates the illuminance values from this calculation.) The basic equation for each location is
$Ei = \tau\ (E\text{xvk} \times \text{CU}k + E\text{xvg} \times \text{CU}g)$

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Where
Ei = interior illuminance at a specific reference point
τ = net transmittance of the window
*E*xvk = exterior vertical illuminance at the window from half of the sky (an unobstructed vertical window sees only half of the sky)
*E*xvg = exterior vertical illuminance at the window from the ground
CU*k* = coefficient of utilization for sky light
CU*g* = coefficient of utilization for ground light

Table - : ILLUMINANCE Values for summer and Winter in Pune at Five Reference Locations

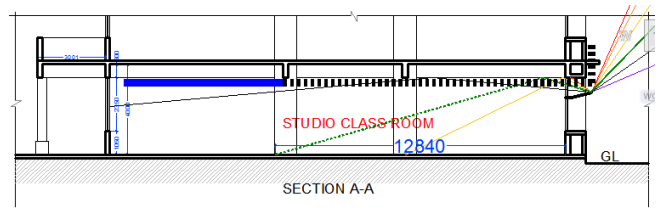
Location	Ei May 21, lux	Ei Jan. 21, lux
10	1970	1080
30	333	**189**
50	**176**	**100**
70	**146**	**83**
90	**140**	**80**

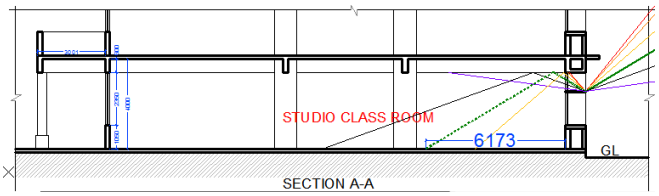
As per IS:10894-1984 (Indian bureau of standards) 300 Lux level is required at class room area. It can be seen that after 10% distance day-light becomes insufficient in May and in Jan. it is 30%.
By considering minimum day lighting period that month of January supplementary passive strategy will be recommended as follows.

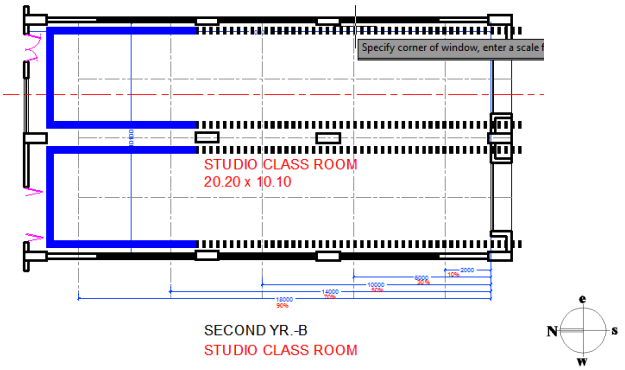
1. Light shelves- To extend day light inside the room with angle variation of 15 degree.
2. Solar tube light – This will act as supplement day light after the limit of light shelves.

Light shelve – Existing window height has divided in two section, first is 1.50 m which is sliding aluminum window and another 0.85 m above part is fixed glazed aluminum window. Hence light shelve is recommended at 1.50 height of the window. Solar altitude angle of January month has been considered at 7am,8am,9am,10am,11am and 12 noon. As per analysis at 9am after 10% distance daylight light deficiency observed. After introduction of light shelve light lux level which almost 2000 at window level when it get reflected from light shelve after 50% light loss it becomes 1000 lux. Then after re-reflecting it from the white ceiling it again loses 50% and 500 to 300 lux level can be achieve at 6m.(30%) distance. However as per shown in upper section if 15 degree tilt proposed to the light shelve then this day light penetration can achieve till 12.84m.(60%).

Solar tube light - The light pipe operates by collecting light through a heliostat; channeling daylight through a reflective tube made of prismatic glass, plastic film, and mirrors; and diffusing light at the end of the pipe. It is an exciting strategy because of the length it can transport light—65 ft (20 m)—from a single- point light source. This strategy can be used for the remaining 8.00 m depth of the room. As solar light outside is approximately 2000 lux and after re-reflecting it inside the solar tube assuming 50% light loss it will give 1000 lux till the end of the pipe. Considering the limit of 20.00 m, outer end of the solar pipe can be installed at the slab projection above the window. As the required lux level is 300 there for solar pipe need to be wrapped till the 12.00 m distance from window and exposed it as per the desired lux level at farther end of the room. In the below figure dark blue color n section and plan indicate solar tube , however black dotted line indicate wrapped solar pipe.







	Existing condition at 9.00am	With light shelve	Light shelve 15° tilt	Solar light tube
Light penetration in percenta	10	30	60	100

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ge				
Light penetration in meter	2	6	12.84	20.20
			Recommended	Recommended

DISCUSSION

As per existing class room size if the window size is big enough and there is no scope to increase it further then above strategy is use full till the 20 m depth of the room. As the day light is more important rather than direct sunlight hence the material to be chosen for the light shelve should have 80% of reflectance rather 100% reflective surface. While material selection for the solar tube should have 100 % reflective surfaces inside the tube.

CONCLUSION

From above research study it can be stated that at a given size of the room and window position oriented to south side, combination of passive strategy that is light shelve with 15 degree angle & solar pipe with heliostat could be work effectively. Light shelve can be useful for the 60% penetration of daylight and solar pipe can supplement for the rest of the 40% farthest end of the room till the depth.

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude from the bottom of my heart to my guide Prof. S L Kolhatkar sir for his valuable guidance, inspiration and encouragement. His keen and indefatigable indulgence in this work helped me to reach an irreproachable destination.

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A Comparative Analysis of Cost and Energy Performance of Envelope Assemblies Used in Green Buildings and Conventional Buildings

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Abstract : Green building certification is gaining popularity nowadays. Yet for a major percentage of the small scale residential buildings, opting for green materials is difficult due to lack of awareness and knowledge about cost and performance. There is a perception that initial cost involved is higher. While selecting materials, knowledge of the energy performance and cost is required to optimize the benefits. Various combinations of envelope assemblies for roof, walls and windows were analysed for cost and energy performance using calculations and simulations for a live case. The results show that every green material assembly is not costlier than conventional one, but have better energy performance. Optimization of cost and thermal performance is necessary while selecting building envelope materials.

Keywords- Green building materials, Hard cost, envelope, energy performance

1.0 INTRODUCTION

Buildings account for a huge percentage of energy consumption and carbon emissions in its life cycle causing adverse impact on environmental, social and economical sustainability. It has thus become important to design and construct buildings which have minimum impact. Various Green building certification systems give guidelines for sustainable development, so that, overall performance of the building in terms of occupant's comfort & energy usage is improved and environmental impact is minimized. Green building certification systems assess a construction project based on various aspects of sustainable development such as – sustainable site planning, water conservation, material and resource conservation, energy conservation and indoor environmental quality. *(NA, IGBC green homes, 2017)*

The cost of green-rated building involves both hard and soft cost where hard cost is the actual construction cost and soft cost is the cost required for certification process, consultant's fees, etc. There are assessment criterions given for each of the aspect. From the case studies and market trends it can be seen that fulfilment of these criterions requires some additional initial investment which can be termed as hard cost. Also there is a cost involved in certification process which can be termed as soft cost.*(Nurul Zahirah, 2012)*

Government and local authorities provide incentives or tax rebates for certified green buildings to attract people so that they would choose green buildings over conventional ones. *(NA, Green building policy, Maharashtra state, 2018)*. But there is a lack of awareness regarding financial benefits of green buildings. In some of the cities where green building certification systems are not so popular or not regularly practiced, still there are many opportunities to achieve the same goal of sustainable development. This research's objective is to understand current scenario of awareness regarding green construction and its financial benefits amongst architects and compare hard cost involved for green construction and conventional construction. As far as thermal performance and energy efficiency is concerned, the building envelope accounts for a major percentage of heat gain and loss in residential buildings. *(Decay & Brownthird, 2014)* Parameters governing the heat gain or loss in a building include site conditions, orientation, form, materials, window areas, shading devices, etc. In the era where space is the most important constraint for construction, there are limitations on the building design in terms of its orientation, zoning of spaces, window locations, and sizes, etc. Yet, there are opportunities to improve thermal performance by changing materials used for building envelope. There are many construction

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materials and assemblies which are now readily available in the market and can be easily used for the same, even if people are not willing to go for green building certification. But, in most of the cases cost is the major factor governing the decisions related to materials. Hence it is important to compare cost and energy performance of these materials and calculate payback period.

2.0 METHODOLOGY

The research is carried out in three stages. First stage is to understand current scenario and awareness regarding green buildings and its cost and to identify parameters for the study, from literature and interviews of architects. Literature is referred to identify parameters used in assessing a green building and architects practicing at various locations and of varying age groups were interviewed using online forms. Second stage is to identify materials and assemblies through interviews and market availability. Practicing green building consultants were interviewed using telephonic conversations to identify commonly used green building materials and assemblies and market study is done to check their availability and identify cost. Third stage is to compare various combinations of building envelope assemblies using calculations and software simulations to check whether green construction is always costly, and calculate its payback period.

2.1 Awareness

Practicing Architects from various locations in Maharashtra were interviewed to understand current scenario of awareness regarding green building concepts, certification and its benefits.

Figure 2 Floor plans

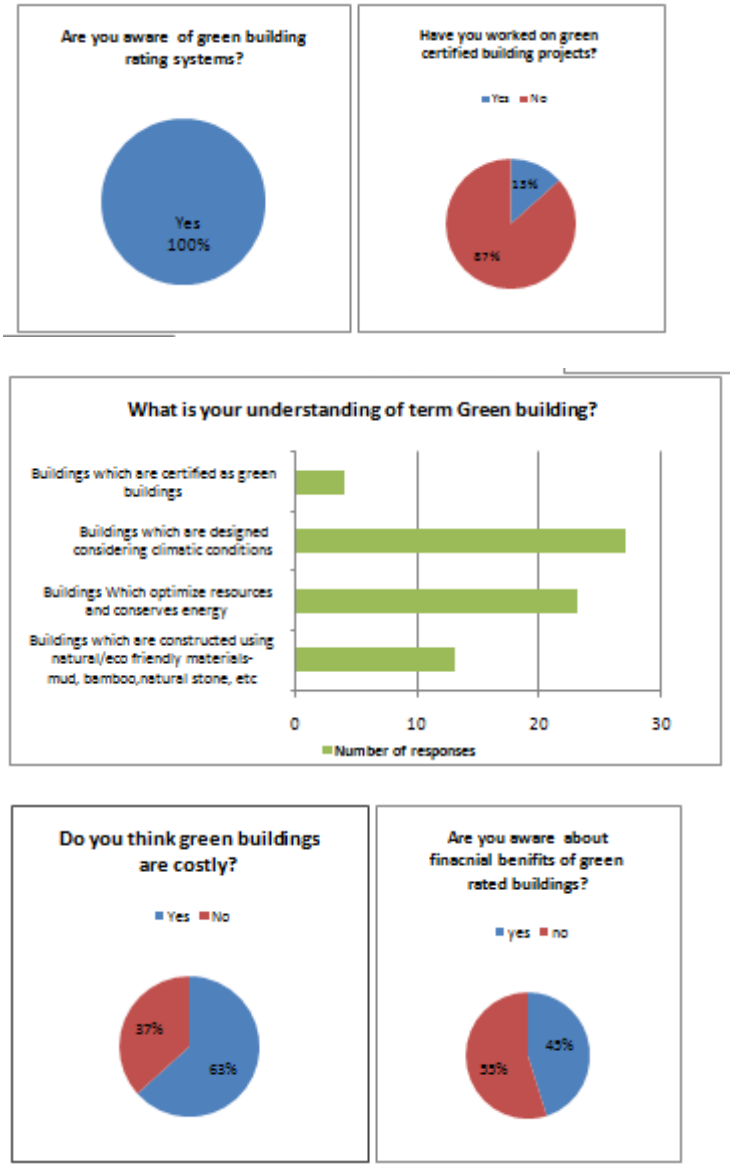

Figure 1 Survey questionnaire results

2.2 Identification of materials and assemblies

Practicing green building consultants were interviewed using telephonic conversations to identify various materials commonly used in Green rated residential buildings. According to them commonly used envelope materials are as follows

- Wall- AAC blocks, Fly ash bricks, Porotherm (in rare cases)
- Roof layers- XPS, PUF insulation, Inverted earthen pots(in rare cases)
- Fenestration- Single glazing, Low E glass, DGU (in rare cases in residential buildings)

2.3 Comparison of cost and energy performance

2.3.1 Case for analysis

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This case is taken for calculating quantities of each material required.
Proposed Bungalow at Aurangabad
Latitude- 19 degree North
Climate- Hot and dry
Ground +1 structure
Site area- 174.25 sq.mBuilt up Area- 159 sq.m.
No. of occupants- 6

2.3.2 Materials and assemblies

Materials and assemblies commonly used in green construction and which are readily available in the market are selected for comparison against conventional ones. Cost per unit of each assembly is identified from market survey and State scheduled rate.

	Conventional	Green building materials			
	Wall				
	Brick	AAC	Fly ash	AAC cavity wall	Porotherm blocks
U value	2.4 W/sq.m.K	0.74 W/sq.m.K	1.23 W/sq.m.K	0.71 W/sq.m.K	1.8 W/sq.m.K
block cost	RS. 6-230*115*75	RS.49-600*200*100	RS. 5-220*110*75	RS. 49-600*200*100	RS. 38-600*200*200
Per unit	6004/cub.m.	6119/cub.m	5412/cub.m.	6119/cub.m	1820/sq.m
labor	1360/cub.m	1662/cub.m	1360/cub.m	1662/cub.m.	466/sq.m
Total	7364/cub.m	7781/cb.m	6772/cub.m	7781/cb.m	2286/sq.m

	Waterproofing/ insulation layers on roof				
	brick bat coba	aac block coba	PUF insulation	XPs insulation	Inverted earthen pots
U value	2.06W/sq.m	1.19 W/sq.m.K	0.34 W/sq.m	0.48 W/sq.m.K	1.8 W/sq.m.K
Material	rs. 700/ cub.m.	Rs.1500/cub.m	2100/sq.m, Vapour barrier-100 /sq.m, , epoxy based waterproofing 350/sq/m	550/sq.m, Vapour barrier-100 /sq.m, epoxy based waterproofing 350/sq/m	
Per unit	937/sq.m	1400/sq.m	2500/sq.m	1100	
labour	482/sq.m	482/sq.m	500/sq.m	400/sq.m	
Total	1419/sq.m	1882/sq.m	3000/sq.m	1500/sq.m	1750/sq.m

	Fenestration			
	Clear- Single glazed unit aluminium frame - 3 track	Clear - Double glazed unit aluminium frame- 3 track	LOW E coating - Single glazed unit aluminium frame- 3 track	Tinted glass - Single glazed unit aluminium frame
Glass U value	5.6	1.9	3.8	5.6
Glass SHGC	0.6	0.25	0.27	0.43
Glass rate	1450/ sq.m	2600/sqm	2250/ sq.m	1800/sq.m
Per unit	4959/sq.m	20450 /sq.m	5700/sq.m	5200/sq.m
Labour	1603/sq.m	-	1603/sq.m	1603/sq.m
Total	6562/sq.m	20450	7303	6803/sq.m

Table 1 Details of materials and assemblies

2.3.3 Calculations and simulations

Total 9 combinations of assemblies are selected for comparison. Total cost is calculated for the required quantity of each assembly and then added together to get total cost of wall, roof and fenestration. Simulations were done for the same combinations considering following conditions-

Rooms which are used for maximum time and where comfort is required in a residential unit are air conditioned include- Living Room, All the bedrooms and study room.

1. As temperatures are above comfort temperature (20.3 – 26.7 degC for Aurangabad) for maximum time, Simulations are done for air conditioned

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rooms in order to derive energy consumption for cooling.

2. Comfort temperature range -20.3degC to 26.7 degC (above or below this range HVAC system is used for achieving comfort)
3. Design humidity- 40%
4. No of people= 6
5. Clothing index= 0.6
6. Illumination Levels=150Lux
7. Air conditioning system –Individual Room unit
8. Air conditioning system efficiency= 90% *(NA, ASHRAE standard 55 and current handbook of fundamental model, 2013)*
9. Operation schedule for various rooms is set as per the usage

Payback period is calculated based on difference in cost of conventional and green material assemblies and cost saving due to reduced energy demand.

3.0 RESULTS

3.1 Awareness

From the survey responses it can be inferred that all of the respondent architects are aware about term green buildings and about green building rating systems. More than 60% of the respondents think green construction is costly and the reason for additional cost is material and fixture cost and certification process both. More than 50 % of the respondents are not aware about financial benefits of green buildings. It is observed from the responses that respondents practicing in Class B and Class C cities like Aurangabad, Yavatmal, Kolhapur are not aware about financial benefits of green buildings.

3.2 Calculation and simulation results

The table indicates the assembly, total cost of wall, roof and fenestration and annual energy consumption when that assembly is used in the construction.

Assembly	Wall	Roof insulation	Fenestration	Total Cost of Wall, Roof, Fenestration in INR	Annual energy consumption in kWh
1	Brick	Brick bat coba	Clear single glazing	601566.95	14418.917
2	AAC	AAC bat coba	Double glazing	1087130.40	7104.19
3	Fly ash	Inverted earthen pot	Low E coated single glazing	630183.51	10074.946
4	Porotherm	PUinsulation	Tinted single glazing	824549.95	13182.035
5	AAC cavity wall	XPS insulation	Low E coated single glazing	673100.36	6541.804
6	AAC cavity wall	PUF insulation	Double glazing	1234259.83	6119.746
7	Porotherm	Inverted earthen pot	Tinted single glazing	729524.95	14002.825
8	Fly ash	Inverted earthen pot	Tinted single glazing	613178.51	13834.815
9	Porotherm	PUF insulation	Double glazing	1288684.42	11849.467

Table 2 Calculation Results

The analysis indicates that for some cases, there is hardly any difference in per unit cost of construction in comparison to conventional building envelope assemblies.

Following Graph indicates annual energy consumption of various combinations of building envelope assemblies, when they are arranged in ascending order of initial cost per unit.

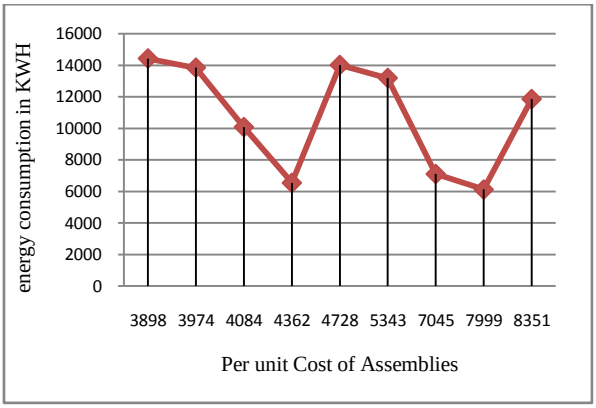

Figure 1 Graph- Per unit cost vs Energy consumption Source- Author

From the graph it is observed that General perception is costlier assemblies might have the best energy performance, but it is not true.

3.3 Payback period

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Assembly	Cost per unit	Annual Electricity consumption	Monthly average consumption	Cost of electricity	Energy cost saving per month	Payback period in months
	(Rs/sq. m)	(kWH)	(kWH)	Rs	**Rs**	Months
Conventional	3898	14419	1202	15020	-	
2	7045	7104	592	6808	8212	59
3	4084	10075	840	9655	5365	5
4	5343	13182	1099	13731	1288	173
5	4362	6542	545	6269	6269	11
6	7999	6120	510	5865	8750	72
7	4728	12003	1000	12503	2517	51
8	3974	13835	1153	14411	608	19
9	8351	11849	987	11356	3664	188

Table 3 Results of payback period calculations

From the analysis it can be inferred that the payback period depends on both initial investment and energy performance

Following Graph indicates Payback period of various combinations of building envelope assemblies, when they are arranged in ascending order of initial cost per unit.

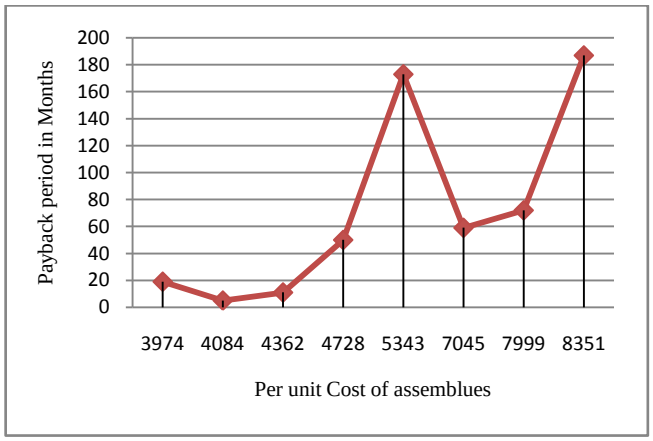

Figure 2 Graph- Cost per unit vs payback period Source- Author

It can be observed from the graph that costlier assemblies will not necessarily have more payback period

4.0 CONCLUSIONS

There is a lack of awareness regarding financial benefits of the green building certification and green building materials. There are green construction materials available in the market which are less expensive than conventional ones. General perception is costlier the better ,but it is not true in this case. Optimization of cost and energy performance is necessary while selecting building envelope materials.

5.0 ACKNOWLEDGEMENT

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Building Envelope Design Components and Its Role for Designing An High-Performance Office Building: A Review

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Abstract: Building envelope refers to as the skin of the structure that separates the indoor conditioned space from the outdoor unconditioned space and it is responsible for most of the energy consumption that occurs in the building. Designing of building envelope and its components plays a very important role to attain energy efficiency of a building & reducing energy consumption without compromising on user's comfort. The aim of this paper is to describe the various components that help to achieve energy efficiency or high performance office building by reviewing the research papers of the past researchers, books, author's guidelines and recommendation as per ECBC for various building envelope components.

Key words – Building Envelope, Office Building, Energy Efficiency, Design components, Materials and Thermal Comfort, Energy Conservation Building Code (ECBC)

I. INTRODUCTION

Building envelope is the outer shell of the building which comprises of walls, windows, roof, opening, skylights which separates the indoor conditioned space from the outdoor unconditioned space of a building. The building envelope acts as a thermal shield which protects the interior and the occupants from the prevailing extremities of climatic conditions. Creating a high-performance building envelope means each component and design element is designed to minimize the transfer of thermal energy, which in turn creates an energy-efficient building. The main goal of energy efficient building envelope should be to minimize the heat loss in winter and heat gain in summer. As in today's scenario of the contemporary office building visual comfort, thermal comfort, and physiological comfort are the major concern while designing and office space.

About 39% of energy consumption has been residential and commercial sectors. Out of this consumption, HVAC (Heating, Ventilation, Air Conditioning and Cooling) systems was 39%,lighting 25%,office equipment 22%, domestic hot water 1%,lifts 4%,others 9%.HVAC system contributed to most usage of energy. The amount of energy that HVAC systems consume depends on many factors such as the building location, climate, temperatures during the day and night, timing of the use of the spaces, building envelope, material, U- Value, windows and insulation, etc.Energy conscious design considering the prevailing climatic conditions , help the building occupants and the owner's to reduce the operating costs, improve the comfort of the occupants be it visual comfort, thermal comfort , physiological comfort which directly have an impact on the work output of the user's.

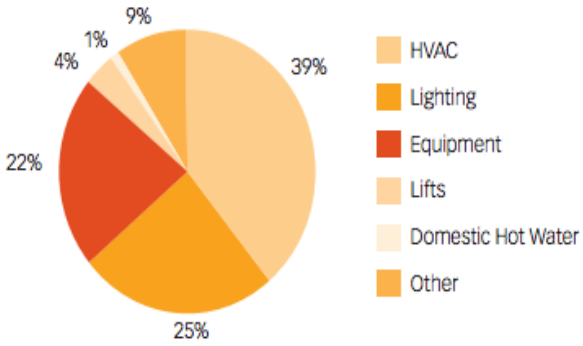

Fig 1 Typical Energy Consumption In An Office Building.

II ROLE OF HIGH PERFORMANCE BUILDING ENVELOPE OFFICE BUILDING

With the current rate in urbanization and subsequent increase in energy demand, energy efficiency in building has a significant role to play in contributing to energy security in developing countries. There has been a tremendous growth in IT Sector, resulting in corresponding growth in commercial floor space. The commercial building sector currently contributes to about 695 million sqm , a growth of 5% to 6% per year commercial building space growth is expected to reach to about 1932 million sqm by year 2030.

Energy consumption can be reduced by energy consumption measures taken during the design phase. Energy consumption measures are approached through which energy consumption of a building can be reduced while maintaining or improving the thermal comfort in the building. They can be categorized into

•Reducing heating and cooling demand;

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•Reducing the energy requirements for ventilation and use of
HVAC system;
•Reducing energy use for lighting;
•Reducing electricity consumption of office equipment and appliances, heating water for domestic uses.

The designing of building envelope components with respect to climatic condition plays a very important role. By improving the building envelope, the energy demand can be reduced.HVAC systems are electrically driven and have a significant impact on green house effect. The use of passive solar design can have a great impact in reduction of energy consumption. In passive solar designed building the building components collect, store and distribute the solar energy in the form of heat in winter and reject solar heat in summer.

ECBC encourages energy efficient building systems such as building envelope, lighting, heating ventilation and air conditioning (HVAC), service water heating and electric power distribution within the building facilities while enhancing the thermal and visual comfort and productivity of the occupants. ECBC recommended measures on improving energy performance of commercial buildings in the five climatic zones of India. High performance buildings in India would be defined as buildings that have integrated low energy/solar passive architectural design strategies and energy efficiency measures as recommended by the Energy Conservation Building Code 2007(iv).

III METHODOLOGY

The review began with the searching of relevant data base and terminology for the high performance building, building envelope design components, factors that affect the performance of the building, role of high performance office building, energy consumption statics. A number of research papers, articles and books were studied with the relevant data. Based on the finding and study from the literature review, case studies a number of finding are been put across that could determine the design components of a high performance building.

The Energy Conservation Building Code (ECBC) of India ECBC recommended measures on improving energy performance of commercial buildings in the five climatic zones of India. Energy saving opportunities, the types of the building envelops components has been reviewed and identified for office building with the help of few case studies.

IV BUILDING ENVELOPE

A building interacts with the environment through its external facades such as walls, windows, projections, and roofs, referred to as the building envelope. The envelope acts as a thermal shell, which if thoughtlessly constructed, would result in energy leaks through every component. Hence, each component needs to be properly chosen to ensure an energy efficient building [i]

V DESIGN COMPONENTS OF A BUILDING ENVELOPE

The building envelope and its components are key determinants of the amount of heat gain and loss and wind that enters inside the building [viii].They primary elements affecting the performance of a building envelope are

BUILDING SHAPE

The volume of space inside a structure that needs to be heated or cooled and its relation with the area of the envelope enclosing the volume affects the thermal performance of the building. This parameter, known as the S/V (surface-to-volume) ratio and it determines the building form. The more compacts the shape of any given building, the less wasteful it is in gaining/losing heat. Hence, in hot, dry, regions and cold climates, buildings are compact in form with a low S/V ratio to reduce heat gain and losses respectively. The depth of a building also determines the requirements for artificial lighting - greater the depth, higher the need for artificial lighting. High performance design should aim first of all to reduce building energy consumption for heating, cooling and electric lighting. In larger commercial buildings there is a greater need for cooling than heating over the seasonal cycle especially with the one with deep floor plates planning. This is due to high occupancy rate and less natural light reaching the interior spaces.

ORIENTATION

The orientation of a building determines its exposure to sunlight. Building orientation should be determined at early design stage, keeping in mind the shape of the building, location, climatic zone. The most preferred orientation and shape in the tropical countries will be elongated along east- west axis, so that the maximum facade is faced to north-south direction. West orientation should be avoided since afternoon the temperature and solar radiation reaches its peak. Also the windows east-west allow maximum heat gain, and increasing the load on HVAC.The planning of the rooms and spaces which require can be done accordingly.

MATERIAL

Improving thermal performance of the building envelope and minimizing thermal bridge is one of the criteria for selection of material. Thermal bridging is an area of a building construction which has higher heat transfer than

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those of the surrounding materials. Material selected should have the least negative impact on the environment. The life-cycle assessment approach determines the environmental impacts of material selection, where material contents, production methods, energy requirements, and waste are analyzed to identify the real cost of a material and its environmental impact. Selecting materials based on the embodied energy data is an appropriate method for considering environmental impacts. The embodied energy is the amount of energy required to extract, process, transport, install, and recycle or dispose of a material [ix].

WALL

Walls are the major part of building envelope and are directly exposed to solar radiation. Building wall generally consists of several layers with different thickness and thermal properties. The combined value of conductance (k) and resistance R-value of each material layers determine the overall thermal properties of the wall, which can be represented by the U-Value The lower the U-Value the better because of the lower thermal transfer (ii).the thickness of the wall and the material can be selected based on the heating and cooling requirements of the building.

Table 1: Opaque Wall Assembly U-Factor and Insulation R-value Requirements as per ECBC

Climate Zone	**Hospitals,hotels,call centre's(24-hours)**		**Other Building Types(Daytime)**	
	Maximum U-factor of overall assembly (W/ m²-K)	Minimum R-factor of the overall assembly (W/m²-K)	Maximum U-factor of overall assembly (W/ m²-K)	Minimum R-factor of the overall assembly (W/m²-K)
Composite	U-0.440	R-2.10	U-0.440	R-2.10
Hot And Dry	U-0.440	R-2.10	U-0.440	R-2.10
Warm And Humid	U-0.440	R-2.10	U-0.440	R-2.10
Moderate	U-0.440	R-2.10	U-0.440	R-2.10
Cold	U-0.369	R-2.20	U-0.352	R-2.35

FENESTRATION

Fenestration of the building is significant with respect to energy efficiency and aesthetic. A better combination of glass & solid, shading, reflectance, view, solar control affect the overall consumption, occupants well being, health comfort and productivity. While choosing Fenestration material properties should be taken into consideration such as U-value, SHGC and visual transmittance. In today's time a lot of new products with new advances in building technology allow transparent glazing with defense against solar heat gain. The spaces between the glasses can be filled with inert gases to low the U- Value of the unit. Low-e, reflective coating can be applied to glass to reduce the heat gain. Window to wall ratio (WWR) is another important characteristic, the ratio of glazed to opaque area. It plays a very significant role in determining the energy consumption of the building. The reduced amount of WWR i.e. less percentage of glazed façade with respect to opaque facade improves the energy efficiency.

ROOF

Roof is the most important building envelope component in modifying the heat again, ventilation &daylight as it is directly exposed to the solar radiation. Roof material should be decided considering the climatic zone. In hot region roof should be properly insulated to minimize the heat gain. Few Insulation techniques are earthen pots/filler slab, covering the top layer of terrace with china mosaic tile, green roof, and white wash of the roof during summers.

Table 2: Roof Assembly U-Factor and Insulation R-value Requirements as per ECBC

Climate Zone	**Hospitals,hotels,call centre's(24-hours)**		**Other Building Types(Daytime)**	
	Maximum U-factor of overall assembly (W/ m²-K)	Minimum R-factor of the overall assembly (W/m²-K)	Maximum U-factor of overall assembly (W/ m²-K)	Minimum R-factor of the overall assembly (W/m²-K)
Composite	U-0.261	R-3.5	U-0.409	R-2.10
Hot And Dry	U-0.261	R-3.5	U-0.409	R-2.10
Warm And Humid	U-0.261	R-3.5	U-0.409	R-2.10
Moderate	U-0.261	R-3.5	U-0.409	R-2.10
Cold	U-0.261	R-3.5	U-0.409	R-2.10

THERMAL COMFORT

Thermal comfort can be defined as condition of the body that expresses its satisfaction with thermal environment. Thermal comfort is measured with parameters like Dry Bulb Temperature, Air Velocity, Relative Humidity, Wet Bulb Temperature, and Calorific Value.

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THERMAL MASS

In region where the daily temperature swing is high, thermal mass plays an important role as the heat gained during the day time gets absorbed and radiated during the night time.

HEAT AND MOISTURE MOVEMENT

The transfer of heat follows a basic principle of heat flow from higher temperature to a lower temperature .This takes place with the help of following process

A) Conduction (heat flows between two facade materials in contact with each other)

B) Convection (heat is conveyed by air currents within the facade);

C) Radiation (heat flows as electromagnetic energy through materials and air spaces within the facade);

D) Air leakage (heat is conveyed by air passing through the facade).

Design strategies for controlling heat flow include using a continuous insulation layer, filling air gaps between material layers to prevent conduction, providing a continuous air barrier to prevent heat loss through air leakage, and avoiding thermal bridging. Air leakage can affect a building's overall energy consumption.

DAYLIGHT

The orientation and WWR influence the availability of daylight, illumination requirement in the interior spaces. While designing, the designer should consider the daylight, protection against glare and harsh sunlight, illumination requirement for a workspace. Analyzing daylight during the different seasons is a critical part for high performance building design. Light shelves have been successful and economically viable option .during summer months the direct sunlight is blocked by the light shelves and redirect the diffused light to roof which further reflects to the interior spaces.

GLAZING

Glazing connects the building occupants to the outdoors spaces and affects the visual comfort, thermal comfort of the users. At the same time the use of glass affect the energy efficiency & cost saving of the building in long run. The Selection of glazing, placement of glazing with respect to orientation of the building ,climate zone, WWR(Window wall ratio),U-value, SHGC(Solar heat gain coefficient) and VLT(visual light transmittance) are some of the integral factors to be considered by the designer. Low –E coating can be used with high-level of visible light transmittance and low U-factor &SHGC. Use of double and triple glasses with air in between reduces the transmission of solar radiation.

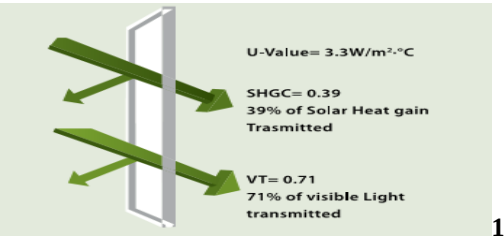
Table 3: Vertical fenestration U-factor and SHGC requirement as per ECBC

Climate Zone	Maximum U-factor of (W/ m²-K)	Maximum SHGC	40%<WWR<60% Maximum SHGC
Composite	3.30	0.25	0.20
Hot And Dry	3.30	0.25	0.20
Warm And Humid	3.30	0.25	0.20
Moderate	6.90	0.40	0.30
Cold	3.30	0.51	0.51

COLOUR AND SURFACE TEXTURE

The nature of the external surface finish determines the amount of heat absorbed or reflected by it. A smooth and light-colored surface reflects more heat and light; a rough textured surface causes self-shading and increases the area for re-radiation. White or lighter shades have higher solar reflectivity and therefore are ideally used for reducing heat gain in warmer climates. Moreover, a heavy texture on these light-colored surfaces helps to reduce the glare. Dark colors absorb more radiation, which increases heat gain through the surface, and can thus be used in cooler regions (i)

VI CASES OF BUILDING ENVELOPE COMPONENTS OPTIMISED FOR ENERGY EFFICEINCY



1. COLLECTOR OFFICE, PUNE

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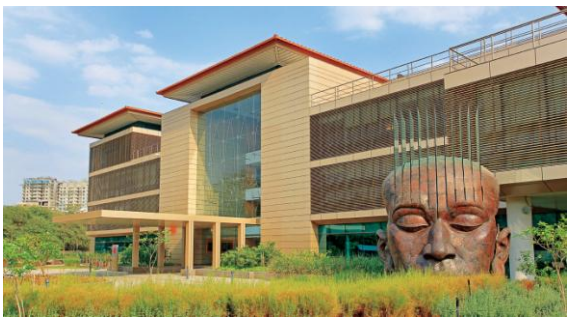
The building is designed based on solar passive &climate responsive strategies. The office consists of 4 masses, wing A, B are placed in such an arrangement to form a semi open plaza with fourth mass, wing C on the top of wing A & B which form the covering to the central plaza.. As major part the building envelope faces east –west the facade is protected with vertical fins to reduce the solar radiation with the use of materials like acc blocks and fly ash providing visual and thermal comfort. Wall assembly U-factor 0.13 Btu/hr, Roof assembly U-value 0.08 Btu/hr, WWR (Window to wall ratio) is 38% with DGU glass having SHGC 0.23 optimized shading device to control the glare and improving the visual and thermal comfort for the occupants and the users

2. HPCC+CCCR, PUNE

The two building, HPCC & CCCR are rectangular form building oriented such that the longer façade of the building faces north and south direction and reduce the heat gain in the building. The building consist of layered envelope – combination of single glazed window and aluminum louvers which help control the heat and wind flow. On the east and west side of the building envelope double layered cavity wall is used to reduce heat load .the external wall composition is of 230 mm fly ash blocks with 30,external stone Crete plaster and 5 mm gypsum finish inside.

3. SUZLON, ONE EARTH

Maximum blocks in the campus are oriented north, south, North West and south east. The curtain walls are of full height, covered with louvers to avoid glare, direct heat radiation & maximize day light .Use of siporex fly ash blocks for obtaining good insulation. The glazing used has a low-e value which substantially reduces the heat gain.



CONCLUSION & RECCOMENDATION

Urbanization and growth of buildings are responsible for use of large amount of resources, energy, and green house emission. Designers should design considering the macro climate of the site , Building envelope & its components to obtain maximum efficiency. There is vast scope in saving energy with the use of climate responsive building design strategies and use of ECBC recommendation.

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I would like to thank my guide Dr.Parag .Narkhede for his support, valuable comments and continuous encouragement throughout the process of researching. This accomplishment would not have been possible without him.

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Life Cycle Energy Assessment : Green Rated Home vs Neo-Vernacular Home

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ABSTRACT: ***The Life Cycle Energy (LCE) of a building comprises mainly of EmbodiedEnergy (EE) and Operational Energy (OE), of which, EE is of utmost importancehaving direct impact on environment and resources. Today, the Green Building Rating Systems are providing a pre-define set of instructions to build Sustainable Buildings. However, in some parts of the country there still exists climate responsive Vernacular Architectural Style, which can be adopted in a new way (Neo-vernacular) by fulfilling the needs of current generation. This paper presents finding of the study conducted to know which among a Green Rated Home and a Neo-Vernacular Homehas greater environmental impact by assessment of EE specific to building construction materials. The results drawn show that the Green Rated Home resulted in high EE as compared to Neo- vernacular home.***

Key words – Life Cycle Energy, Embodied Energy, Building Materials, Sustainable Building, Green building Rating Systems, Green Rated Home, Neo-Vernacular Home

INTRODUCTION

The comparison between a Conventional building and a Green building have been done many times, with results always in favour of green building for low energy consumption(Reddy, Prseeda, & Mani, 2017). But, when it comes to comparison of two buildings, both claimed to be climate responsive and Green Buildings, but are built with different materials and techniques, which one actually consumes less energy is generally not known.

The idea of this study was generated from the same observation to compare between both a Green rated home and Neo-vernacular home through calculation of EE of sample field case study of each type, so as to set a benchmark for future construction of buildings.

In India, the construction sector is responsible for the largest contribution of carbon-dioxide emissions (22%) in the atmosphere. Besides offices, commercial and industrial buildings, more than 20,00,000 residential buildings are built annually. Demand and supply gap for residential buildings is increasing every year (20 million units in 1980 to 40 million units in 2000), **cement** (> 75 million tons per year), **iron** (> 10 million tons per year) and **bricks** (> 70 million tons per year) are the largest and bulk consumption items in the Indian construction industry(Jagdish & B.V. Venkatarama Reddy, 2003).Reducing the use of conventional materials with high EE, by using alternative materials, methods, and techniques with low EE, can result

in scope for considerable energy savings as well as reduction of CO2 emissions.

Today, the building materials in different parts of the world are slowly being replaced by new materials, which are essentially the most affordable in the market but not necessarily environment friendly or low energy consuming.In the construction process, the abandonment of vernacular building methods was first realized by utilization of cheap and abundant concrete and reinforced concrete instead of stone and wood, which were the vernacular structural materials. This is where, there is a need to draw a line and return to natural or hybrid materials that require energy-saving construction techniques with low pollution and low environmental impact. Therefore, the need is to assess EE of the building materials due to excessive use of energy throughout the Life Cycle of buildings.

The following various concepts are discussed in this study.

Green building Rating Systems in India:

Green building rating system like IGBC and GRIHA systems in India are gaining popularity and success over both the conventional and traditional part of construction industry. Therefore understanding their practical approach towards energy consumption and resource conservation is of utmost importance.

Neo-Vernacular architecture:

Neo vernacular or new vernacular is not a new style of architecture but simply a shift in attitude whereby, studying vernacular morphology, structure, technique and materials, a new system can be developed with the help of a professional that is compatible with contemporary reality but pays tribute to the traditional building principles.

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Life Cycle Energy (LCE):

Total energy consumption throughout a building's entire life span is called its Life Cycle Energy (LCE) of a building, mainly consists of its Embodied Energy (EE), the energy required in manufacturing, processing and transportation og building materials, Operational Energy (OE),the energy used to operate a buildingand Demolition Energy (DE), energy at the end of life cycle of a building, which accounts for only about 1% of the total LCE(Praseeda, Reddy, & Mani, 2017).

Today, there is more importance of EE in buildings running on Renewable Energy for operation & maintenance, because in such buildings the OE becomes nearly zero whereas EE increase from 10% - 20% to almost 100% as building material and construction would still need energy for manufacturing, processing and transportation(Praseeda, Reddy, & Mani, 2017).

Literature Case Study:

Four book case studies have been taken from two different research papers. One of them has researched on rural dwellings in India (vernacular architecture)(Reddy, Prseeda, & Mani, 2017)and the other has researched on urban residential buildings in India (Conventional building)(Praseeda, Reddy, & Mani, 2015).

The EE of construction materials of some dwelling units from the literature study are shown in table 1 below.

Table 1 EE Assessment of Literature Case Studies

Literature Study Analysis		
	Materials Used	**EE (MJ/m² of built up area)**
Rural Dwelling study 1	Adobe + Mud roof + Tin sheet	170
Rural Dwelling study 2	Adobe + Burnt Clay bricks + Tile Roofing	510
Urban Dwelling study 3	AAC blocks + R.C.C. slab	1027.16
Urban Dwelling study 4	FALG Blocks + R.C.C. Slab	1131.82

The results from literature study shows that Case Study 1 & 2 i.e., rural dwellings made of traditional building materials (like adobe, mud roof etc.) requires nearly **half the EE** of case study 3 & 4 i.e., urban dwellings made of conventional materials (like R.C.C).

METHODOLOGY

A detailed survey and field study of a Green Rated Homes in Pune and a Neo-Vernacular Home in Pune was carried out. The detailed survey questionnaire and observation list was prepared, which included personal interviews of Architect of the house, to understand the materials and design strategies of the house. The detailed sections of wall, roof, and slab were drawn, detailing every material used for construction of building.

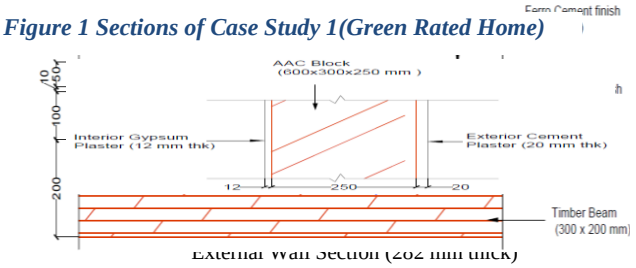
The measurement drawings for case study 2 (neo-vernacular home) were generated using AutoCAD, unlike Case study 1 whose readymade drawings were made available from the resident.

EE Assessment:
The EE assessmentwas carried out in following three steps:

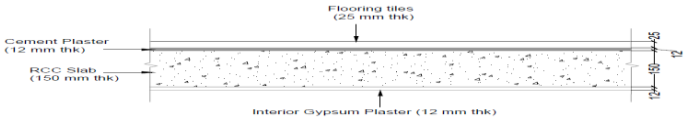
Step 1: A Bill of Quantities (BOQ) was prepared for all slabs, doors, windows and walling material of both the sample houses.

Step 2: Detailed sections of walls, slabs and roofs were prepared mentioning every material used in their construction as shown in fig. 1 and 2 below. Then total EE of each individual material was estimated as a product of EE of material and total quantity of material used in units m² (Area) or m³ (Volume) or Kg (Weight), depending on the material and its application.

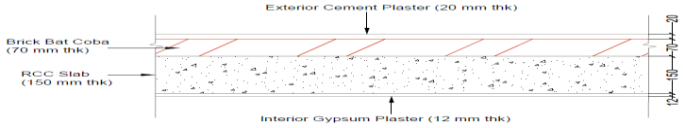
Figure 1 Sections of Case Study 1(Green Rated Home)



External Wall Section (282 mm thick)



Floor slab Section (200 mm thick)



Roof Section (252 mm thick)

Figure 2 Sections of Case Study 2 (Neo-Vernacular Home)

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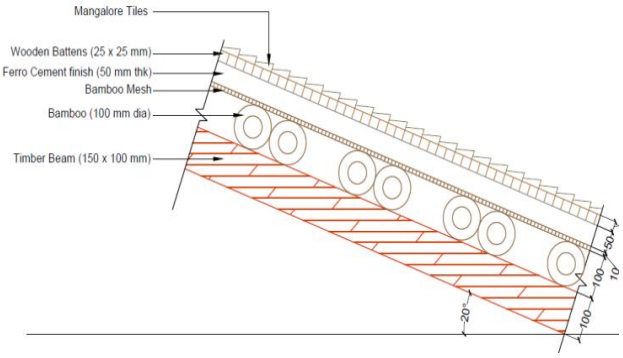
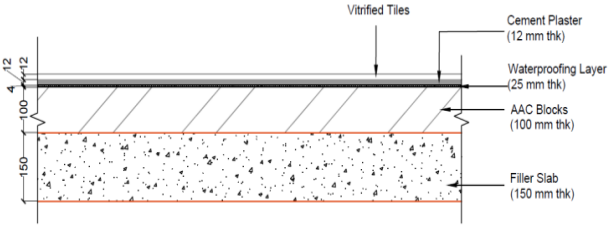
First floor Slab Section (360 mm thick)



Sloping Roof Section (285 mm thick)



Toilet floor Section (278 mm thick)

Step 3: All the value from step 1 are added up and the sum (in MJ) is divided by the total built up area (in m²) of the respective building, to get the final value of EE of the building expressed in MJ/m² of built up area. The reason for acquiring the final value as in units of MJ/m² of built up area is because the scale of all Field case studies might not be the same, so to compare the final values of EE, the total value needs to be break down to per unit area of built up.

The EE of all relevant materials observed in case studies has been taken from research journals (Jagdish & B.V. Venkatarama Reddy, 2003)(Deepak, Singh, & Sawhney, 2013)(Reddy, Prseeda, & Mani, 2017)(Reddy, Prseeda, & Mani, 2017). The EE used here is inclusive of the Energy used during various phases of manufacturing, processing, transportation (within 50km and within 100km).

Table 2 EE Assessment of Field Case Studies

Material	Measurement Unit	EE (MJ/Unit)	Quantity of Material	Total EE (MJ)
Case Study 1 (Green Rated Home) - Built up 742 m²				
AAC Block	m³	255.55	217.50	55582.13
Cement plaster	kg	6.7	18963.89	127058.08
Gypsum Plaster	kg	1.8	53037.04	95466.68
Cement Mortar	m³	1268	10.44	13237.92
Brick Bat Coba	m³	2515	13.40	33695.97
RCC	m²	730	933.50	681455.00
Glass	kg	25.8	293.16	7563.56
Painting	m²	29.06	1493.16	43391.23
EE of Home				
Case Study 2 (Neo-Vernacular Home) - Built up 200 m²				
Adobe	m³	51	81.81	4172.16
Cement soil Mortar	m³	849	5.45	4630.28
Mud Plaster + Lime rendering	m²	0.87	40.90	35.59
Cement plaster	kg	6.7	1207.90	8092.96
Ferro cement	m³	158	8.133	1285.01
Bamboo	kg	1.5	3409	5113
Glass	kg	25.8	104.46	2695.02
Mangalore Tiles	m²	227	83.66	18990.82
Timber (Flooring+Battens)	kg	3.06	2030.00	6211.80
Burnt Clay Brick	m³	2515	8.962	22539.43
Filler Slab	m²	590	148.11	87384.90
Mud Flooring	m²	0	108	0.00
AAC Block	m³	225.55	3.5	789.43
EE of Home (MJ/m² of built up area)	**809.75**			

RESULTS AND DISCUSSION

Results from Live Case Study are discussed below:

In Case Study 1 i.e., the house constructed on Neo-vernacular principles made use of local materials (like Bamboo) and on-site production of materials (Like Adobe blocks) has consumed nearly **half the EE** of the Case Study 2 i.e., Green Rated Home, constructed of some modern materials with recycled contents (Like AAC Blocks) and some conventional materials (like R.C.C slabs). Although, AAC blocks requires much less energy for production, but the overall energy consumption along with other materials in the Green Rated home have much higher EE.

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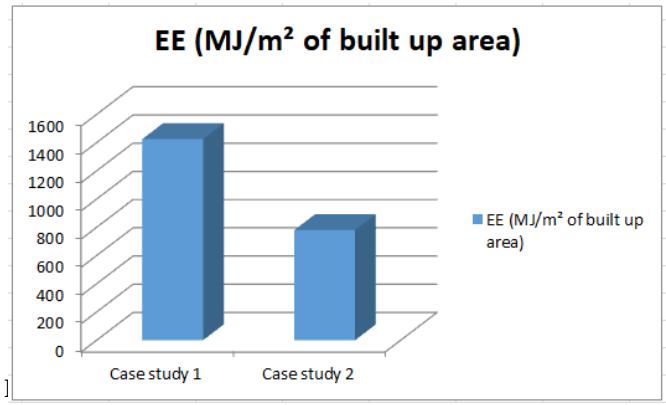
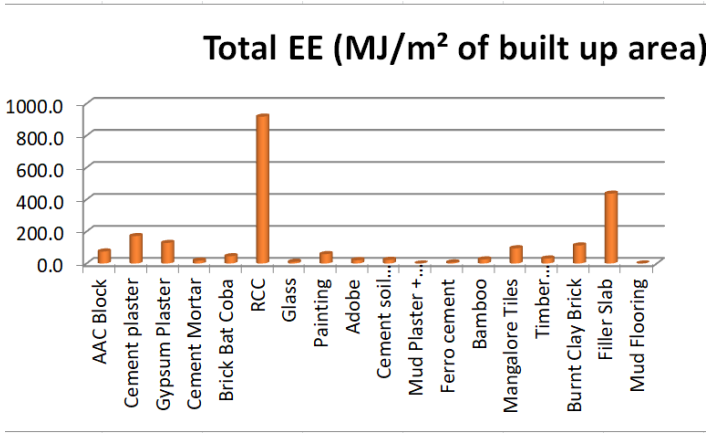
Figure 3 below shows the graphical representation of field study analysis.

Figure 3 Field Case Study Analysis



Thecomparison between EE of each material used in construction of the buildings of both field case studies carried out, is shown in the graphical representation in the given figure 4 below.

Figure 4 Total EE of all materials used



Results:

The result drawn from the (*figure 4)* shows that RCC(918.4 MJ/m²) in a high-energy intensive material which can be substituted by filler slab(436.9 MJ/m²) which consumes nearly half its energy. Among walling materials burnt clay bricks requires comparatively more energy than AAC blocks, while adobe blocks consumes the least energy. Other materials like cement plaster, gypsum plaster also have high EE.

Therefore, the traditional and local natural materials (like bamboo, mud, timber, Ferro cement) should be included in building construction more due to very less EE.

The literature and live studies both shows more than 50% of EE reduction in houses built with natural or vernacular materials as compared to houses constructed using the conventional materials.

CONCLUSION

The study conducted shows that the overall EE of buildings mainly depends on the EE of individual materials along with their quantity. The study also concludes that the other low EE alternatives can be used in place of R.C.C., which is high energy intensive.

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Feasibility Of Groundwater Recharge For Maintaining Groundwater Table In Charholi Budruk, Pune

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Abstract: Groundwater is the main source of domestic water requirement in India and its overexploitation has led to water scarcity. Because of rapid urbanization, land uses have changed which is affecting low infiltration rates of rainfall into the soil and has diminished the natural recharging of aquifers. To respond to the growing crisis of groundwater, the artificial recharge of aquifers has become widespread in India. In this paper, the feasibility of Groundwater recharge for the Charholi area was assessed. From literature review, it was found that in rainy season groundwater table in this area is 2-5m but the level goes down up to 10m in the summer season. Case studies from Maharashtra were studied to identify how effective groundwater recharge methods are and which type of methods are suitable in this area and also the relation between recharge methods, geographical conditions and topography are studied. The research paper gives various methods for groundwater recharge in Charholi area.

Key words – Groundwater, artificial recharge, water table, Charholi

I. INTRODUCTION

The main resource which is needed to survive on earth is Water. Only 3% of the world's water is freshwater and the problem of water scarcity is worldwide. Groundwater is the major source which is used for domestic purpose. In the last three decades, exponential growth in the number of groundwater structures has been observed. This has lead to an enormous withdrawal of groundwater for various uses of agricultural, industrial and other domestic needs (CGWB,2011). Increased use and limited recharge have contributed to the lowering of the water table (Ramaswamy, 2007). Groundwater recharge is a hydrologic process**,** where water moves downward from the surface to the underground. There are two types of Groundwater recharge-

1. Natural Groundwater recharge- through rainfall, water bodies like lakes & rivers. The natural replenishment of groundwater reservoir is slow.
2. Artificial Groundwater recharge- The term artificial recharge refers to the transfer of surface water to the aquifer by human interference. Therefore, any man-made structure which adds water to an aquifer is called as artificial recharge. Artificial groundwater recharge is becoming increasingly important in India, where over-pumping of groundwater has led to underground resources becoming depleted.

Recharge is an important process for sustainable groundwater management since the volume-rate abstracted from an aquifer in the long term should be less than or equal to the volume-rate that is recharged (Ajoy Mishra). An aquifer is a geologic formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs. There are generally two kinds of aquifers. 1. Unconfined Aquifers- It also called a water-table aquifer, which is an aquifer that has the water table as its upper boundary. Unconfined aquifers occur near the ground surface.

2. Confined Aquifers- A confined aquifer is an aquifer that is bounded above and below by confining beds. Confined aquifers generally occur at significant depth below the ground surface (Molly Maupin & Nancy Barber, 2000).

As cities grow urban area expands geographically, characterized by impervious surfaces like roads, pavements and buildings. Rapid development and construction in these areas result in the loss of greenspaces. This decreases the cities capacity to absorb water, decreases groundwater, causes urban flooding, worsens the status of wetlands, disturbs the entire hydrological cycle and ecological area. Proper pre-planned groundwater management in urbanizing areas can save these areas from water scarcity in the future hence preplanning of artificial recharge methods is important in Urbanizing areas.

II. THE STUDY AREA

According to 2011, the Census of India, Pune district is the fifth urbanized district in Maharashtra state. Rapidly increasing population in the Pune city is creating a burden on natural resources like water. Pune city and its neighboring villages which are urbanizing are already facing water scarcity problems. The study area is Charholi Budruk, an ancient village near Alandi, in Pune district adjacent to Pune city. Charholi lies in the southern bank of the Indrayani river with 1752 Ha. Area. The main occupation of people living in Charholi Bk. is farming and water used for farming is from wells hence, maintaining

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the groundwater table is very important in this village. The annual rainfall in this area as per IMD is 757mm. As per the Water Resources Information System of India depth of Post monsoon water table in Charholi is in between 2-5m. whereas, post monsoon water table goes down up to 10m (Fig 1).

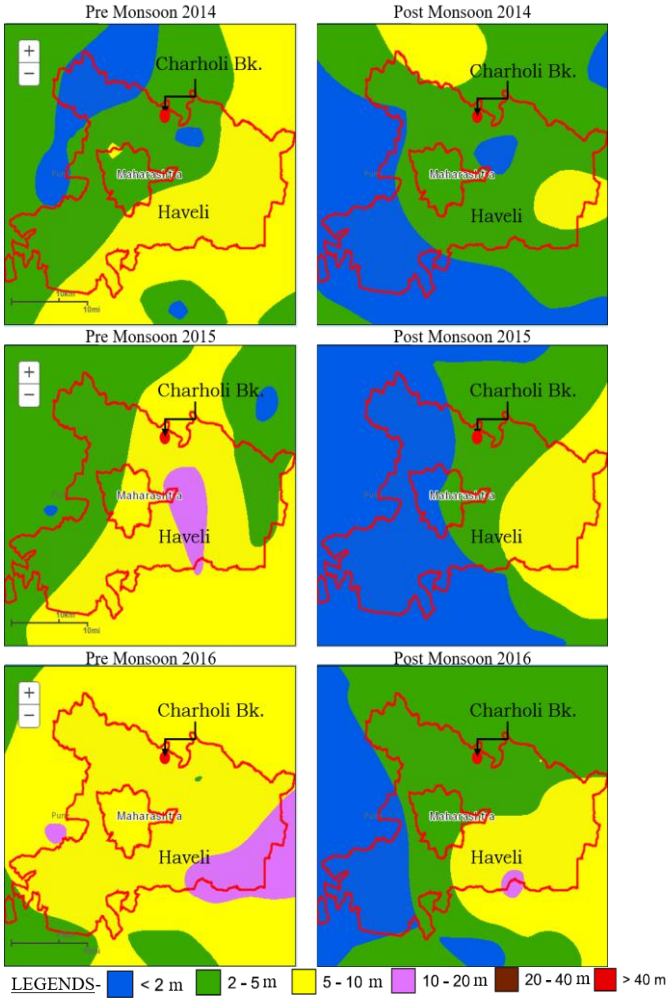

Fig 1. Haveli taluka groundwater table

III. METHODOLOGY

In the present study, the groundwater table of Charholi Bk. is assessed by studying the pre- and post-monsoon groundwater level maps from WRIS India and rainfall data for the years 2014, 2015 and 2016. Maps of soil type & geology of the area are collected and relation with the groundwater is studied. Also, the prioritization map by Groundwater survey & development agency is analysed with the other two maps. The topography of the land is identified by site visits and the slope of terrain is identified from google earth software. The watershed area is identified from GIS software. Approximate groundwater recharge capacity has been calculated based on case study & recharge methods used.

IV. DATA COLLECTION & FINDINGS

A) RELATION OF GEOLOGY, SOIL AND GROUNDWATER

Geology is the science which deals with the physical structure and substance of the earth, their history and the processes which act on them. Understanding geology while studying groundwater is important. Rock type controls the depth and degree of weathering as well as controls the types of water-bearing discontinuities that may be formed in the bedrock, they also define aquifers locations. Geologic structure influences the distribution, nature, and yield of water-bearing zones by providing the framework along which weathering and possibly stress-relief can occur. The water bearing properties depend upon the intensity of weathering, fracturing and jointing which provides availability of open space within the rock for storage and movement of groundwater. The geology map of the Charholi area shows three types of geology formation- Alluvium, Bushe and Khandala formation.

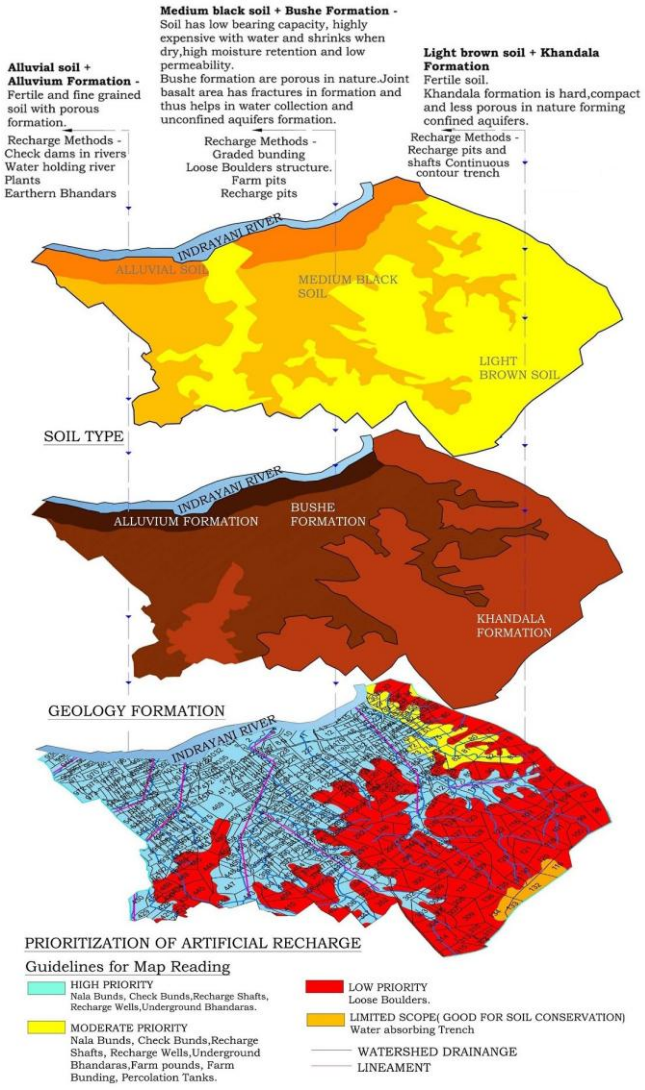

Fig 2. Map of geology, soil & prioritization of recharge

Soil properties play an important role in water infiltration in the ground. For recharging Aquifer, the water has to

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pass through the soil before reaching the water table and the amount of recharge is therefore largely governed by the hydraulic properties of the soil. The amount and timing of runoff from a catchment is also considerably influenced by these hydraulic properties. The soil map of Charholi area shows Alluvial soil along riverside above Alluvium formation, Medium black soil is on Bushe formation in the middle part of the map & Light brown soil on Khandala formation is in the lower part of the map. Alluvial soil & Alluvium formation is rich in minerals and it is permeable with good water holding capacity. Medium black soil has clayey texture, high fertility, good moisture retention capacity hence farming is done mainly on these two types of soil. Bushe formation also has high porosity. Light brown soil & Khandala formation has low permeability as compared to the other two soil types. The soil type also affects the vegetation of the zone and the evapotranspiration cause from the surface.

B) ARTIFICIAL RECHARGE METHODS –

1. WATERSHED MANAGEMENT-

A watershed is a land area that drains to a common point. Normally, rainwater flows out along the natural drainage lines from watershed area.

Watershed management is the process of implementing water management practices and land use practices which helps to improve and protect the quality of the water and other natural resources within a watershed area.

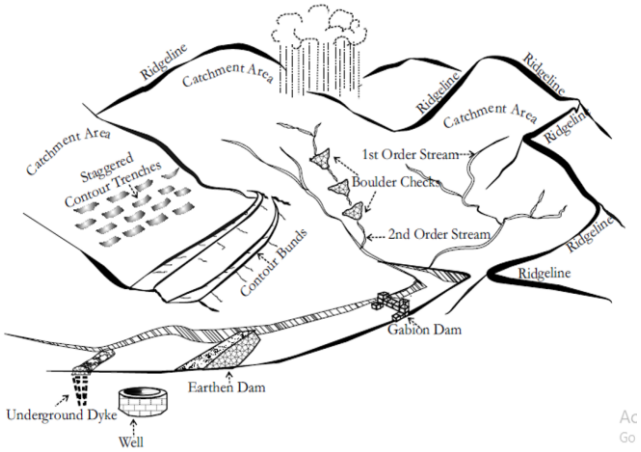

Fig 3. Schematic representation of Watershed management

2. CONTINUOUS CONTOUR TRENCHES

Trenches made on hill slope along contours and perpendicular to the flow of water are called continuous contour trenches.

It reduces the rate of runoff, results in an increase in percolation rate & reduction in soil loss. Which eventually helps in increasing green cover over the area and soil quality. The method is applicable on Slope of 0%-33% and it helps to develop the degraded lands. The Water percolation capacity of one trench having a size of 0.6mx0.45mx30m is 5400 Lit. The CCT is proposed on a hill slope in the area of 1ha.

3. LOOSE BOULDER STRUCTURE AND SMALL EARTHEN BANDARA

A Loose Boulder structure (LBS)and Earthen Bandara is a small barrier constructed of rock, gravel bags, sandbags or reusable products, placed across a constructed swale or drainage ditch. It stops the soil loss. LBS is provided on a slope of 4%-33%. Small Earthen Bandara is provided on a slope of less than 8%. It reduces the rate of runoff, results in an increase in percolation rate. It also helps to develop the degraded lands.

4. WELL RECHARGE-

To recharge aquifer directly, a well recharge is done. Recharge wells are similar to pumping wells. The abandoned tube wells can be used to recharge the aquifer but sometimes the method becomes costlier as wells are required to be bored. Also, flowing surface water and rooftop rainwater can be filtered and allowed to recharge the open wells.

5. RECHARGE PIT FOR AGRICULTURE LAND (FARM PIT)

Unconfined aquifers can be recharged using farm recharge pits. In the agricultural field, mostly the top layer of soil is less permeable. Due to this, the surface flooding methods of recharge do not show satisfactory performance. In such cases, the recharge pit is excavated which is sufficiently deep to penetrate the less permeable strata.

6. AFFORESTATION

Vegetation can significantly impact groundwater recharge due to transpiration and by intercepting rainfall and overland flow; changing land use can therefore, affect recharge patterns. Maximum groundwater recharge occurs at intermediate tree cover in seasonally dry tropical areas. Soil evaporation and surface runoff become high without trees, which leads to low groundwater recharge. Afforestation on hills is proposed.

7. Roof Top Rainwater Harvesting

In urbanized areas where open land is not commonly available, the water from the rooftop can be used for groundwater recharge. Urban housing complexes, historical forts, and institutional buildings generally have large roof areas and can be utilized for harvesting rooftop rainwater to recharge the depleted aquifers.

Methods of Rainwater Harvesting in Urban Cities-

1. Store the rainwater in containers above or above grounds or below grounds;
2. Recharge into the soil for withdrawal later by groundwater recharging basis.

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Any rainwater harvesting will have four elements: - Catchment area, Conduits, Settlement Tank, Recharge facility or storage facility.

C) CASE STUDY FINDINGS-

In the drought-prone Ahmednagar district of Maharashtra lies Hiware Bazaar. In the village of Hiware Bazaar, a rain shadow area with an annual rainfall of 400 mm, the villagers have demonstrated the benefits of artificial groundwater recharge & rainwater harvesting.

Watershed Development Program – Under the comprehensive watershed development program, implemented by Zilla Panchayat, the water conservation structures are constructed in the village given in chart 1. The concept of the ridge to the valley is implemented under the watershed development program. Under this program, various structures constructed like cement check dams, gully plugging, gabion structure, loose boulder structure, nalla bunding, etc.

Rain Water Harvesting and Artificial ground Recharge -

Borewell Blast Technique (BBT) –It is an unconventional method developed by Groundwater Surveys and Development Agency in the village to increase groundwater storage and recharge.

Rain Water Harvesting –A rainwater harvesting structure on the school building and two farm ponds were constructed in the village.

Shallow soak pits were created in the areas where CCT was not possible. This helped in collecting the rainwater and through seepage the water would be available to surrounding plantation. Farm bunds & roadside tree plantations were also taken up with the help of the Forest Department and People Participation.

Water conservation structures of the village						
Sr. No	Type	No	Capacity	Percolated water	Store water	
1	Percolation tank	2	100	10	140	
2	Cement bandhara	4	2	0.4	5.6	
3	Gabbian bandhara	0	0.5	0	0	
4	Farm pond	3	7	1.05	14.7	
5	Earthen Dam	52	0.5	1.3	18.2	
6	CCT	210	Ha	37.8	0	
7	Underground bandhar	0	0.5	0	0	
8	Looze boulder	3035	0.01	1.52	21.25	
9	Kolhapur type bandhara	6	2	0.6	8.4	
Total				52.67	Cr,.ltrs	

Chart 1- Details of recharge methods used in Hiware bazaar

D) SITE MAPS

Site maps of a watershed, the terrain is generated from GIS software and overlapped on one another to find out the suitable locations for artificial recharge.

Fig 3. Overlay map of google earth, watershed, terrain.

V. GROUNDWATER RECHARGE PROPOSAL

After studying Geology, soil, groundwater levels, watershed, terrain and existing built up area following methods are proposed in Charholi Bk. for artificial groundwater recharge. Chart 2 shows the details of water percolation capacity of different techniques and Fig.4 shows the location of proposed recharge methods.

A) WATERSHED MANAGEMENT-

Watershed management is proposed in the Charholi area after studying current land use and watershed maps. Under this management plan following techniques are proposed. The location of these structures is proposed such that it helps in the irrigation of farmland.

1. Continuous contour trenches- This method is applicable on a Slope of 0%-33% hence it is proposed on three barren hill slopes in the area of 10 ha. The Water percolation capacity of one trench having a size of 30mX0.6mX0.3m is 54000 Lit.

2. Loose boulder structure and small earthen bandara- LBS are suitable for a slope of 4%-33 hence 20 LBS are proposed on the first order watershed as the width of the first order is 3-6 m. 24 Small Earthen Bandaras are proposed on second order watershed wherever the slope is less than 8%.

B) Well recharge- It is proposed near the watershed area so that the retained water from the watershed can be filtered in a pit and diverted towards well for well recharge. 20 well recharge structures are proposed with a chamber of size 1.5mX1.5mX1.5m. This will have a total percolation capacity of 4L Lit.

C) FARM PIT-

20 nos. of farm pits are proposed in the farmland of size 2.5 M x 2.5 M x 2.5M which has a percolation capacity of 1 L.Lit and storage Capacity of 15000 Lit. each.

D) Roof Top Rainwater Harvesting-

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Pimpri - Chinchwad Municipal Corporation has made RWH mandatory by enacting building bye-laws. Hence it is mandatory for any new construction to provide roof top rainwater harvesting.

Sr. No.	Type of work	Area/ Nos.	Water Percolation capacity (L. Lit)
1.	Continuous contour trenches	10 Ha	180
2.	Loose boulder structure	20	-
3.	Small earthen bandara	24	-
4.	Well recharge	20	80
5.	Farm Pit	20	20
	Total		280 L. Lit

Chart 2. Details of proposed recharge methods

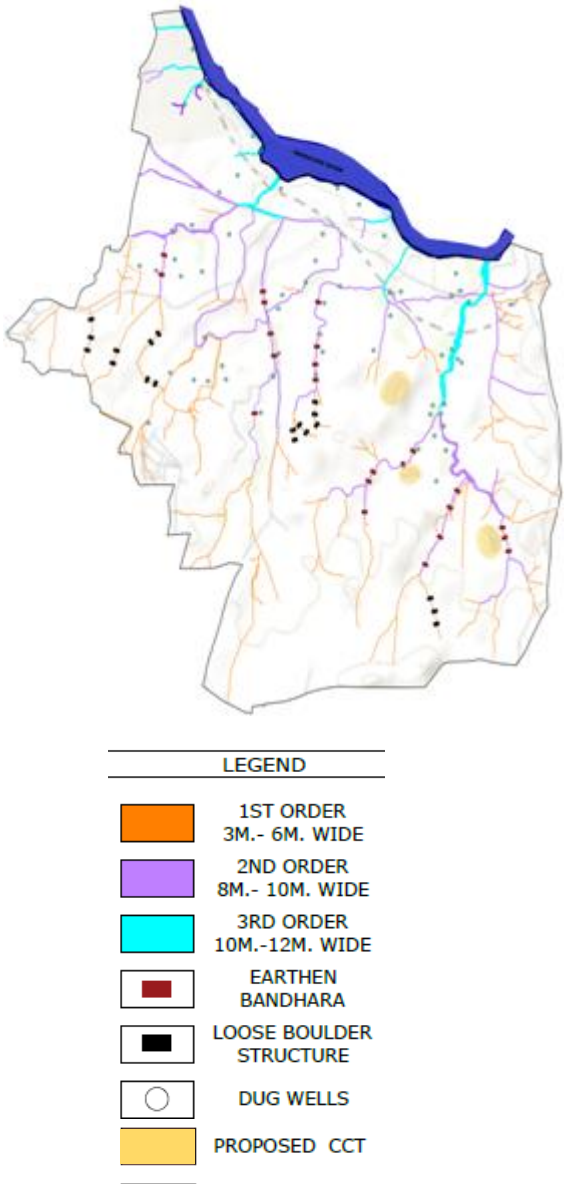

Fig 4. Map with location of proposed artificial recharge methods.

VI. CONCLUSION

The groundwater level of haveli taluka is found to be reducing every year. The various artificial techniques which are used for groundwater recharge are proved to be effective. Since the Charholi area is not completely urbanized, there is a scope of artificial recharge. If the proposed recharge methods are implemented, approximately 280 L lit. water can be percolated.

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Carbon Sequestration by Treesfor Case –Hinjewadi Village, Pune District, Maharashtra State, India

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Abstract : Carbon sequestration involves the capture of CO2 from the atmosphere and storage in the plant tissues in the form of carbohydrate by the process of Photosynthesis. The biomass of the trees also increases and can be computed to know the amount of Carbon sequestered. The sequestrated carbon plays a major role in compensating in ever increasing the pollution. The simultaneous growth in transportation sector has given a rise to various kinds of pollutants, CO2 emission amongst the major one causing global warming.

In this paper, the research will be carried to estimate carbon sequestration by estimation through numeric formulafor calculating species biomass in Hinjewadi village Pune.Total biomass and carbon sequestrated in the tree species have been estimated using non-destructive method.

Keywords: Biomass, Carbon Sequestration, Natural Sink, Carbon emission, Urban streets, Ecosystem.

Introduction

The current environmental disasters like global warming is creating havoc in the behaviour of all the living organisms including man on the earth. Today's global warming is the outcome of lot of unnatural processes taking place since last many decades. Many manmade gases are responsible to disturb the natural form of air and atmosphere. Among all these gases, dominance of Carbon dioxide is mainly responsible for global warming. Maintaining the optimum level of CO2 in the atmosphere is the major challenge in today's modern world FSI (2009).

Trees are most important elements on the earth as they play a significant role in ecosystem dynamics. They absorb carbon dioxide, reduces their level, improve the property value and contribute to aesthetic beauty. The plants are important sinks for atmospheric carbon as they have about 50%carbon dioxide in their standing biomass (Ravindranathetal. 1997). The industrial revolution and increasing urbanization in the modern world are leading to increase the concentrationof different air pollutants especially greenhouse gases (GHGs) *i.e.* Methane (CH4), Nitrous oxide (N2O) and Carbon Dioxide (CO2) in the atmosphere. CO2 is a major contributor to global warming. Thus increasing CO2 emission is one of the major environmental concerns and it has been well addressed in 'Kyoto protocol'.

However, in the modern era due to industrial and technological advancement the vegetation has undergone destruction and degradation by human activities. This development has resulted in emissions of carbon in the atmosphere. Therefore, there is an urgent need to deal with environmental issues. In appreciation of the importance of trees an attempt has been made to study the sequestered carbon in trees of Hinjewadi village of Pune city.

Materials and Methods

Study Area:

The study area is located in Pune. The elevation of the study area is about 580 metres above mean sealevel and situated at 18.5917° N, 73.7456° E. The village islocated in the north-west outskirts of Pune is within the commuting distance from the heart of the Pune City. Hinjewadi village is close to Pune-Mumbai Express Highway.

In this study, the amount of carbon in standing woody biomass of trees in the village was calculated. The random sampling method was used for sampling the above ground vegetation. Plot method is used, which is one of the most commonly used for all kind of vegetation sampling. The method is versatile, cost-effective and applicable to baseline as well as project scenario. "Plot method" is also among the methodologies approved by the Clean Development Mechanism for afforestation and reforestation projects under the Kyoto Protocol. The fig1: shows the geographical image of study area which is Hinjewadi village.

Fig1: The Geographical Image of Study Area

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Methodology: (Sampling Method)

In all 60 plots of 20 m size were laid randomly, measuring the indicator parameters (e.g. tree DBH, or height), using different approaches such as algometric functions to calculate the biomass and extrapolating the value to per hectare and for the total project area.

Tree Height and Diameter at Breast Height (DBH):

DBH can be determined by measuring tree Girth (measurement at middle of tree) at Breast Height (GBH) approximately 1.3 meter from the ground.

Above ground biomass (AGB) of trees:

This including of branches, leaves, flower & fruits. Calculated by the formula:

AGB kg = volume of tree (m3) x wood density Kg/m3

$V = \pi r2H$

V= volume of the cylindrical shaped tree in m3

r = radius of the tree in meter.

H = Height of the tree in meter

Radius of the tree is calculated from GBH of tree.

The density of wood will be providing by the website www.worldagroforestycentre.org/sea/products/AFDbases/WD/.

Belowground biomass (BGB) of tree:

Includes all biomass of live roots excluding fine roots having < 2 mm diameter. The BGBhas been calculated by multiplying AGB by 0.26 factors as the root shoot rati

RESULTS AND DISCUSSION

The present study has calculated the standing biomass of the above ground woody parts of the trees in the Hinjewadi village. Table 1 depicts the species wise carbon sequestration of the study area.

In village 3700 trees of 28 species are present.the total organic carbon of each species in tones and the total organic carbon sequestrated in 3700 trees have been summarized.The organic carbon sequestrated in some common species like Ficus amplissima (221.0 tons). The othermajor carbon sequestrating species were Mangifera indica (95.2 tons), Dalbergia lanceolaria (73.082 tons), Ficus racemosa (57.96 tons), Pongamia pinnata (60.48 tons), Lagerstoemiamicrocarpa (43.0 tons), Syzygiumcumini(41.36 tons), Acacia spp (24.0 tons), Dendrocalamusstrictus (19.5 tons), Memecylon umbellatum (18.6 tons), and Bombax ceiba (11.7 tons). The remaining tree species were having organic carbon content below 10 tons/species. The Gnidia glauca has lowest carbon sequestration potential (0.0808 tons).

CONCLUSION

It can be strongly concluded that during afforestation, tree species like Ficus racemosa, F. bengalensis, Parkia biglandulosa, Swietenia mahagoni, Acacia nilotica, Cassia siameaand Samanea saman should be planted more.

All thesehave a high potential to sink atmospheric carbon which will help to reduce the greenhouse effect. These data are also helpful to estimate the organic carbon stock present in Pune city and forest covers by using a non-destructive method.

ACKNOWLEDGEMENT

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Table no. 1: Field data of trees from study area

Sr No	Name of plant species	Number of individuals	Average GBH (cm)	Average Height (meter)	Average organic carbon (t/individual)			Organic carbon (t/species)
					Above Ground	Below Ground	Total	
1	*Acacia concinna*(Willd.) DC.	10	60.0	15.3	0.266	0.069	0.335	3.35
2	*Acacia* spp	100	62.2	8.95	0.191	0.049	0.24	24.0
3	*Allophylus cobbe*(L.) Raeusch	20	32.0	5.1	0.033	0.008	0.041	0.82
4	Albizia procera (Roxb) Bth.	20	101.0	5.1	0.248	0.064	0.312	6.24
5	*Bombax ceiba* L.	900	20.0	10.2	0.011	0.002	0.013	11.7
6	*Bridelia retusa* (L.) Spreng.	20	56.0	3.4	0.042	0.011	0.053	1.06
7	*Carissa congesta*Wight	20	20.0	6.8	0.012	0.003	0.015	0.3
8	*Catunaregam spinosa* Tirveng	80	32.5	5.46	0.027	0.007	0.034	2.72
9	*Cordia dichotoma*forst.	40	67.5	3.4	0.073	0.019	0.092	3.68
10	*Dalbergia lanceolaria*L.	20	175.0	17.0	2.900	0.754	3.654	73.08
11	*Dendrocalamusstrictus*(Roxb.) Nees	1200	17.8	8.5	0.012	0.003	0.015	18
12	*Diploclisiaglaucescens*Diels	20	36.0	3.4	0.021	0.005	0.026	0.52
13	*Ficus amplissima*Sm.	20	300	20.4	8.770	2.280	11.05	221.0
14	*Ficus racemosa*Sm.	60	140	8.2	0.767	0.199	0.966	57.96
15	*Gnidia glauca* (Fresen.) Gilg	20	20.0	1.7	0.0032	0.00084	0.00404	0.0808
16	*Lagerstroemia microcarpa*Wight	20	132	20.4	1.71	0.44	2.15	43.0
17	*Mangifera indica* L.	140	114.2	8.84	0.54	0.14	0.68	95.2
18	*Memecylon umbellatum* Burm.f.	110	69.0	5.38	0.123	0.032	0.155	17.05
19	*Meynalaxiflora*Robyus	20	120	5.1	0.350	0.091	0.441	8.82
20	*Nothapodytesnimmoniana*(Grah.)Mabb.	40	18.5	2.25	0.0036	0.00095	0.00455	0.182
21	*Olea dioica* Roxb.	20	50.0	1.7	0.020	0.005	0.025	0.5
22	*Osyrisquadripartita*Salzm.exDecne.	60	26.6	6.8	0.022	0.005	0.027	1.62
23	*Pongamia pinnata* (L.) Pierre	140	97.3	6.80	0.343	0.089	0.432	60.48
24	*Stereospermumchelenoides*(L.f.)	20	80.8	8.5	0.258	0.067	0.325	6.5
25	*Syzygiumcumini*(L.) Skeels	220	61.45	7.10	0.15	0.038	0.188	41.36
26	*Terminalia bellirica*(Gaerth.) Roxb.	180	131.34	17.58	1.445	0.376	1.821	327.78
27	*Terminalia chebula*Retz	60	47.33	5.66	0.096	0.025	0.121	7.26
28	*Zanthoxylum rhetsa*(Roxb.) DC	120	32.16	5.66	0.027	0.007	0.034	4.08
				TOTAL Carbon Sequestered:				1038.35 (t)

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Review about traditional courtyard as a micro climate in the improvement of human thermal comfort in hot and dry climate

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Abstract: Courtyards as a traditional strategy were used to create a suitable microclimate for dwellers, but in contemporary architecture, inadequate knowledge of form and features of courtyards makes them deficient to serve the purpose as an element to provide thermal comfort. This paper focuses on traditional courtyard considering them as a micro climate and discusses about the various physical parameters affecting the human thermal comfort such as courtyard geometry, orientation, wind effects and features of courtyards like its height, etc. for hot and dry climate. Each parameter is discussed in detail along with various factors affecting those parameters. The key findings of this research paper are identifying the optimized contemporarily-built environment with the climate based on traditional factors to reach sustainable contextual courtyards the for achieving and improving the human thermal comfort in hot and dry climate.

Key words – Traditional courtyard, microclimate, thermal comfort, physical parameter.

Introduction:

Several studies reported that, in past ten years, the earth surface temperature has increased drastically, and human are facing a heat phenomenon as global warming. This heat creates negative impact on city residents and causes a severe thermal discomfort [i]. Currently, the energy demand for construction industry is 34% of total energy in the world comparing it to global industrial and mobility energy needs, which is also emitting significant greenhouse gas emissions [ii]. Therefore, residential buildings have the major impact in global climate change. Courtyards in residential buildings have a major role in providing thermal comfort and space quality for inhabitants. In various climatic conditions, courtyard control temperature and energy consumption rates in buildings. Hence, courtyard is considered as a heart of the house in hot and dry climate. Courtyard must be compatible with environment and act as a temperature regulator and microclimate in spatial structure [iii]. But in contemporary architecture, inadequate knowledge of form and features of courtyards makes them deficient to serve the purpose as an element to provide thermal comfort.

This paper focuses on traditional courtyard considering them as a micro climate and has compiled the literature review of research papers which had discussed about the various physical parameters affecting the human thermal comfort such as courtyard geometry, orientation, wind effects and features of courtyards like its height, etc. for hot and dry climate. Each parameter is discussed in detail along with various factors affecting those parameters. The key findings of this research paper are identifying the optimized contemporarily-built environment with the climate based on traditional factors to reach sustainable contextual courtyards for achieving and improving the human thermal comfort in hot and dry climate.

Research Method:

In this paper quantitative type of research method is used to address the theme by using combination of simulation and experimental results derived from various case studies available in the literature. This paper is an attempt to review about the various physical factors affecting the human thermal comfort for traditional courtyard like direction and orientation of the courtyard, wind speed and courtyard height, solar radiation, vegetation and albedo. These factors are addressed one by one along with related articles along their significance from which the results and conclusions are drawn as discussed below.

Literature Review:

The history of courtyard uses, and its application goes back thousands of years and extends across different parts of the world. Courtyards are the microclimate transformer in the house due to their capability to moderately maintain high temperature, wind breeze and adjust the relative humidity. Various design elements of courtyard such as size, shape, details, proportions, and surrounding wall vary based on hot and dry climate. These variations arise from various external factors like social, economic, cultural and environmental factors [iv]. The courtyards not only serve the purpose of social economical gatherings, but also, they induce the source for airflow and maintain the thermal comfort to inhabitant. Also, the thermal lag and the properties of self-shading are used to reduce the heat gain. The courtyard surrounding walls and floor is a very good

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radiator of heat depending on the material used. Thus, the courtyard provides a cool air especially in hot and dry climates where the clear sky condition and maintains lower temperature in the court [v]. To understand the environmental conditions and performance of courtyard, in context to microclimate, various physical factors like orientation, direction, height of courtyard, wind speed, vegetation and albedo (reflection) which are affecting the level of human thermal comfort are reviewed and key findings are reported below.

Physical Factors:

Direction and Orientation of Courtyard

Zamani et al [vi] in his article investigated the effect of a building's orientation on the level to which thermal energy is received along with the effective internal heat, by performing simulations in three traditional houses. The results (as shown in figure 1) clearly indicates that the northern front -among the other parts- always has received the highest radiation and the lowest internal temperature.

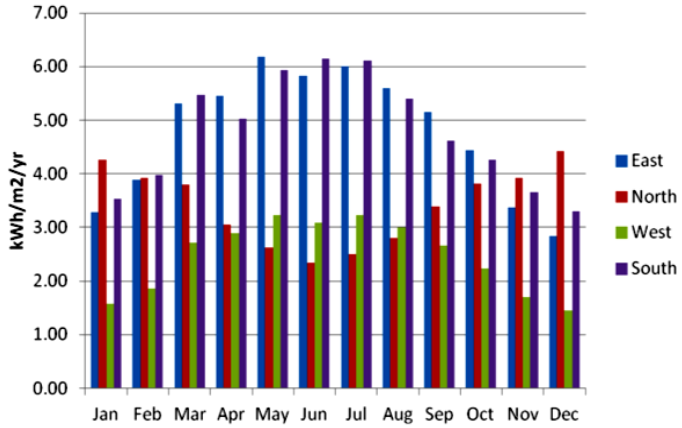

Figure 1: The average heat energy per square meter in four dimensions [6]

Totally in the three houses, the eastern and western fronts show the highest received solar gains per year (relatively 23.4 and 23.8 kilowatt per hour in square meter). While the northern front with 23.2 kilowatt per hour in each square meter always shows the most ideal climatic condition. This information provides ideal concepts and innovative procedures while selecting types of courtyard in planning architecture designs. Furthermore, it is clear that if the construction length is eastern to western side and also if less width is allocated to the eastern and western sides, the most efficiency would be gained from the courtyard. Soflaei et al [vii] concluded that appropriate courtyard orientation considered as North West –South East with 10-45-degree tilt (as shown in figure 2a) or East - South direction, but the longitude / latitude should be taken care of concurrently. For dimension and proportion, that length to width ratio of courtyard varies between 1.09 to 1.68 and for courtyard walls and windows, the opening on north and south has been focused more as compared to east and west, the maximum opening is given on north (as shown in figure 2b) and in some cases it is 94 % but normally it varies between 17 -33 % average. Muhaisen et al [viii] concluded that for hot dry region the optimized courtyard ratio should be between 4 - 8. Courtyard ratio is defined as the courtyard which allows maximum amount of radiation in winter and minimum in summer. It is also found that rectangular orientation of courtyard is best for hot and dry climate. In hot dry area the longer axis should face in between NE-SW to N-S as shown in figure 3.

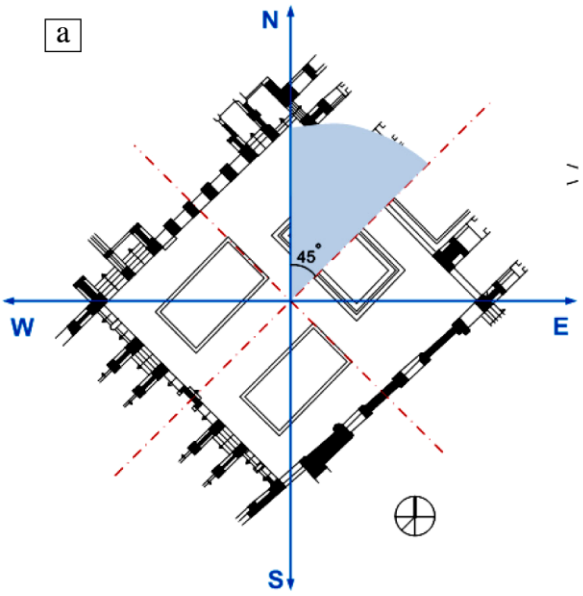

Figure 2a: Orientation and rotation angle of the courtyard [vii]

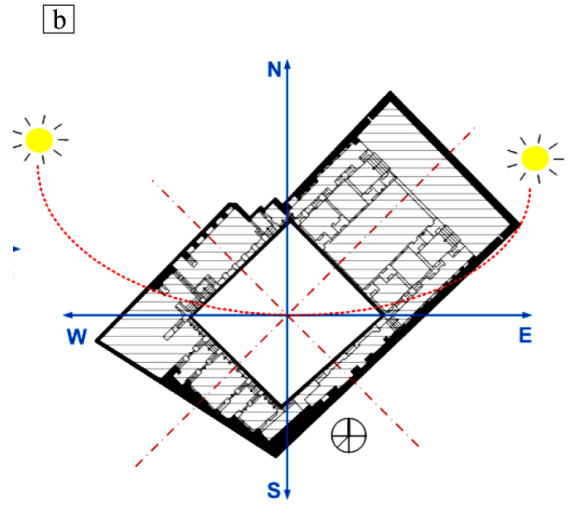

Figure 2b: Orientation and rotation angle of the house [vii]

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Soflee et al [ix] made an environmental analysis of courtyard in traditional Iranian houses. There are many criteria for evaluation such as symmetry between solid space (occupied space) and void space (courtyard space), the rotation angle and extension direction, the proportion related to physical bodies of courtyard such as earth and water, proportion associated with dimension of courtyard, symmetries of opener in artificial bodies (openers in four elevations) and symmetries of artificial bodies (quadruple elevation of courtyard). It is being concluded that in all courtyards the occupied space to unoccupied space (courtyards) is 60:40%, the proportion of northern surface is around 37 %, southern surface 33 % and rest is eastern or western surface, orientation mainly depends on wind direction, the proportion of water is around 10 % and earth is 20 %. The opening on north surface 22%, southern side 28% and eastern, western side is 39 %.

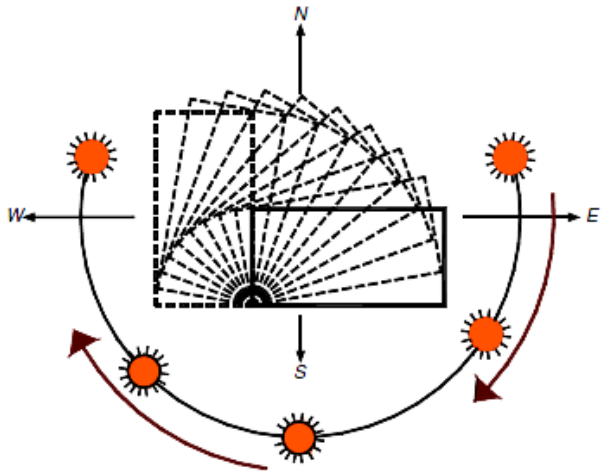

Figure 3: Changing the orientation of the courtyard form from 0^o to 90^o [8]

WIND SPEED AND HEIGHT OF COURTYARD

Almhafdy et al [x] identified that the orientation of courtyard is directly proportional with the ventilation and wind speed, such that the direction of wind and speed to the courtyard causes a decrease in temperature of 1.5 degree Celsius. Al-Masri et al [xi] reported that the building direction and determination of appropriate orientation of courtyard is the major parameter for maintaining an optimal thermal comfort in courtyard. The orientation and height of the perimeter wall surrounding the courtyard have substantial effects on the thermal conditions of the courtyard and the adjacent spaces. Jamei et al [xii] identified the optimal orientation of courtyard varies according to the various climatic conditions and the need for the need for the varying extents of radiation absorption and reception of heat from the sun, as well as the degree to which a building needs to be shaded or needs to receive optimal levels of wind. Yasa et al [xiii] described courtyard forms affecting the energy performance and thermal comfort status in different climatic regions hot –dry, hot –humid and cold climate. The research is being carried through CFD (Computation Fluid Dynamics). CFD is a simulation tool to calculate the convective heat transfer through building surfaces. The stimulation is done by varying the height of the courtyard H, 1.5H, 2H, 2.5 H options. It is concluded that gaining solar radiation in winter is more critical then escaping the heat in summer, required energy demand is parallel to its length, in case of square the energy demand is less, annual energy consumption increases as the courtyard building shape gets longer as a direction of prevailing wind.

SOLAR RADIATION

Hussein et al [xiv] proposed a methodology to maximize the solar radiation in winter and reduce the solar radiation in summer. The study conducted for three traditional houses for direct solar heat gain and shading (21st June and 21st December) in courtyard on walls, floors and openings. It is being concluded that the projection and enclosure ratio have major effect on increasing shaded area. The average height in all courtyards does not exceed 1.5 times the width of courtyard except one case. Each façade of the courtyard has its own design, opening ratio and arrangement as per solar radiation, the north façade has maximum opening. Tubes et al [xv] analyzed the shape of courtyard in determining the energy consumption. Circular form courtyard gets affected easily for shading only through minor change in dimension, the shallow courtyard is good for winters and deep courtyard are good for summer. The solar radiation absorbed on the surface of courtyard affects the required cooling and heating.

VEGETATION

The use of plants, trees and proper vegetative cover can improve a courtyard's functional conditions in residential buildings. The green areas and the vegetative cover bring a reduction in the energy consumption, besides improving the thermal comfort of the inhabitants by reducing the temperature and the creation of shaded areas [xvi]. The presence of greenery influences the temperature, transpiration, relative humidity and wind speed [xvii].

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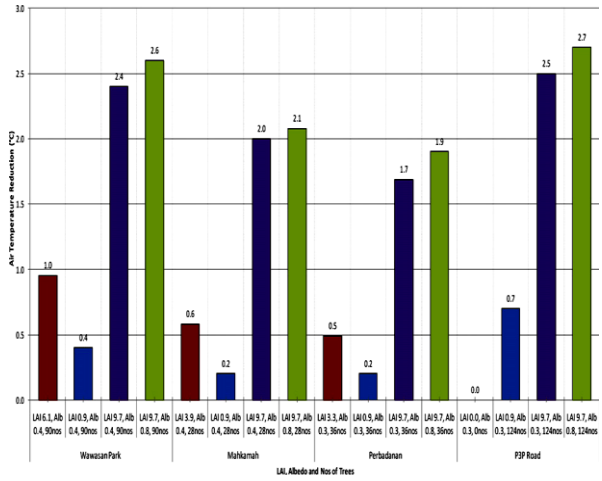

Figure 4: Air temperature reduction influence by variation of tree canopy density, quantity and types of tree [18]

Shahidan et al. [xviii] investigated the physical characteristics of trees and the effect that these characteristics have a significant involvement on the shade that trees provide. This research made use of simulations and field studies to evaluate the physical features of trees, including the type of tree and the volume of leaves contained (as shown in figure 4). A temperature difference of about 2.85^{o} C was stated compared with the existing conditions. The findings confirmed that the trees' physical characteristics play a major important role in absorbing solar radiation. These vegetative covers can act as a barrier to the diffusion of solar radiation; therefore, it may hamper the extreme absorption of solar radiation, leading to a decrease in the ambient temperature and the exterior spaces via respiration and evaporation. Taleghani et al.[xix] also discovered that 30% vegetative cover plays a predominant role in reducing the temperature in areas featuring higher temperatures and lower relative humidity levels. The shade created by trees is found to have a high influence on the amount of solar radiation absorption and reduction of the temperature, as well as a general cooling effect on the surrounding environment. The quality of the shade generated by trees depends on the height and type of the trees, and on the density of the leaves [xx]. Ghaffarianhoseini et al [xxi] evaluated the ability of unshaded courtyards for providing thermally comfortable outdoor spaces according to different design configurations and scenarios, including the orientations, height and albedo of wall enclosure, and use of vegetation. The study shows that according to design parameters such as the building height ratio, abundance in the amount vegetation the courtyard can achieve an acceptable level of thermal comfort for the tropics and may be enjoyed by its users for a long duration of daytime even during the noontime.

ALBEDO

In general albedo is referred as the portion of thermal radiation reflected by a surface. Considering the optimal use of masonry and reflection rates, the usage of high thermal characteristics of masonry [xxii] is an effective method for maintain thermal comfort. The ratio of reflection of light is different for every material and it can be used in determining the absorption rate or solar radiation on various surfaces. In real life situation, the masonry with bright surfaces absorbs lower radiation rate and it less likely to preserve day temperature. Materials with high reflection rates can cause reduction in various surface (as shown in figure 5) and environmental temperatures through convection [xxiii]. Taleghani et al [xxiv] studied the measurement of reflection rate and evaluated effect of reflection rate effect on degree with respect to change in temperature variations. It is concluded that bright materials with 0.9 reflection rate increases the global temperature of 1.05^{o} C and also increases mean radiation temperature of about 3.06^{o} C on comparing with dark materials, which caused increases in global temperature and mean radiation temperature by 0.52^{o} C and 1.45^{o} C, respectively. Benrazavi et al [xxv] investigated the effect of various masonry types commonly used for floors with surface temperature in hot and dry climate region. Information on materials that causing higher reductions in the ambient temperature are reported. Cotana et al [xxvi] proposed a novel methodology to alleviate Global Warming by artificially enhancing earth's Albedo. Such methodology allows quantifying the maximum environmental benefit achievable through the installation of Albedo control technologies, as a function of local meteorological conditions, the geographical features of the installation site, radiative properties, orientation of the surfaces and tilt angle. This benefit is directly quantified in terms of CO_2 eq offset.

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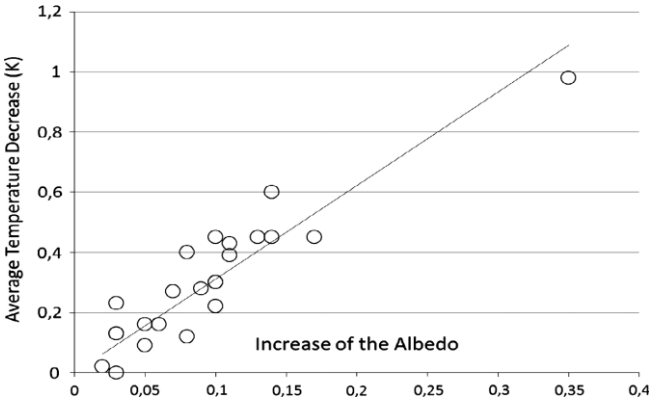

Figure 5: Correlation between the albedo change and the corresponding decrease of the average ambient temperature [23]

RESULTS AND DISCUSSIONS:

By continuously controlling the shadow on the courtyard surfaces, suitable dimensions and the direction of the building, it is possible to reduce the transfer of heat from the sun to the buildings. Based on the various literatures it is found that having a rectangular geometry is always better for hot and dry climate. Also by increasing the ratio of length to width of the courtyard and increasing the height of the walls of the courtyard increases the percentage of shading. For orientation, it has been proved from many simulation results that, a northern courtyard orientation is best to avoid direct solar radiation even in early morning hours with significant wall height. It is also reported that by increasing the height of the walls, the noontime temperature decreases, and the night time air temperature is higher than in the courtyards with lower walls.

CONCLUSION:

The human thermal comfort mainly depends on design features of courtyard, materials used to build and technologies available, as well as on the climatic conditions on various regions. Therefore, based on the available literature, it is concluded that, for hot and dry climate a courtyard with rectangular geometry, northern orientation, 30% tree coverage, high wall enclosure and more reflecting surface materials are recommended for maintaining human thermal comfort.

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The author conveys their sincere thanks and concern to her guide Prof. Aparna Mhetras for helping and supporting in writing this review article.

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Use of Perforated Screen as Double Skin Façade for Office Building in Jaipur

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Abstract: Jaali as perforated screen for light and ventilation in buildings have been extensively used in India. Similarly, Double skin facade is an envelope construction comprising of two transparent skins separated by an air corridor. In today's time contemporary building designs use Jaali as double screen façade as a passive method for natural ventilation. This article aims to study the factors that affect Jaali screen façade and understand the effect of Jaali as a passive strategy for building envelope for a composite climate. The research shows that Jaali screens with 30% to 50% perforation on South Facades in a composite climate provide an improved daylight quality in office buildings.

Keywords – Double Skin façade, Perforated Screen, Jaali, Passive strategy, Daylight, Natural Ventilation.

INTRODUCTION

This research study explores the performance of Jaali screen façade as double skin façade in terms of daylighting, natural ventilation and cooling (by shading). The motivation for using double skin façade concept in buildings is a solar passive design concept.

Energy represents a major component in any country's economy and hence it affects the world's economy. Saving energy consumption, especially in buildings, directly affects national economy. The shortage in the traditional energy sources motivates the design of energy saving buildings. Many design treatments are developed to achieve energy saving through buildings.

Building envelope plays an important role in the energy consumption of the building as major parts of the building are exposed to the sun radiation. If treated properly this can considerably help in controlling the thermal comfort inside the building. An energy-efficient building envelope refers to an effective boundary between the conditioned interior space of the building and environment beyond it. Passive or climate responsive architecture uses the natural processes of a site to reduce or replace the need for mechanical systems in buildings.

City Character: Jaipur represents rich and vibrant lifestyle and tradition of Rajasthan. Jaipur being financial center and capital of Rajasthan, is dominated with office buildings. It is famous for its archetypal architecture and beautiful Jaali screens. As per ECBC climate zones Jaipur comes under Composite climate. It means it experiences extreme climate in both summers and winters. The city's climatic evaluation as per the bioclimatic zone necessitates requirement of passive strategies for reducing heat gain and this research paper is a step in this direction.

The Double skin façade is a passive design option for buildings used to improve the energy efficiency and indoor thermal comfort. It consists of a internal façade, an air cavity and an additional external skin. It presents the range of natural ventilation and daylight performance. It is a European architectural trend that is currently gaining momentum throughout the world. The form and construction of façade system have a strong influence on both the energy consumption of a building and the comfort level of its occupants. According to the source book of Belgian Buildings Research Institute (BBRI) "An active façade is a façade covering one or several stories constructed with multiple skin. In this kind of façade, the air cavity situated between the skins is naturally or mechanically ventilated. The air cavity ventilation strategy may vary with time."

'Jaali' means a fine and ornamented web, generally found in Indian, Indo- Islamic and Islamic Architecture. Jaali as a perforated screen is used for permitting light and ventilation in buildings. These screens provide protection from direct solar radiation and regulate social interaction between spaces. Presently, these screens are used in commercial buildings to reduce glare and control solar heat gain through fenestration. When properly designed, these systems can not only improve visual and thermal comfort but also greatly reduce electric lighting, cooling and heating energy consumption (Lee, DiBartolomeo, Selkowitz 1998). Previous studies on the Jaali as Screen façade show that the amount of energy reductions attained varies depending on shading geometry and climatic variations.

METHODOLOGY

This study adopts three tools to reach the outcome. The first method is a case study of existing building, second method is analyzing the Jaali types and perforation found in the traditional architecture of the city and third method employs simulation for daylight of

critical façade for a proposed design office space using Ecotec software to understand the daylight achieved with double skin façade and solar shading on the inner skin of double skin façade.

Method 1- Case Study

Pearl Academy of fashion is a low-rise educational building located in hot and dry climate; 20 km distant from Jaipur city. It is designed by Morphogenesis architects in the year 2008. The building façade represents contemporary use of Jaali façade design which can be used for any building type. The building is protected from direct solar radiation by double skin façade which is inspired from traditional building element Jaali that is found in traditional Rajasthani architecture. The Double skin acts as a thermal buffer between the building and the surrounding as shown in fig 1. The design of the external façade is such that it gives the visual comfort from inside and also breaks the glare coming inside the space. The Jaali screen acts as filter for air, light and privacy.

Fig 1: Pearl Academy of Fashion with double skin façade
Source: Arch daily images

Method 2- Jaali screen

In Rajput architecture for hot climates, floral motifs are incorporated at the center of the module. The fenestration is longer and narrow which allows deeper penetration of light and air. There are different traditional geometrical perforation and depth of Jaali screen found in Jaipur city. Hawa mahal or "the palace of winds" is an icon of Jaipur and has its façade packed with honeycombed patterns facing the main street. It is seen that most shapes are derived from hexagonal pattern in Jaali screen. In order to simplify the process, basic shape of a hexagon was selected for the purpose of comparing the impacts of the different perforation pattern and daylight distribution. As per previous studies on Jaali, perforation of 30%, 50% and 70% are common designs that are observed in screens.

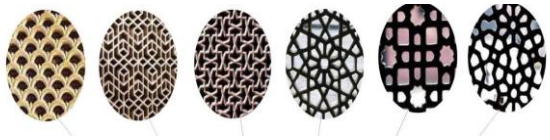

Fig 2: Different types of Jaali pattern found in Jaipur city
Source: idianjalidesign.com

Method 3- Experimental Design

The simulation model used for this study is a U-shaped building with 3 floors on the north side block and 5 floors on the south side block. The building is oriented in North east and South West direction to avoid large exposure on the south façade. The double skin façade is designed only for the critical façade which is found according to the solar radiation chart of the city. The building is oriented such that it reduces solar gain in summers and allows more solar gain in winters.

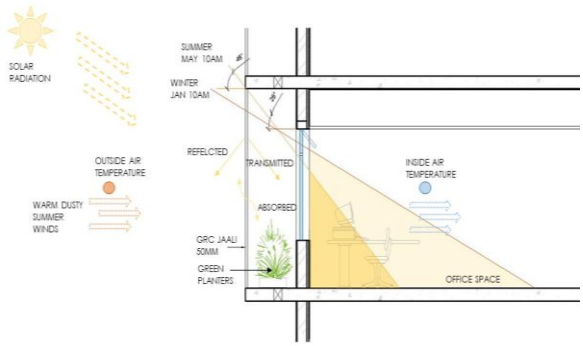

Fig 3: Section showing the outer skin and inner skin reducing the direct sunlight inside the work space and air movement inside the office space.
Source: Author

The inner skin is a composition of AAC block and gypsum board wall with U value 0.285 W/Sqm.K as per ECBC requirement and the outer skin is a GRC Jaali with desired perforation percentage. The perforation was taken as per the pervious study but the design was developed by the author as using computational shadow analysis on Sketchup software based on the orientation of the facades. The outer skin sits 1.2 m away from the inner skin of the building to reduce direct heat gain through fenestration yet allowing for diffused sunlight. The distance between the inner skin and outer skin is kept as per the solar altitude angle taken for the summer month.

The fig 3 shows a schematic section of a Double skin façade and adjacent office space cross section taken from the same building design showing heat transfer and air flow mechanisms in a model. In summers the hot air enters the cavity through the outer skin and gets humidify due to the potted plants in the cavity which helps in cooling the air and thereby improving the internal thermal comfort of the building.

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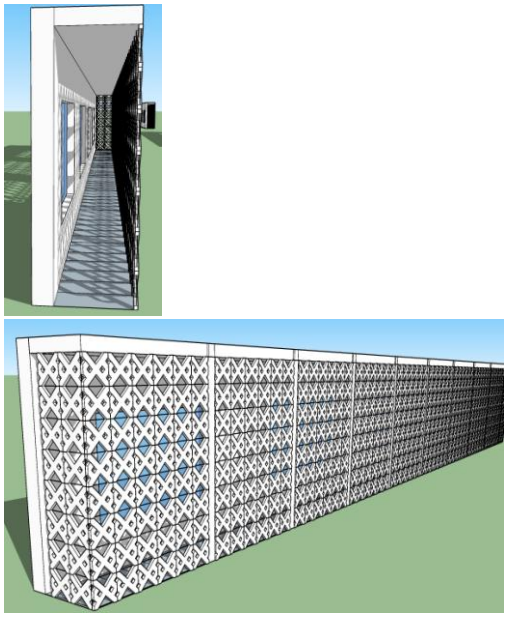

Fig 4: Sketchup Analysis of Shadow cast on the inner surface and Jaali designed for the south façade for the building.
Source: Author

The experimental design is a co working office building with various office spaces range from small offices with 3 occupants to large offices with 100 occupants. The building design is to maximize the effect of natural ventilation and reduce the direct solar heat gain inside office space. The DSF is modelled covering the entire face of the building.

Fig 5: Layout of proposed design co-working office space with workstation furniture.
Source: Author

A co-working office space from the layout was selected for daylight analysis with double skin façade. The orientation of office is such a manner that the two external façades are south east and south west. These façades receive the maximum daylight throughout the day making it critical for heat gain, thus protected by double skin façade. Fig 5 shows the layout of co-working office space with solar azimuth angles indicated for May and January month with 275˚ and 239˚ respectively which shows amount of daylight penetrating into the workstation. Daylight analysis was carried out using Autodesk Ecotec software to find the satisfied daylight achieved for the office space with DSF. For an office space the required lux levels are between 500 lux to 750 lux. This level should be suitable for prolonged work on computer, reading and machinery. The no of perforation percentage of Jaali was taken between 27% to 35% to achieve the optimum daylight. The external façade Jaali is considered to of GRC with 50mm thickness.

Attribute	Input
Co-ordinates	26.92 N, 75.82 E
Time zone	+5:30 Delhi
Weather data	Jaipur.wea
Sky Illuminance	8500 Lux
Working Plane	750mm -900mm

Table 1: Data inputs for Autodesk Ecotec Daylight Analysis

ANALYSIS AND FINDINGS

On basis of above three tools the following results were obtained: -

1. Daylight: Optimum daylight

In the experimental design method, the open work stations for the office layout are placed along the fenestration, which helps in allowing the sufficient daylight to enter the building space.

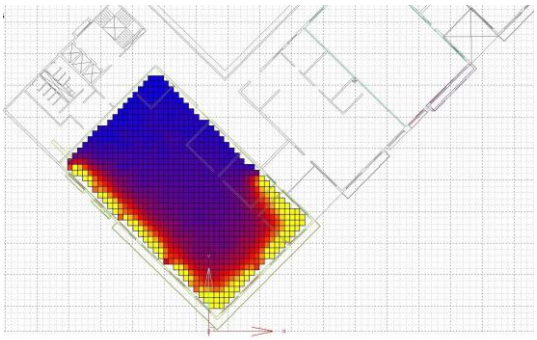

Fig 6: Daylight Analysis of Co working office space with double skin façade for on the southwest side of the building.
Source: Author

The Lux level achieved for open work space area is between 800-450 for office space, which is a suitable range for working and as per ECBC compliance. The area with less lux levels are designed as conference and service area which does not require direct sunlight and high lux levels for function. The achieved Jaali perforation as per the shadow analysis controls the light

entering the work space and cuts off unwanted glare with controlled illumination required for the office space. This helps in reducing the power consumption required to light up inside work space and making it visually comforting to the employees.

2. Reduced Solar Heat Gain: The inner skin is protected from the direct solar radiation by the outer skin and the cavity between two skins. As Jaali controls the light entering in and reflecting some light back from the outer surface this also reduce the heat coming inside. The shadow of the outer skin falls on the inner skin which results in less heat gain from the building envelope, thus reducing the cooling load inside the office space and helping in economizing the cost of HVAC and providing thermal comfort

3. **Improved Ventilation:** The wind in the subject city is mostly dusty entering and presence of outer skin and potted plants trap the dust particles present in the air finally supplying filtered air inside the building and hence improving the quality of natural ventilation inside a building. The small holes increase the velocity of air passing inside through them, similar to the function of funnel effect, accelerating even the mild breeze outside and allows deeper penetration. The air cools down while moving through the small apertures, thus comfort of the occupants is increased.

CONCLUSION

The following study shows that perforated skin as double skin façade and vernacular shading strategies might be well suited to this context and can be successfully adopted to contemporary buildings in composite climate such as Jaipur. External shading provides cost effective passive design strategy to reduce energy demand in composite climate while improving occupants' thermal and visual comfort.

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Social Relevance of Architecture : Analysis of Temple as a Representative Built Form

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Abstract : Relevance implies logical connection between what is seen and its interpretations. Social relevanceis a way in which a built form is relevant to the society; as an expression of Human Civilization. Shapes and styles of the built form are influenced by the social norms and as and when these norms changed the characteristics of shapes and forms of the buildings have also changed. As, certain aspects of the social norms are influential in the built form; they are incorporated into the architecture.Religion being the major factor influencing social norms; the changes are predominantly seen in religious built form. The aim of this paper is to find out the social relevance of Architecture, taking temple as a representative of the religious built form.

Key words: Temple, Social norms, built forms, functions, relevance, Architecture, Religion

Introduction

Architecture is the representation in the built form of the needs and desires of the society, with a set of spatial criteria for deciphering its values and systems. It is also a form of non-verbal communication conditioned and regularized by social context to evolve symbolic meaning. For the purpose to find out the social relevance Temple has been chosen as a representative built form to understand the relationship of the social psyche with the functions being performed in the routine manner in the temple and how this routine has helped to evolve the built form. How does the sitting of the oriented

towards the cardinal directions, facing east and the devotee ties to find through them an approach to the Supreme; enclosed in a small internal chamber, the sacred space, Garbhagriha.

The temple architecture represents the outer and inner cosmos. The outer cosmos is expressed in terms of connection between the temple structure and the motion of the sun, the moon and the planets while the inner is represented in terms of the consciousness at the garbhagriha and various levels of the superstructure that correspond to the state of consciousness. In the built form the unfolding takes place, both in the details and at the level of whole composition, and is brought about by temple designs; built form, its surrounding environment, the exterior, the plan within and without, specific building elements etc. of the temple; demonstrate the relevance of social factors?

Temple Architecture, throughout has reinforced religious life in anticipation of an eternity and appealed human emotions through ritual performances, which occur through well defined spaces; these spatial dimensions has acquired meaning through its association with symbols. The repetitive performance of aspects of rituals imbues elements of the built environment with social significance.The shrine becomes key ritual symbol, standing for and evoking sentiments among the devotees; who are already in the minimal space of the ambulatory. The circulation within this space at times creates an intense sensation of unity with the deity such that the devotee looses the sense of his individual bounded self and merges with the social and physical environment of the religious built form.

This transformation within the mindset of the devotee takes place through the rituals. They bring the devotee close to the divinity in an arranged structured pattern of movements along the east-west axis and through a series of increasingly sacred spaces in the architectural composition of temple.The temples are planned with a sense of centrifugal dynamism originating at the apex point of the towering mass called shikhara; progressing down wards towards the base of this vertical axis and a horizontal ground- plane axial system

compositional elements are made to emerge and expand out from shikhara and also from one another. A series of configurations of elements are sensed as a chain of separate entities, seen several times, at different stages, ultimately creating a pre-determined sequential movement of the devotee, to meet the deity, to attain the peace of mind.

Methodology

This paper is based on literary works on ancient treatise and research works on the temple architecture of India: an effort is made herein to bring out the basic socio-religious concept of the religionand how it influenced the design of temple

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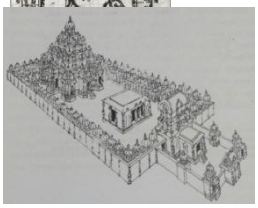
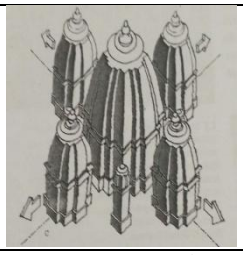
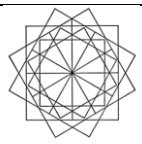
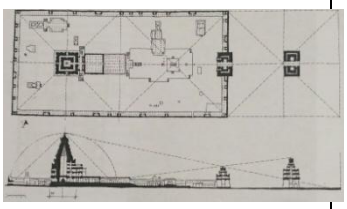
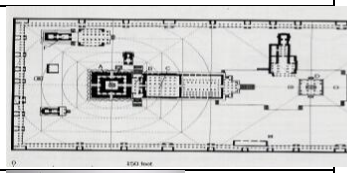
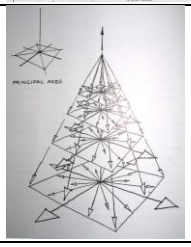
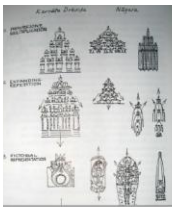
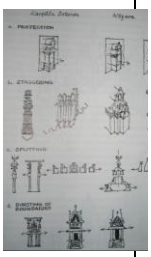
architecture. The object of this paper is to present a frame work for further research on the subject.

The social relevance of the Temple Architecture is explained in the following table.

Concept/quote	Relationship/siting of Built Form
God is omnipresent can be seen in all things	Nature
Elements of temples differ across regions, all based on a single philosophy of design	The concept of Cosmology, the divine Vastupurushmandala
The ideology is to link man with the God. Place where God's presence can be felt through rituals and ceremonies.	The entire built form of the Temple 
Elements are designed to correct proportions with harmony and symmetry	
High degree of outer adornments with matching and mixing of small details with massive structure	To exert positive influence on the surroundings
Decoration: the interior is plainer compared to exterior.	So as not to divert attention from the Icon in the central shrine
The basic form is a square cell, oriented to the four cardinal directions and a doorway on the east.	

Concept/quote	Relationship/siting of Built Form
	
The Central shrine is the heart of the devotee	
Tower represents the flight of the spirit to the heavens	
Movement Projection Staggering Splitting Bursting of boundaries Progressive Multiplication Expanding repetition Pictorial representation	 

(Badami Temple-Wikipedia, others-from Temple Architecture of India by Adam Hardy)

The age old concept in the Hindu religion demonstrates that, God is omnipresent and can be seen in all things, especially in nature; thereby suggests a strong relationship of the natural surroundings, both symbolically and spiritually with the society; and is seen being reflected into the design of the built form. These religious forms developed a typical temple culture within the surroundings called as a Religious culture which carried out a dominant role on the human life, since civilization till today;becoming the life-centre of the society. This temple culture has a multiplying effect on the state and the society; by bifurcating itself in to i) Religious culture and ii) Non-religious culture. The religious culture was related to the daily chores within the four walls of the temple itself while the Non-religious culture contained the service providers for the main Religious culture; thus providing employment opportunities to thousands of the people; starting from priests to deep down to coolies. They were also developed as social and educational centres and

economic institutions; further adding to the cause of social development.

James Fernandez, who used Anthropological theories of Metaphor as applied to the built environment, while explaining social relevance of Architecture states that "Cultural identities are negotiated through the interplay of contrasting and/or similar metaphors in language and built environment. Metaphors allow one to move from the abstract and inchoate to concrete, ostensive and easily graspable. Human predicates pace upon them and obtain qualities that they, in turn, project upon space. These predications and projections transform spaces into place. Metaphor becomes transformed into metonym." The built form thus communicates social culture. Amos Rapoport in his most widely known work 'House Form and Culture' asks 'what do built forms mean and what social processes give rise to built forms?'This paper is a small effort to find out the answer.

Conclusion

Historically, in each of the periods, the related society has created architectureand has evolved its own forms that are distinctive and local in shapes and details and gaining symbolic meaning beyond functionalityand become part of their 'social culture' bringing in the relevance of Architecture and the society.

Acknowledgement

It gives me immense pleasure to express my deep sense of gratitude to my guide Ar. Renuka Chutke Chakradeo for her valuable guidance and constant encouragement, inspiration and motivation for timely completion of this paper.

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RESEARCHING CARBON SINK FOR PUNE CITY- TIME TO VALUE THE OLD

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Abstract: As Pune is trying to become carbon neutral city by 2030, it is trying to reduce its carbon emission by adopting all its measures like use of sustainable resources, preservation of natural resources, alternatives to fossil fuels, tree planation etc., this type of rapid development of the city is harming the ecological cycle of the urban system in the city. This study mainly focuses on the carbon sink of the city and how well they can act as a carbon sequester ,if carbon sinks are well studied and planned , it can be managed to make carbon as a resource for the better ecological system of the city. The research will mainly talk on the solutions for the better carbon sink, which is well thought for acceptance and to value the principles of sustainability i.e. Social, economical and environmental dimensions of the city.

Keywords : Carbon Sink, Carbon Sequestration, Native Trees, Ecological cycle, Sustainability, Biodiversity, Indian Culture

INTRODUCTION:

The concept of carbon sink is to capture carbon by growing trees. The Pune city, in hurry to accomplish its carbon neutrality by 2030, started growing native trees which a good step is taken with active support of the citizens. But there is a broad thinking for carbon sink in other countries, which talks about the grasslands and its importance in carbon sink and how ecology plays important role in sequestration with respect to grassland.

India has a long history and connection with its grassland and its ecological system. Due to the invaders and influence of the western culture, the country has lost its heritage of worshiping nature and forgot its rural - urban relationship. In this paper the research is aiming to recall and establish a lost heritage of country , which has emerged as a solution for the carbon sequestration , which will also try to open up connections , linkages with government and support given to public for better establishing relation with biodiversity.

The research will talk about how better the carbon sequestration can be done in different ways by proper management and unique ideas for the storage of carbon, to help not to participate in climate change. Pune Municipal Corporation has an area of 243.84 sq.km. 20 - 22 % of its land area has forest cover, which shows the ideal percent coverageof green area for a city. The World Health Organization recommended the availability of a minimum of 9 m^2 of green space per individual with an ideal UGS value of 50 m^2 per capita. These statistical values correlate with a number of UGS standards, including: linkages between sustainable cities and better health [1]. The Pune city has its population of 3132143 in number according to PMC census data 2011 [2].The present study indicated that Pune city emits 7.8 lakh tons of carbon per year.

The civic body of Pune Municipal Corporation has counted around 4009623 trees in 2019 news reported in Hindustan time's newspaper. The plantation is still in process to increase carbon sink under the notice of PMC. The municipal corporation has also set rules for Townships, NGO's etc. for tree plantation to promote indigenous species of trees to support the native biodiversity in ignorance of exotic species. As Pune is covered by hills and ranges it has good forest cover and green patches of grassland which is home to several animals and support too many herbivores for grazing their food. Grassland to be protected for balancing ecological cycle of animal to human relation, which is degrading day by day impacting humans health mentally and physically as human in its busy urban life has no time even to look at nature around it peacefully. World's healthy milk (27%) and animal breed (23%) comes from grassland [3]. Grassland provides livelihood to many poor people and nomadic

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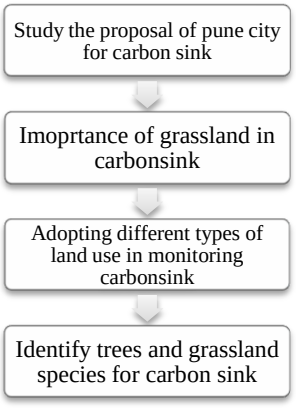
caste (Dhangars) of the state. Dhangars are the pastoral community of Maharashtra state. Farmers invite them to their agricultural land to manure it by their flocks and feed them stubble. The community contributes to the economy of the state or country with their occupation and help to complete the carbon sequestration cycle. Thus we should protect our grassland and the precious community, which are a big part of the carbon sink.

For carbon sequestration of Pune city, it all talked about growing trees, filling empty lands with native tree plantation etc.6, but lack of the focus is noticed towards land use pattern, in terms of preserving grasslands, connecting cattle's and livelihood animals and community back to nature, this research will fulfill the gap and provide a brief idea for sustainable importance of forgotten human culture.

MATERIAL AND METHODOLOGY:

Carbon emission is the strongest contributor for causing global warming in the world, increase in carbon emission is one of the major concerns, for which the citizens and the government should step forward to solve the issue. Pune city has accepted this challenge to become carbon neutral. This study states about how the city is planning to achieve its carbon neutrality by its carbon sink and what on additional it can take steps to manage its carbon sink for better sequestration.



Pune City's Strategy for Developing Carbon Sink

The city has hills like Katraj Hill, Panchgaon Parvati, Ramtekdi, Gultekdi, Range Hills, Dive Ghat, Fergusson Hill, Chatushringi Hill and Vetal Hill. The city has alkes like pashan, katraj, khadakwasla, etc. which has got a grater ecological value. The plantation strategy should also focus and pay attention on urban areas to improve their biodiversity. PMC has developed 111 gardens from which 35 are under development. Below are the names of hills and other areas available for plantation program

1. Taljai hill - (PMC acquired this area for development of forest park under hill top hill slope category) the land area taken is 110 acres and the proposal is to restore the greenery and protect the land from illegal encroachment.
2. Parvati hill - (acquired under transfer of development rights for development of parks) 50 acre of land area is marked to restore the greenery and protect the land from illegal encroachment.
3. Bhamburda hill, panchgaonparvati hill and warje hill area are been issued with amount of credit for tree plantation, erecting compound wall, soil & water conservation etc.
4. Tree plantation and protection under joint forest management project.
    - Work executed by forest department of the city – 987.5 acres
    - Work executed by Pune municipal corporation - 812.5 acres
5. Land acquired from irrigation department for plantation is (along canals) – 30 acres.
6. Land acquired from revenue department for Biodiversity Park is 546.5 acres.
7. Plantation along the rivers, lakes and nallahas under JNNURM program.
8. Plantation by local organizations and NGO's with municipality support
9. Road side plantations, provision of medicinal, fruits, ornamental plants for citizens.

Grassland and Its Importance in Carbon Sinks

Grassland holds 26% of the world land area with 20% of the world's carbon stock in soil [3].grassland stocks around 34%, forest land holds around 39% and agro ecosystem around 17% of world's carbon [3]. Grassland provides resources like food and forage to people and animal, grasslands have been converted into agricultural land since ages. In the recent years we are seeing the increase in carbon emissions as there is

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increase in burning of fossil fuels, pollution from industries, making of homes more comfortable etc. is leading towards greenhouse effect and increasing global temperature. The released carbon in atmosphere is intake by plants through photosynthesis and thus carbon is stored in leaves as well as roots of plant species, as those grass or plants are eaten by herbivorous animals the carbon transfers into animals as food. The plant, grass etc. if dies starts decomposing in soil therefore carbon becomes organic compound of soil. This is how the ecological cycle of grassland for carbon sinks works.Preserving grassland is must, it plays important role in giving livelihood to people, and homes to many animal species. The Dhangar community of Maharashtra state carry forward the old tradition of their nomadic life by roaming with their shepherds, cows, buffalos, goats, camels etc. they roam around with their cattle's in search of fodder. Grasslands are livelihood to these types of people; they are totally dependent on grasslands. Blanket weaving is their main occupation of Dhangara's. Cattle's help in rotation of carbon cycle of the grassland. After every rainy season of the year they come to the place where grasslands are available for grazing their cattle's.

"Grasslands – home to cattle's,
As forests to wild animals"

Grazing management - grassland if managed properly, can improve nutrient cycle of grassland ecosystem and can save forage species also from animal traffic or physical breakdown.

S.No.	Botanical Name	Common Name
1	*Eucalyptus*	-
2	*AlbizaProcera*	White siris
3	*Ailanthus Excelsa*	Mahanimb
4	*Azadiratha Indica*	Neem
5	*Dalbergia Sisso*	Shisham

Fire management – when grassland dies and becomes woody, the land parcel should be clean and prepared for upcoming mansoon for new growth of grass species. Fire management is done to clean and remove unwanted encroachment of woody species also. The left out charcoal after burning is a form of carbon, which later on mixes with soil and become an organic compound of soil.

Different Types of Land Use for Managing Carbon Sink As the land is precious resource for human kind and has high value in urban areas, so that they have to be managed in such a way that it gives out some environment and economical benefit. Empty land parcels of Pune city which falls under green belt can adopt Agroforestry practices like -

- Agri-silvicultural methods - produces agricultural crops & forest products.
- Silvo-pastoral methods - produces both wood products & livestock.
- Agri-Silvo-pastoral methods - mixture of the two systems above, which produces tree products, crops & livestock.
- Mixed garden methods - which integrate trees, crops, and animals on small land parcel for supplying nutrients, materials & marketable products for a family.

The agroforestry practice has potential to sequester more carbon than agricultural farming or grazing grasslands. This agro forestry is economically also vital to practice.Agroforestry produces more organic carbon compound in soil than grasslands. It does not suggest that grassland or agroforestry should replace forests. Forests sequestration of carbon is highest than any other land use. It indicates towards conserving grassland and promotes agro forestry.

Trees for Carbon Sink
Forestry for carbon sink is the best sequester to get level down of carbon emission. Native tree plantation with good carbon sequester property can help to create good carbon sink for the city.

These lists of trees sequester more carbon within short period of time and have agroforestry property also.

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Native tree can help to preserve biodiversity and ecological balance of the place, which further have connection with water cycle, climate issues, soil nutrients etc. and benefits for conservation of natural cycles. There are some native trees listed down with their carbon storage property and can be used in agroforestry practice as well.

The grasslands in the hilly areas of Maharashtra consists mainly of *Cymbopogon martimi, Themeda quadrivalvis, T. triandra, Pseudanthistriaheteroclita, Heteropogoncontortus, Ishaemum indicum, Sehima nervosum* and *Apludamutica.* There are many species of grasses of grassland according to place where it can grow which is further mentioned in GRASSLAND [4]. *Dalbergia Sisso* + *Sporobolus Marginatus* is best example for hortipastoralagro forestry, there common names are shisham + khevaiga grass the combination of these two sequester more carbon.

Agro forestry management and value to animals

RESULTS AND FINDINGS

The World Health Organization recommended the availability of a minimum of 9 m^2 of green space per individual with an ideal UGS value of 50 m^2 per capita, if we calculate green space per individual for Pune city.

The Pune cities area is = 2443840000 sq.m.

Total green cover of the city is = 22%

Therefore,

22% of 2443840000 sq.m. city area = 53644800 sq.m.

Total population of Pune city recorded is = 3132143 individuals

Hence the cities green area per individual is = green space of city / total population of the city

= 53644800 / 3132143

= **17.12 sq.m. Green space per person** is the ratio of

SrNo.	Botanical name	Common Name	Carbon Storage Property	Use
1	*Gmelina Arborea*	Gamhar	24.12 to 31.12 Mg/Ha	Construction, Furniture, Musical instruments etc.
2	*Azadirachta Indica*	Neem	8 to 78 Mg/Ha	Medicinal plant, Organic pesticides, Timber
3	*Dalbergia Sisso*	Shisham	254.72 Kg/tree , 12.84 Ton/Ha	Fodder, Timber, Erosion control, Oil
4	*Acacia Nilotica*	Babul	228.42 Kg/tree	Fodder, Medicinal plant
5	*Albizia Lebbeck*	Siris	219.84 KG/tree	Cash crop, Forage, Erosion Control, Hard wood

Pune city, which is in between of 9 sq. and 50 sq.

The city has to work more potentially to increase its green area per person ratio and become role model for other cities also in nation. City working on hills, gardens, parks, river banks etc. should go with idea of agroforestry, grasslands preservation & management, etc. discussed above to use its land resource more economically and ecologically useful for its species and to sequester carbon more efficiently. Communities reliable on grassland and forests should be made aware of opportunities and schemes made by government for them. The ICAR Indian council of agriculture research should work on this forest land, grassland, cattle preservations for quality breed, etc. for healthy biodiversity.

This hills, biodiversity parks, green river banks etc. can accommodate native cattle's like left over cows, buffalo's, bulls, ox, dogs, horses, donkeys, pigs, goats, monkeys etc., in today's world they are very rare to see in urban sprawl. Ignorance to these creature is also a major factor of climate change and sequester of carbon is in mild swiftness.

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As we have seen carbon stock in grassland 34% and forest stocks 39%, we can understand the value of grasslands and its biodiversity. Therefore grassland can play very important role in lowering the carbon stock from atmosphere and bring it to soil.

Grazing horses after mansoon, lohegoan, Pune

Nomad community, university road, Pune

Nomad community with shepherds, hinjawadi, Pune

Sheeps grazing on hill,lohegoan, Pune

Seasonal watershed canal became grassland for sheep's, environmental friendly urban space hinjawadi, Pune

Silvi pastoral Pathmeda, Rajesthan

Agro forestry

CONCLUSION

It has been understood now that grassland contributes in storage of carbon with increasing soil organic compound SOC. Increase of soil organic compound through land use changes is a low cost economical, sustainable and environmentally beneficial idea for sequestering carbon from atmosphere. Time has come to recall old practices to save our environment from the mess created by us human. These land use practices can be role model for other cities, farmers, and citizens etc. to understand the value of natural elements including animals. Pune city should adopt these ideas to handle its carbon emission and to manage cities urban ecology.

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Performance Analysis of an Existing Resort by Use Of Online Assessment Tool And Recommending Strategies For Retrofits And Energy Efficiency

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Abstract: Worldwide, and specifically in India, the overall energy consumption is witnessing an exponential growth. According to recent surveys, buildings contribute to around 30-40% of overall energy consumption. Electrical consumption currently in commercial buildings in India is about 8% of the total supply[1]. Designing and operating buildings in an energy efficient manner is hence the need of the hour, and also leads to several benefits such as energy cost savings and contributing to sustainability. This study evaluates the performance of a resort, using the online EDGE assessment tool, and intends to recommend energy conservation measures to optimize the performance and also put forth recommendations for major retrofits.

Key words – Energy performance index, energy audit, energy simulation, calibration, benchmarking, energy performance analysis, energy conservation measures

INTRODUCTION

Amongst the building typologies, hospitality buildings are responsible for very high energy consumption due to luxury and comfort requirements. This leads to significant rise in energy consumption, especially during peak hours in various metro cities and tourist destinations. The sector is witnessing unprecedented growth owing to better spending capability of local population, demand from tourism and increase in overall travel in the country.

Some World Tourism Data Points

- 9% GDP
- 1/11 jobs are in the tourism sector
- US $ 1.3 trillion in exports
- 6% of the world exports are dependent on the tourism industry
- 6% of the exports are from least developed countries

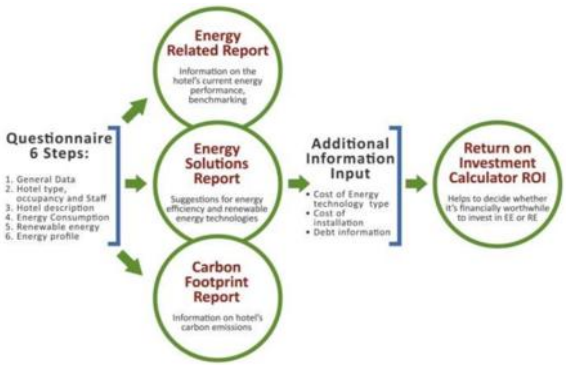
World Tourism Organisation – specialized agency of UN

In India, 70% of the buildings that will exist by 2030 are yet to be built.[2] Buildings already account for two-thirds of electricity consumption and four-fifths of water use in large cities.[3] To achieve a viable future, buildings must be designed to conserve precious natural resources.

Resorts have different building designs, functional facilities and operational requirements because of which energy performance is difficult to evaluate. Much of this energy consumption can be reduced or optimized by changing the way buildings are operated and maintained, renovated and upgraded. To promote effective operations and management of resorts, benchmarking of the energy performance reveals useful information to support strategic decision making and planning. Further investigation in evaluating key energy consumers for the facility can help understand the best strategy for optimum performance. For existing resorts, such informed decision making can help facility owners and managers save on the capital expenditure as well as operational expenditure.

Energy efficiency in hospitality industry will help increase Profits, Competitiveness, Sustainability, Responsibility and Brand Value. It will assist in mitigating the sector's CO_2 emissions, will help decrease - Costs, Energy consumption, Carbon footprint and Tourism's impact on climate change. There is a gap between available Energy Efficiency (EE)/ Renewable Energy (RE) technologies and their actual use in resorts.

Resorts also play a significant role in sensitizing their visitors towards resource efficiency by giving them a first-hand experience of using energy saving technologies. Hence, selecting a resort for the study was considered, as it addresses all these issues comprehensively.



Source : Hotel Energy Solutions

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EDGE – Excellence in Design for Greater Efficiencies

EDGE identifies the most cost-effective ways to reduce energy use, water use and embodied energy in materials by trying to achieve a minimum projected reduction of 20% as benchmarked against a standard building. This certification will help increase the marketability of buildings for new construction, existing and renovations of homes, offices, hospitality, retail industry, ware houses, hospitals and educational buildings. In many countries including India, GBCI administers EDGE certifications and credentialing. EDGE helps determine the optimum combinations of building design strategies for the best return on investment.

Advantages of using EDGE

- Free and easy to use online tool to calculate your ROI for green building strategies
- Advanced database understands local climatic conditions and building usage
- Project and report your savings in energy, water and GHG emissions
- Efficiency simulations are built into the software and certification can be achieved with existing documentation
- Certification is globally recognized and backed by WBG (World Bank Group)

MATERIAL AND METHODOLOGY

A 12 years old existing resort has been selected for the study. There are 3 buildings on the site. Main building houses most of the facilities. Accommodation is separate. They have 8 cottages and 27 rooms. The total plot area is 10,400 Sq.m and the combined built-up area is 4334 Sq.m

Many physical and operational factors influence energy usage (Bohdanowicz and Martinac, 2007). Major factors are considered and summarized below to establish and evaluate the resort energy benchmarks.

Table 1. Major factors considered for this resort's energy benchmarks

Factors	Description
Resort star ratings	A pragmatic approach with some risks, as there is variation in star brands and not every resort is rated.
No. of rooms	This is not an index for resort size; it simply is corelated to the no. of rooms/cottages/suites within the resort.
Floor area	This varies independently of other factors and can be a significant contributor to overall energy usage of the site.
Scale of conference areas	Other independent factors play a substantial role despite it being linked to linked to resort quality.
Swimming pool	It has a marginal correlation to star rating and the scale of the pool varies significantly.
Occupancy	Level of occupancy typically should be a major influencer in energy and water consumption; but many a times is not significant due to resorts remaining prepared for unexpected arrivals.
Other facilities	Gym, house-keeping, administration and accounts

Note: This information has been adapted from Bannister (2008).

Resort operations are majorly equipment-based than people-based services (Jones and Lockwood, 2002). Resorts have very typical and specific operation schedules which may lead to difficulties in energy management.

A resort can be largely classified into three distinct zones:

1. Guest areas : accommodation, washrooms
2. Public area : Reception, lobbies, restaurant, bar, swimming pool, gym, conference areas, outdoor landscaped areas
3. Service area : kitchen, offices, store rooms, staff facilities, service areas

OBJECTIVES

- To estimate the energy performance index of the resort and compare it with national and international benchmarks.
- To identify the energy conservation measures and develop the cost benefit analysis using online tools.

RESULTS AND TABLES

Approach

Data collection was done by conducting a walkthrough audit (ASHRAE Level 1). Based on the site observations, floor plans were updated, inventory of equipment, lighting etc. was obtained and interactions with the facility manager and electrician helped in understanding the schedule and operations of the resort on a daily basis.

DATA Inputs

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Its design aspects were studied and evaluated using the EDGE tool which uses ASHRAE 90.1 2007 as baseline for evaluating energy performance.

As is evident from the EDGE reports, the design is supposed to perform with an EPI of 34.69 kWh/Sq.m/year. In fact; with effective energy saving measures, more than 20% energy can be saved. FIGURE.1

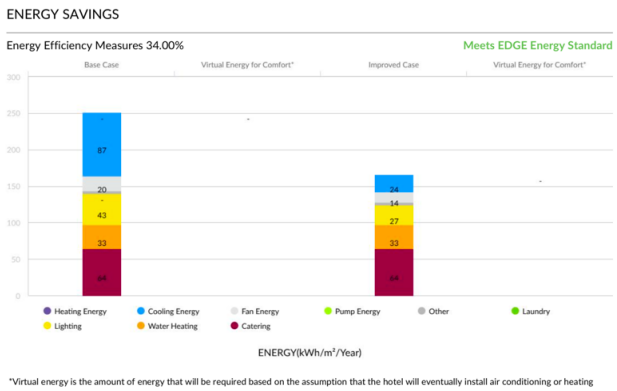

FIGURE.1 EDGE report output for energy savings

In comparison we also have the electricity consumption of the facility for the past 2 years. Average of 2018 and 2019 was taken and after discussions with the facility manager and verification of data related to occupancy, a comparative occupancy graph was derived. FIGURE.2

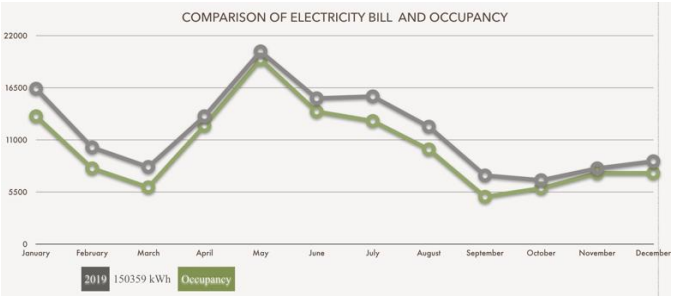

FIGURE. 2 Energy consumption curve derived from monthly Electricity bills and compared with Occupancy at the resort.

This shows that during peak months with high occupancy the energy consumption is high and during non-seasonal months when the occupancy is low the graph drops.

After evaluating the energy use, it is evident that the facility is performing with an EPI of 41.62 kWh/Sq.m/year.

ANALYSIS

The facilities performance has deviated from the predicted performance. The difference in both the EPI numbers shows the potential for energy savings at the facility. Moreover, considering the many changes and upgrades happening over time in facility operations, and the fact that some of the energy consuming equipment is due for replacement/retrofit.

1. VRV system needs a major overhaul, also the split air conditioners which are nearly 10-12 years old.
2. Light fittings are in excess and there is a predominant number of CFL fittings to LED fittings; Changing of these CFL light fittings to LED; illuminance levels as required shall be verified on IES and suggestions for replacement and payback period shall be calculated.
3. Solar panels installation will decrease the dependency on electricity from main grid and green energy shall be used. This will help in cost savings on energy bills and reduce energy usage.

CONCLUSION

Further investigation would be required to evaluate the performance of each of the key energy consuming end uses; to come up with elaborate conservation measures; and also do a cost benefit analysis which will enable the property owner to take informed decisions.

ACKNOWLEDGEMENT

I wish to express my deepest gratitude to my guide, Akshay Pahade for his guidance and technical support. Without his persistent help this research would not have been possible.

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Feasibility Study on Reduction of Energy Usage, Till Construction Completion of Residential Projects at Satara

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Abstract : Energy usage in the building industry has effectively and successfully undergone various improvements but largely it is focused over the lifespan of the project and the energy efficiency in the construction process is evidently ignored. Hence, this paper focuses on finding out and understanding the attitudes, approaches, inclinations, barriers behind improvising the energy efficiency in the construction process for residential projects at Satara.A questionnaire survey was conducted amongst the construction process decision makers and onsite influentialpersonnel to elicit information pertaining to energy usage. The findings of this study focus on key processes to improve efficiency,will guide the decision makers as well as policy makers to channelize attention and bridge the gap towards energy usage during construction.

Key words: Energy, Construction, Residential, Efficiency.

I. INTRODUCTION

Construction projects have undergone lot of innovations to improvise the quality, costing and also the end product throughout the lifecycle of the project. These innovations have increased the use of energy in different forms. Green technological innovations and applications have permitted us to reduce this use of energy to a considerable extent but these are majorly focused on the energy use after the completion of project. Residential sector for India alone, has predicted the rise of more than twice increase in floor area compared to the current residential floor area till 2060 [v] (UN Environment and International Energy Agency, 2017). With the recent signed Paris agreement there are increased pressures on the construction industry to reduce usage of energy in Construction process [vi]. Given the potential quantum of rise of residential sector, the Construction energy requirement is going to increase more than twice of today's requirement correspondingly increasing pressure on energy use reduction in construction process(United Nations, 2017).

Green Building Certification Agencies like LEED & GRIHA are more focused on the energy usage after the construction process so the increase inenergy usage and thereby carbon footprint of any building by just the process happening on construction site is ignored by many professionals.

Also, awareness about these facts, quantum of energy involved, implications and measures for energy usage during construction is somewhere lacking in the construction professionals.

There is a remarkable increase in low carbon construction projects across India. This progress is important for low carbon construction efforts and it is significant for society and specially for construction companies. So to further develop low carbon construction practices, the industry has to be more innovative with how it uses natural resources and current sources of energy in all areas of the construction site.

II. OBJECTIVES:

- To find if the awareness of energy efficiency exists in the professionals working on site
- To what extent the process on their respective sites are formulated to make them energy efficient, and identify the barriers in doing so- if any.
- Knowingly or unknowingly do the professionals follow any streamlined processes
- Policy suggestions if any that can be derived

III. SCOPE

- The area of study is confined to the construction process.
- Although the direction of this study is more directed towards the sustainable approach, the emissions from the construction processes are not incorporated in this study.

IV. METHODOLOGY

Following steps approach is used:

- Identification of types of activities and energies used on the site.
- Understand the basic energy saving processes or approaches that can be used on construction sites
- Formulation of Questionnaire for construction professionals to find the relevant approaches,

applications and understanding of the energy saving agenda
- Determination of relevant variables by which those replies can be quantified;
- Identification / Selection of professionals for the survey monitoring and collect data.
- Transformation, categorization, quantification and analysis of the collected data
- Arrive on the relevant conclusions / findings based on the above.

V. LITERATURE REVIEW

The research in the construction process energy consumption efficiency is highly segregated and the data from each study needs to be picked up to have a concise understanding of the areas possible to reduce energy consumption.
Energy in the construction industry is fragmented because of the processes and stakeholders involved in the construction process[i]. It has various contractors and subcontractors resulting into subdivision of the whole construction process (Department of Commerce, 2005)

A study by Shrivastava, S., &Chini, A on estimating energy consumption during construction of buildings [iii] incorporates a methodology which BOQ is connected to the work data and it is thereby connected to the labourers and their equipments. So at the end a report that has energy consumption information and segregated areas of high demand energy tasks are identified. The conclusions of this paper concludes on material procurement and energy utilized by equipments as high demand areas. (Shrivastava & Chini, 2011)

In another study of Managing the efficient use of energy on construction sites and cost reduction by AA Talukhaba, B Phungula and MB Manchidi[iv]in which it was concluded that Transportation, hoisting and concreting are some of the processes that demand more energy usage. It is also observed that a lot more effort will be required to improve site management and training of workers to be more conscious of the use of energy for the achievement of onsite energy efficiency. It was further suggested that a logistical transportation system is required for delivery and waste removal on site. (Talukhaba, Phungula, & Manchidi, 2013)

The company named BAM [ii] which focuses on how energy efficient construction process can be. They have included measures like incrementally improving the thermal efficiency of the temporary accommodation, installing zoning and controls to temporary electrics installations to cut out waste and providing staff with reports showing them how they're performing and where they could make savings. (Putzel, 2015)

Areas identified for as scope energy use reduction is available are as follows:

- Energy efficient site
- Construction waste material reusing and recycling
- Transportation fleet economization
- Sustainable supply chain
- Energy Efficient equipment
- Onsite energy monitoring & management

VI. QUESTIONNAIRE

In regards to find the feasibility of energy usage reduction the questionnaire was formulated to the target audience of the decision makers and the persons who can by their set of actions take notable steps towards onsite energy usage reduction. Thus the set of questions wereidentified towards Architects, Developers, Construction Managers &Site Engineers.
The starting question types were also formulated to understand the attitude, acceptance ofenergy crisis and willingness of taking steps against it. The areas where energy reduction can be possible were identified from the Literature Reviews and onsite self- observations. And the further questions were targeted based on these areas to check approaches

- At the moment we are being presented with a picture that we are living in an energy crisis. Do you think this so?
  - Yes
  - No
- Do you think that energy saving is important to you?
  - Yes
  - No
- Have you ever had an opportunity to reduce energy usage previously?
  - Yes
  - No
- If you had to monitor the use of energy, do you think it would help to become more aware about the importance of energy saving?
  - Absolutely yes
  - Maybe yes
  - Not Sure
  - Maybe Not
  - Absolutely No

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- How many of your past completed projects do you consider can stand on the atleast basic certification of GRIHA or LEED?
    - 0-1
    - 2-3
    - 4-5
    - None of the above
- What would motivate you to change your behavior to reduce the energy use? Tick as many as are relevant to you
    - Still increasing cost, eventually savings from them
    - Environmental reasons
    - Public relations
    - Any other_____
- How aware are you about energy efficiency labels and government subsidies related to it
    - Fully Aware
    - Little Aware about labels but don't know about subsidies or Viz
    - Not aware completely
    - Not sure
- Would you prefer to use the solid construction waste generated on site itself?
    - Absolutely yes
    - Maybe yes
    - Not Sure
    - Maybe Not
    - Absolutely No
- What do you consider as a barrier for usage of energy efficient equipment?
    - High price of high efficiency products
    - Energy efficiency products do not always save energy
    - Not cost effective because low electrical price
    - Lifecycle of products is too short, I don't need high efficient product
    - Any other_____

VII. Findings & Proposals

Analysis was done from the responses of 45 professionals of Satara working in residential projects consisting of Architects, Developers, Construction Managers & Site Engineers

Attitude and Acceptance: The analysis of the replies is done in percentages which can be seen in figure 1. It can be observed that the consciousness towards current energy scenario is above 80% in all the replies.

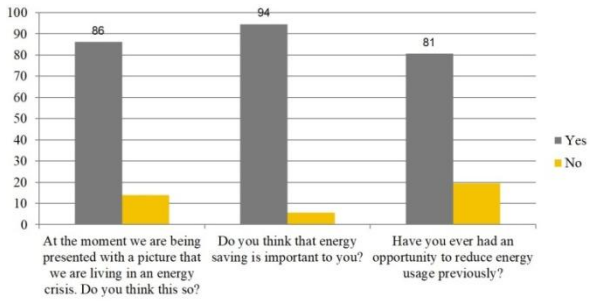

Figure 1: Graphical representation of attitude and acceptance questions replies in percentages

Within which even if 95% of the total respondents agree that energy saving is important to them, the steps towards energy reduction were a bit lacking that can be seen in the next set of replies of opportunity to reduce energy.

Energy Monitoring: Energy monitoring can be a first step towards energy conservation is acknowledged by more than 80% of the respondents. The monitoring process can guide through the understanding and decision making for the processes to make them more energy efficient

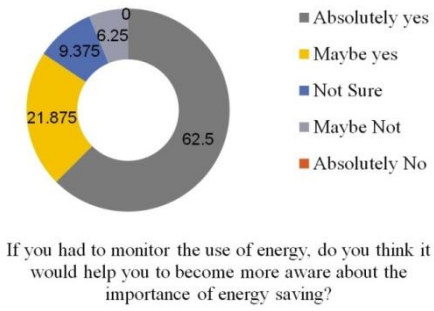

Figure 2: Percentile Representation of Energy Monitoring Replies

Green Building approach : More than 40 % of the respondents believe that more than 2 of their past projects are adherent to green building norms.

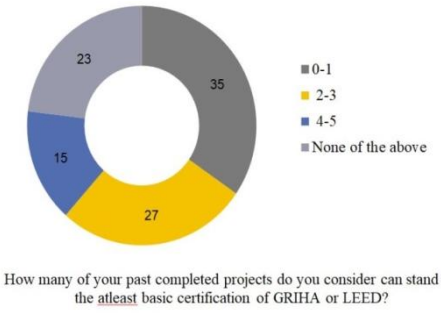

Figure 3: Percentile representation of Green building approach of respondents in past

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Motivational Factor:61% of the respondents claim that environmental reason is the major motivational force for them to change their behavior towards energy usage.

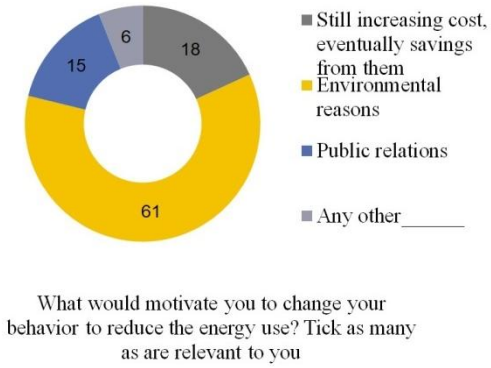

Figure 4: Percentile representation of motivational factors for energy reduction

While 18 % and 15 % respondents believe on increasing energy costs and public relations is their motivational force respectively. This proves that even though energy crisis is not acceptable by few respondents in previous questions but environmental change can be a catalyst. So considering renewable alternatives onsite could a solution generated from this motivational force.

Consciousness of Government Subsidies as motivational factor: Even though it is understood that government does not offer subsidies in the residential commercial sector. In private residences it can be a major expediter since MNRE offers upto 30 % of the subsidies against installation cost.

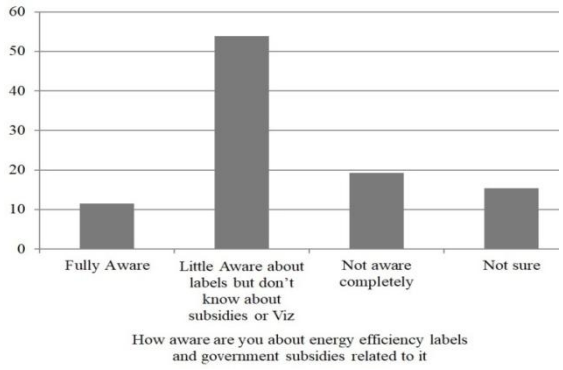

Figure 5: Comparative percentile representation of government subsidies awareness

So the awareness of construction professionals in this regard can be seen in figure 5. where more than 85% of the respondents are little to not aware of the government subsidies.

Solid Construction Waste:

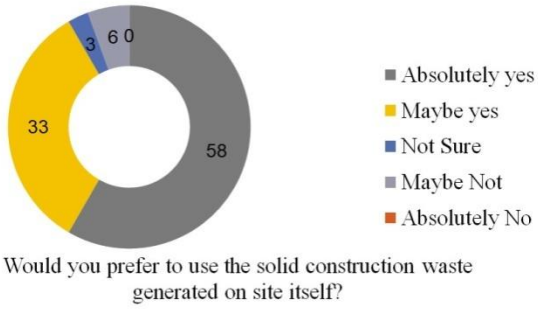

Figure 6: Percentile representation of preference for solid construction waste use onsite

Studies in the literature review have proven that transportation of construction waste is driving factor in increasing energy consumption as well as carbon footprint.In the figure 9 it can be seen that more than 90 % of the respondents believe in energy saving that can happen through utilizing it onsite.

Barrier for Energy Efficient equipment usage: More than 85% of the respondents believe that high prices of energy efficient products is a major deterring factor towards energy efficient equipment and they do not always save energy.

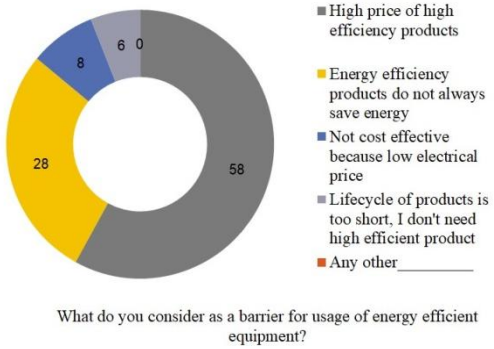

Figure 7: Percentile representation of respondents understanding for barrier of energy efficient equipment onsite

VIII. CONCLUSION & RECOMMENDATION

The potential to energy efficient construction site in residential sector definitely achievable since approach and understanding towards energy efficiency is in the right direction. The motivational forces such as subsidies and understanding of the potential cost savings could further help. Outreach programs by Policy makers, certification agencies could trigger the clearance of these road blocks.

High prices of energy efficient equipment is always going to be compared to the price of energy which has a vast

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difference and nothing can be done about it. If the market trends change with technological innovations making the energy efficient equipment more-cheaper, could make the possibility scenario to tackle this problem.

Policy makers, government agencies, certification agencies can take this data further to incorporate more attention towards the energy conservation in construction process by creating motivational drivers.

FURTHER RESEARCH

The understanding and approaches of sustainability onsite construction brings forward lot of aspects that can be further taken into construction. As far as onsite energy consumption is considered it can be further researched to quantification and with energy monitoring certain thumb rules can be achieved that can further on how much energy will be needed for any project in the initial stage itself so that the stakeholders can take prior decisions and steps to potentially make energy efficient premises or even plan for onsite renewable energy generation as per the need.

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I would like to express my deep and sincere gratitude towards my guide Prof. Laxmi Salgia for guiding me through this research. And I would like to express my sincrere gratefulness towards Prof. Aparna Pangati, Prof BhagyashreeApte& Prof. BhagyashreeKadiwal for inspiring and pushing me throughout this research process.

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Human Comfort in Green Rated Office Buildings

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ABSTRACT: Green rated office buildings are supposed to provide comfort to its occupants and have minimum impact on the environment, both indoor and outdoor. Perceived comfort is a major factor that affects occupant's performance in an office environment which seems to be neglected in green rating systems. This research presents findings of study conducted to understand occupant's perception of thermal comfort in IGBC rated office building in Pune city. It measured the parameters affecting thermal comfort and analyzed occupant's response through surveys and interviews. The results suggest that green building rating criteria are insufficient to fully capture comfort needs of the occupants and need holistic understanding of occupant's perception.

Keywords: Occupant Comfort, Thermal Comfort, Perception, Green Rated Office, Survey Questionnaires, Interviews

1. INTRODUCTION:

Human comfort in buildings can be defined as – "That condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation" (ASHRAE, 2010). Parameters of comfort include; personal factors, health and wellbeing, thermal comfort, indoor air quality, visual comfort, noise nuisance, ergonomics, and so on. "Similarly, occupant behavior is a driving factor of energy use in office buildings, which depends on the comfort criteria of personal choice. The fact that employees are the biggest expense in an office operation, it has compelled organizations to improve health, well-being, and productivity via optimization of workplace environments: day lighting, natural ventilation, natural view, open space, places of respite, and other comforts" (Fei Xue, 2016). More over the employees are often neglected with respect to their working environment conditions and thus it becomes more important to assess their comfort in order to maintain their productivity. In many of the offices which work on single shift basis the employees need to be concentrated in one space for almost 1/3rd of their daily time thus requiring proper amount of comfort. Generally Post Occupancy Evaluation (POE) uses objective measures of thermal comfort focusing on physical parameters and ignore how employees perceive the comfort conditions and their satisfaction. Thus, it becomes necessary to understand the comfort conditions of the employees as in an Indian, the country consists diverse climatic regions that provide varied thermal conditions.

2. CORRELATIVE STUDY OF HUMAN COMFORT PARAMETERS:

The rating of green rated buildings takes into considerations all the required factors for energy savings, resource conservation and human comfort. However, there is still a concern regarding the end user comfort in these buildings as most of the focus in Pre certification and Post Occupancy is given on energy and resources only. Many of the green rated offices do go for POE but, lack the analysis of end user comfort as it is perceived by them. IEQ (Indoor Environmental Quality) can negatively affect occupants' physical health (e.g., asthma exacerbation and respiratory allergies) through poor air quality, extreme temperatures, excess humidity, and insufficient ventilation and psychological health (e.g., depression and stress) through inadequate lighting, acoustics, and ergonomic design if not properly maintained even in a green rated building. (Amanjeet Singh M. S., 2010).

Most of the green rating systems follow various sustainability criteria's such as of resource conservation, energy conservation, material conservation and indoor environmental quality for which they state certain parameters to be fulfilled. These criteria's are to be fulfilled by the buildings for gaining their green certifications. Similarly the case study of an office building in Pune that was being considered also had these above mentioned criteria's fulfilled from which the IEQ criteria for thermal comfort were only considered for the research. The case study consisted of LEED India new construction green building rating certification. The parameters that were mentioned in the rating system regarding IEQ criteria's were studied in detail from the LEED India certification booklet provided to the building. Also, the human comfort conditions to be assessed were studied in detail from another building rating system of 'Well Building Standards'. These

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two above mentioned Green rating standards thus provided the base for assessing the research aim. However, from the below mentioned *Fig. 1* there is no parameter in the green building rating system that analyses the individual thermal comfort mentioned in well building standards. There is a lack of appreciation provided to the user thermal comfort in the green rated building.

COMPARISON BETWEEN WELL BUILDING AND OTHER GREEN BUILDING STANDARDS						
WELL BUILDING STANDARDS						
CRITERIAS (Affecting User health (psychological) and productivity)	FACTORS (That need to be studied)					Green building standards / WELL building standards
Light	Visual lighting design	Solar glare	low grade workstation design	Colour quality	Right to light	Daylighting levels (simulation)
Comfort (Thermal, Ergonomics, Luminous)	Physical and Visual working space design (as per standards)	Individual thermal comfort	Adaptable spaces	Spatial familiarity	Health, wellness and awareness	Olfactory comfort
Acoustic	Exterior noise intrusion	Internally generated noise	Sound masking	Sound reducing surfaces	Sound barriers	
Air	Smoking	Ventilation effectiveness	VOC Reduction	Cleaning protocol	Moisture management	Operable Windows

Fig. 1 (Comparison between WELL BUILDING and GREEN BUILDING standards used)

2.2 Previous Methodology for measuring perceived thermal comfort and process for analyzing the perception of the users -

The methodology for collection of the data in human comfort studies consists of 2 processes of subjective data collection through Survey Questionnaires, Interviews and Observations while objective data collection through measurements of the factors affecting human comfort in the building. (Spengler, 2015). However just by using one of the above subjective methods to assess comfort the results that will be generated won't be appropriate and trustworthy. Hence there needs to be collaborative methods used to get data for the study by considering both survey questionnaires and interviews. Similarly the measurements of the architectural parameters affecting comfort factors need to be done to correlate it with the subjective data. The perceived comfort of the users can be analyzed through various techniques which are mentioned in the research papers that are studied such as frequency analysis, scaling, t-test, z-test, chi-square test etc. (Amanjeet Singh M. S., 2010). However, all these techniques can't be used in all forms of researches as they require specific sample size and response parameters. For this research the analysis tool used is of frequency analysis which is structured using the survey questionnaire responses.

3. METHODOLOGY:

3.1 Overview of Methodology –

The research is based on 3 major parts of study. These 3 major parts include:

Secondary data collection by reading through topic related research papers, articles, drafts or guidelines, study reports etc. which provide solid base for setting up primary on site data collection as well as for future analysis.

Primary data collection by carrying out Live case study and measuring physically the various Architectural IEQ parameters that affect human thermal comfort as well as gathering human perception data by asking people to fill in their views in survey questionnaire. Also, taking personal interviews of certain people form the sample selected.

Analyzing Secondary and Primary data collected by making a correlation in between them. The analysis thus helps to find out the overall perception of the end users with respect to their thermal comfort conditions.

3.2 Methodology Framework –

The Framework consisted of objectives that were to be studied during the research for which various comfort factors were listed down from different literatures. These objectives formed a part of the 3 major study parts mentioned in *section 3.1*. Following are the different objectives and their relative comfort factors derived from literature study –

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1) Objective – To study why human comfort is important in office buildings.
   Factors relative – Workspace productivity, psychological Impacts.
2) Objective – To understand how and what factors affect human comfort in green rated office buildings.
   Factors relative – Air quality, temperature, humidity, ventilation, lighting, acoustics, ergonomic design.
3) Objective – To shortlist and measure the parameters that are considered for this research study which affect human comfort in an office building.
   Factors relative – <u>All factors</u> : Air quality, temperature, humidity, ventilation, lighting, acoustics and ergonomic design.
   <u>Factors considered for study</u>:
   Thermal Conditions - Temperature, Humidity and Air changes.
4) Objectives – To analyze, which of above mentioned parameters affect the human comfort and in what way.
   Factors relative – Human perceived comfort, data representation.

4. CASESTUDY AND ANALYSIS:

The Corporate office complex in Pune which was selected for study is IGBC Platinum rated green building that consists of a G+3 floor office building. All the floors consist of workspaces with different departments on each floor. The office building is centrally air conditioned with maintained temperatures on each floor and there is a main atrium joining every floor centrally. Thus, considering the requirement of the research for open workspace with capacity employees of more than 30 in number, first floor of the office was selected for the study. The office consisted of employees with diverse age groups. Also, the employees had a specific dress code to be worn during work provided by the office management of full sleeves formal shirt and a trousers. Some other details regarding the office are provided below:

- Timings: 9am to 5:30 pm.
- Lunch break: 12 pm to 2 pm (any 45 min. in between the mentioned hrs.).
- Tea break: Not formally in schedule, but employees usually prefer in between 3:30 pm to 4:30 pm.

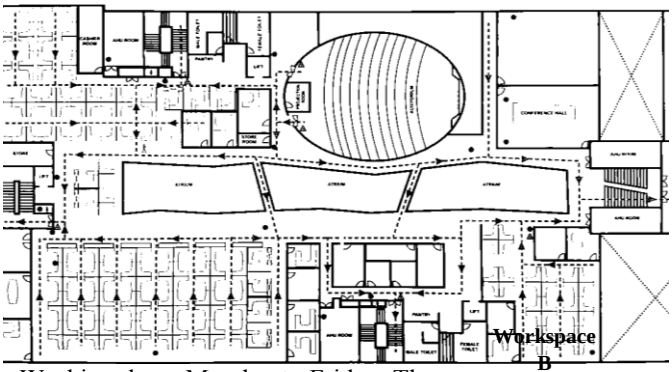

Fig. 2 (Office floor plan – 1st floor)

- Working days: Monday to Friday. The Case study consisted of 2 spaces that were studied on the same floor of the office building which were oriented in different directions. One was a larger workspace area with cubicles that faced the South while the other one was a smaller workspace that faced the North. However, the employees using the Workspace A and B were 70 and 36 respectively. Thus the workspace B had more population density as compared to the workspace A. The method of the study consisted taking readings of temperature for 3 times of the day i.e. Morning, Afternoon and Evening and conducting survey questionnaires and interviews of 20 and 3 ppl each respectively in both the workspaces. The questions were asked with respect to how the people perceived thermal conditioning within the office space throughout the day.

<u>Workspace A – Data and Analysis</u>

<u>Physical Measurements –Temperatures in °C</u>
Inside temp. – DBT ranges 25-26-25.5 and WBT ranges 20.5-22.5-22 from morning to evening.
Outside temp. – DBT ranges 26-27-25.5 and WBT ranges 23.5-25-19.5 from morning to evening.

<u>Survey Questionnaire – Perception data</u>

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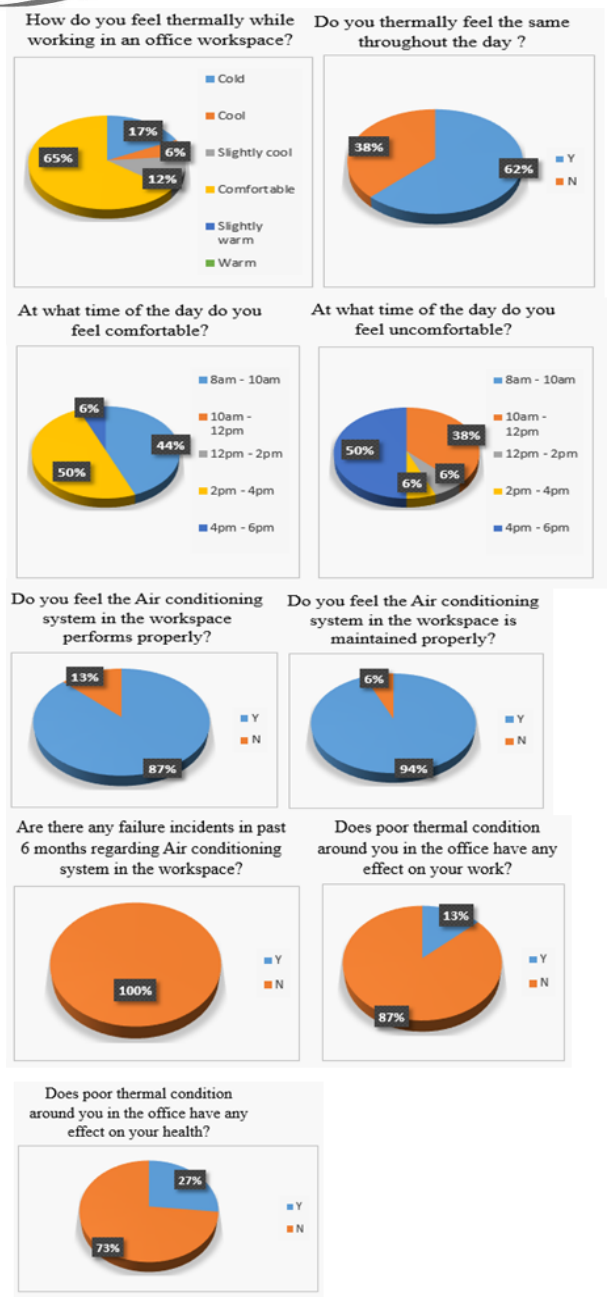

Fig. 3 (Survey responses)

Interviews – Personal perceptions from users

"Sudden cooling happens due to zonal air conditioning system as perceived by the user."

Workspace B - Data and Analysis

Physical Measurements –Temperatures in °C

Inside temp. – DBT ranges 25-26-25.5 and WBT ranges 23-23.5-22 from morning to evening.

Outside temp. – DBT ranges 26-27-25.5 and WBT ranges 23.5-25-19.5 from morning to evening.

Survey Questionnaire – Perception data

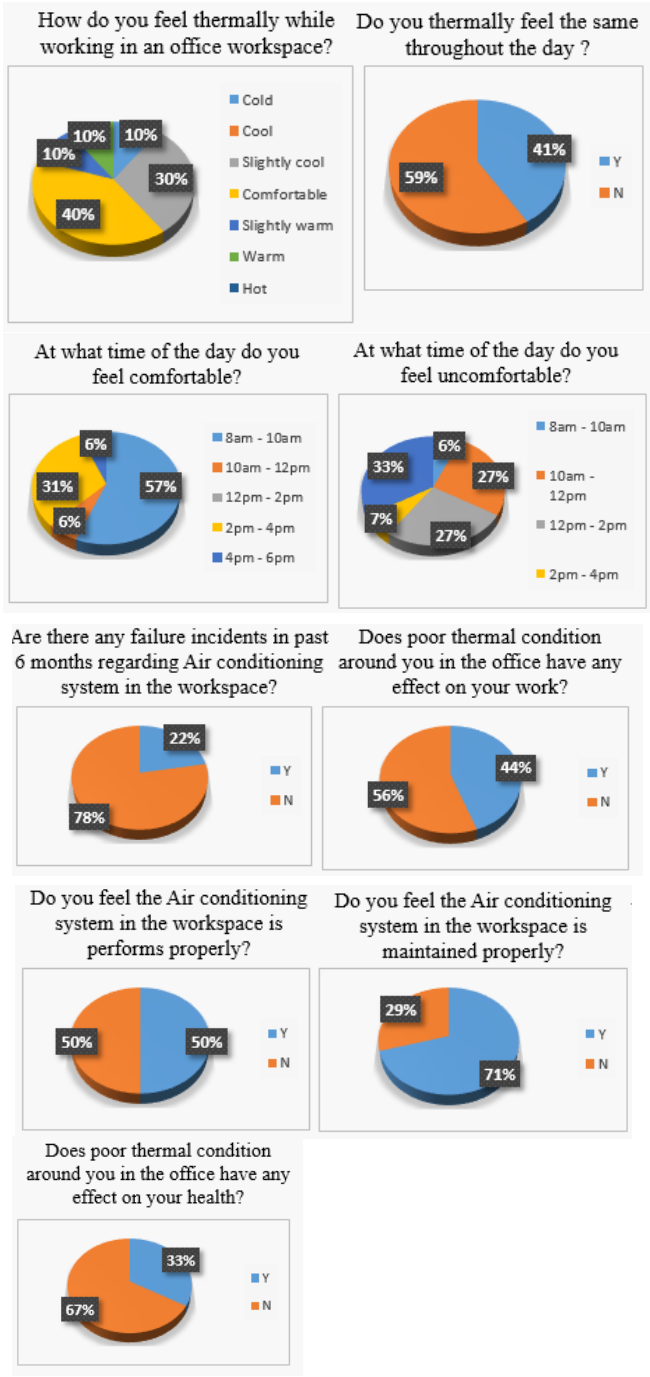

Fig. 4 (Survey responses)

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Interviews – Personal perceptions from users

"Air conditioning system are not maintained properly as well as there is no proper temperature adjustment."

5. RESULTS AND INFERENCES:

Inferences from the survey and interviews –

Workspace B

1) In this case the perception of the employees towards thermal comfort was changing due to improper conditioning of overall space.
2) The thermal comfort majorly depended on how the individual employee perceived it, however most of the employees were not content with the ventilation supply as well as maintenance.

Workspace A

1) In this case the employees had lesser troubles as compared to Workspace B, However there was discomfort as perceived by the employees regarding the zonal cooling from the A.C. system which fluctuated from time to time.
2) Also, employees sitting near to the glazing felt more heat during summers as compared to those sitting to the inside.

Correlation between green rating criteria's followed and human perception results through study –

Factors	Workspace A Perception	Workspace B Perception	Fulfilled Criteria's	Green Rating Criteria's
Thermal Comfort	NOT PROPER	NOT PROPER	Y	Controllability of systems
	N	N	N	Thermal Comfort Design
	N (NOT CONSISTENT)	N (NOT CONSISTENT)	N	Thermal Comfort , Verification

Table 1 (Correlation between green rating criterias and human perception)

6. CONCLUSION:

The Research study and its results suggest that there is a lack of appreciation provided towards the thermal comfort of the users in the building. The users perception tells us that there is a lack of correlation between the designing and the managing of the internal ventilation system (i.e. Air Conditioning). The green rating criteria's do not fulfill the comfort parameters required as shown in *Table 4*. As a result we can state that human thermal comfort in green rated office buildings is neglected in the considered case.

7. ACKNOWLEDGEMENT:

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Study of Existing High Rise Buildings Shadows on the Basis of their Geometry

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Abstract: High rise buildings are a symbol of modern life, wealth to the city and also introduces modernity. However, they are known for their shape and form. In high rise buildings, casting of shadows plays an important role as they tend to cover their neighboring buildings firstly because of their humongous height but also with their concrete mass.To attain these purposes, comparison of existing high-rise buildings will be analyzed to consider shadow pattern from different forms i.e. triangle, square, oval, rectangle and circle and at different heights. In conclusion, the results will be summed up for the best appropriate geometry for high rise buildings on the basis of shadow length and area underneath shadow.

Keywords: High rise buildings, shadow pattern,neighboring, geometry.

I. Introduction

The high-rise building, more than any other building type, has the capacity to capture the public imagination, its sheer scale, visual prominence, and symbolic potential have rendered it a speculative enterprise, economically, technologically and architecturally. The skyscraper is representation of cities around the world. From New York to Kuala Lumpur, London to Hong Kong and Singapore to Sao Paolo, high-rise buildings define the image of metropolis. The high-rise buildingshave been called a “social condenser” and a “vertical machine” and yet it has traditionally been seen as a building type outside the mainstream of architectural culture.

Despite its close relationship to development forces the multistory buildinghas created as provocative and unique range of architectural approaches to its design. Perhaps because of those very ties, it serves as a barometer of contemporary culture.Multistory buildings can also stimulate issues like wind flow, view, sunshine and air pollution. High-rise building can get a sun solar easily especially the upper floors because of its height. What about the impacts of the building on the surroundings area, making shadow and avoiding getting sun solar directly from the sun are the appear points that many researchers concede about it. The effects of this shadow and shading are change in different climate and block the sun with change the access, sun light and solar sun.

As clear that this shading goes back to a number of factors as:

- Differences in height of buildings (sky line)
- Tall buildings direction and location according to surrounding neighborhoods (with sun path and time)
- Mass and form (geometry)
- Urban space between the buildings (distance)

High rise buildings, although they are mostly well-known symbolic figures of metropolises, have been criticized since their first development. Primarily, opponents to tall building construction cite their huge mass as contrary to human nature; with their excessive energy consumption; the extra pressure they cause on city infrastructure; and the exacerbation of already difficult issues such as traffic and parking. Further, opponents object to their unnatural indoor conditions that adversely affect occupant health, and their role in the lowering of the economic viability of surrounding land by blocking the light, air, and view (Bronin, 2009).

The effects of shading by one building upon another can be either positive or negative depending upon the site-specific circumstances of the properties involved. A potential benefit of shading for adjacent structures may be a cooling effect gained during warm weather. Negative consequences of shading include the loss of natural light for passive or active solar energy applications or the loss of warming influences during cool weather. Factors influencing the relative impact of shadow effects are site-specific and include differences in terrain elevation

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between involved properties, the height and bulk of structures, the time of year, the duration of shading in a day, and the sensitivity of adjacent land uses to loss of sunlight.

Tall buildings block the sun of their surrounding environment and change their 'solar access', properties. Reduction at sun light is an important issue for energy efficiency, vegetation, and daylight properties of indoors. With the growing interest in sustainability, the use of sunlight has begun to play a major role in building design and green architectural strategy. This paper highlights the different form of high-rise buildings that can cast different type of shadows and also analyze the best suitable shape forless amount of shadow cast on surrounding buildings. Shadows look different, and even take on different shapes, when cast from different perspectives.

II. Methodology and Results

Famoushigh-rise buildings from different cities with different shape and form has been selected for the analysis of shadowlength and shadow zone.These buildings are:

a) Flatiron Building,NewYork
b) Agbar Tower, Barcelona
c) Picasso Tower, Madrid
d) 30 St Mary Axe (Thegherkin), London
e) Jin Mao Tower, Shanghai

LOCATION - NEWYORK	LAT - 40° 71' N , LONG – 74° 00' W			
	JUNE SOLSTICE		DECEMBER SOLSTICE	
TIME	Azimuth(Az)	Altitude(Al)	Azimuth(Az)	Altitude(Al)
9 A.M	90°	37°	139°	14°
12 NOON	140°	68°	181°	25°
4 P.M	259°	49°	239°	6°

Table 2: Sun Chart of Flatiron, New York

Each structure is selected on the basis of their form, footprint, shape and elevation. Table 1 describes the details about the location of the building, latitude, longitude, numbers of floors, building height, footprint shape, built year and their architects. All the cities chosen falls above Tropic of Cancer.

Sun Chart provides azimuth and altitude angles of sun which is manually derived from sun path diagram depending on their location and latitude of the structure. The sun chart gives seasonal-and-hourly positional changes of the sun as the Earth rotates.

June and December months are considered for every location due to the summer and winter solstice (Shadows cast by structures vary in length and direction throughout the day and from season to season. Shadow lengths increase during the "low sun" or winter season and are longest on December 21-22, the winter solstice. The winter solstice, therefore, represents the worst-case shadow condition and the potential for loss of access to sunlight that a project could cause is greatest. Shadow lengths are shortest on June 21-22, the summer solstice.).Of the total amount of the sun's energy available during a daylight period, approximately 85% of it reaches the earth between 9:00 a.m. and 3:00 p.m. Shadow length will be calculated for 9am, 12 noon and 4pm to understand the best suitable shape and form for high rise building. Similarly, for other cities the sun chart has been made which will be used to study shadow pattern depending on their shape and form.

LOCATION - BARCELONA	LAT - 41° 38' N, LONG – 2° 17' E			
	JUNE SOLSTICE		DECEMBER SOLSTICE	
TIME	Azimuth(Az)	Altitude(Al)	Azimuth(Az)	Altitude(Al)
9 A.M	82°	27°	128°	6°
12 NOON	118°	60°	167°	24°
4 P.M	245°	60°	223°	11°

Table 3: Sun Chart of Agbar Tower, Barcelona

LOCATION - MADRID	LAT - 40° 41' N, LONG – 3° 70' W			
	JUNE SOLSTICE		DECEMBER SOLSTICE	
TIME	Azimuth(Az)	Altitude(Al)	Azimuth(Az)	Altitude(Al)
9 A.M	78°	22°	124°	3°
12 NOON	110°	56°	161°	23°
4 P.M	239°	62°	219°	15°

Table 4: Sun Chart of Picasso Tower, Madrid

LOCATION - LONDON	LAT - 51° 50' N, LONG – 0° 12' W			
	JUNE SOLSTICE		DECEMBER SOLSTICE	
TIME	Azimuth(Az)	Altitude(Al)	Azimuth(Az)	Altitude(Al)
9 A.M	97°	36°	139°	5°
12 NOON	151°	59°	180°	15°
4 P.M	247°	45°	232°	-1°

Table 5: Sun Chart of Gherkin, London

LOCATION - SHANGHAI	LAT - 31° 23' N, LONG – 121° 47' E			
	JUNE SOLSTICE		DECEMBER SOLSTICE	
TIME	Azimuth(Az)	Altitude(Al)	Azimuth(Az)	Altitude(Al)
9 A.M	90°	50°	137°	21°
12 NOON	186°	82°	182°	35°
4 P.M	277°	35°	235°	9°

Table 6: Sun Chart of Jin Mao Tower, Shanghai

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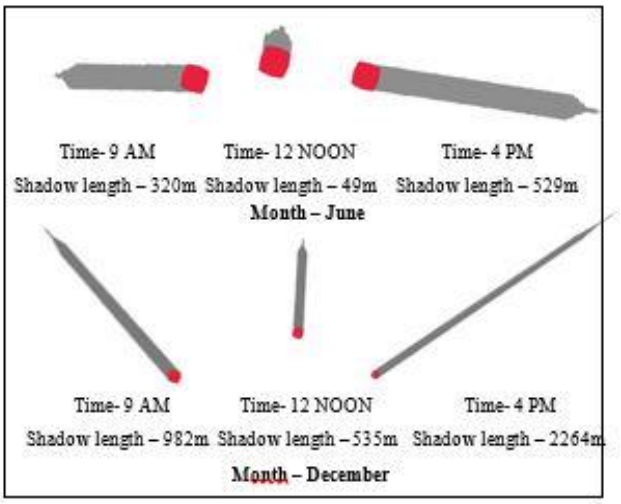

Figure 5: Shadow length of Jin Mao Tower, Shanghai

Shadows are cast to the west by objects during the morning hours when the sun is coming up on thehorizon in the east. During late morning and early afternoon the shadows of objects move northerly and by late afternoon they are cast easterly in response to the apparent movement of the sun across the sky from east to west. Shadows cast in winter are longer, and those at the winter solstice the longest.

To determine shading impacts of the existing structures, their shadow lengths were calculated and their patterns projected in plan view on site. Both winter and summer solstice shadow patterns were examined to document the full (high to low) range of shadow impacts by their shape. A 3D model was made in Sketchup 2018 for all five structures. Shadow settings were applied on 21st June and 21st December, specifically at 9 am, 12 noon and 4 pm.

The shade study graphics were completed through the following process:

1. 3D design model exported from Sketchup 2018 to AutoCAD 2016.

2. Model simplified to remove unnecessary elements (i.e., interior and underground features).

3. Initial base image of the model exported without shadows.

4. Shadow settings applied on the location of the Project site according to the specified dates and times.

5. Model and various shadow settings overlain onto the base orthophoto, to scale.

6. For clarity, enhanced contrast applied to shadows and proposed infrastructure using Photoshop.

7. Shadow zone calculated by overlapping shadow images from 8 am to 4 pm in Photoshop for every form.

HIGH RISE BUILDINGS	JUNE SOLSTICE	DECEMBER SOLSTICE
FLATIRON BUILDING	1:18	1:140
AGBAR TOWER	1:20	1:145
PICASSO TOWER	1:22	1:150
THEGHERKIN	1:14	1:180
JIN MAO TOWER	1:25	1:175

Each shape casting different shadow pattern on ground for their respective height and latitude. The shape of the structures to be designed in such a way that minimum shadow impact on ground level. By analysing the shadow pattern surrounding site function can be designed deliberately. The data in table 7 indicates that the building with the circle footprint (The Gherkin) has less ratio in June solstice but in winter solstice it has the maximum ratio as compared to other building form because of its shape and height. Similarly, for the square shape building(Jin Mao Tower) the ratio is slightly more than the rest of the structures due to the height, building footprint but December solstice ratio is less than the circle shape building. So that leads to the inference for better shape for high rise could be a **square shape building**.

A square shape high rise building might have less shadow zone and shadow length as compared to other forms. All the shadow is casted on the Northeast and Northwest side of the building. In December solstice, all the shadow pattern is of linear shape while in June solstice,

a. Flatiron Building and Picasso Tower has rectangular shape shadow pattern
b. Agbar Tower has flower shape shadow
c. The Gherkin has petal shape shadow
d. Jin Mao Tower has linear shadow pattern

IV. Conclusion

High rise buildings of their shadow can reach very far away from their location. All types of forms of buildings has an overshadowing effect on a geographical wide area. Structure are located on the northern hemisphere above Tropic of Cancer so, the affected zone lies on Northeast and Northwest in June solstice and summer solstice. The solar access of building is obstructed by all different forms resulting in serious reduction of solar energy. If more than two or three high rise buildings are close to each other than their shadow zone would be wider and stronger. According to the observation, square shape might be the best form for a high-rise building. Different forms of high-rise building demonstrate different shadow pattern for various latitudes which indicates that shape does matter and their shadow as well for surrounding areas. And also, orientation of the high-rise building affects the core building spaces. This study helps to design zoning of surrounding area for better quality of life.

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HIGH RISE BUILDINGS	FLATIRON BUILDING	AGBAR TOWER	PICASSO TOWER	30 ST MARY AXE (THEGHERKIN)	JIN MAO TOWER
LOCATION	New York, USA	Barcelona, Spain	Madrid, Spain	London, England	Shanghai, China
LATITUDE AND LONGITUDE	40° 71' N, 74° 00' W	41° 38' N, 2° 17' E	40° 41' N, 3° 70' W	51° 50' N, 0° 12' W	31° 23' N, 121° 47' E
FLOORS	21	38	45	41	88
HEIGHT	87 m	144 m	157 m	180 m	420 m
FOOTPRINT SHAPE					
BUILT IN YEAR	1901-1902	2001-2005	1982-1988	2001 - 2004	1994-1998
ARCHITECT	Daniel Hudson Burnham	B720 Arquitectos,jean Nouvel	Minoru Yamasaki	Norman Foster, Ove Arup & Partners, Ken Shuttlewort	Owings & Merrill Skidmoreadrian Smith

Table 1: High Rise Buildings Data

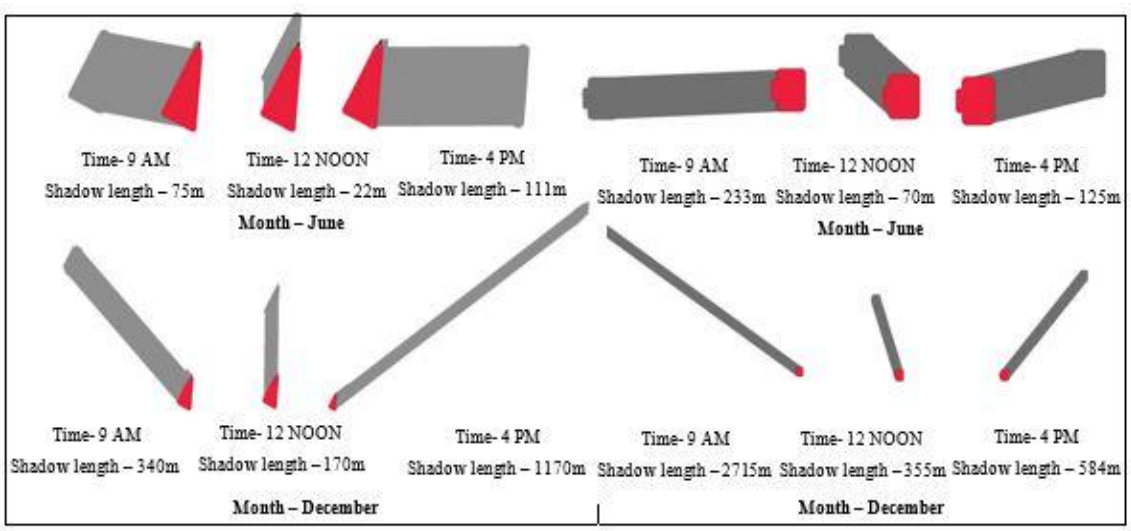

Figure 1: Shadow length of Flatiron Building, New York

Figure 3: Shadow length of Picasso Tower, Madrid

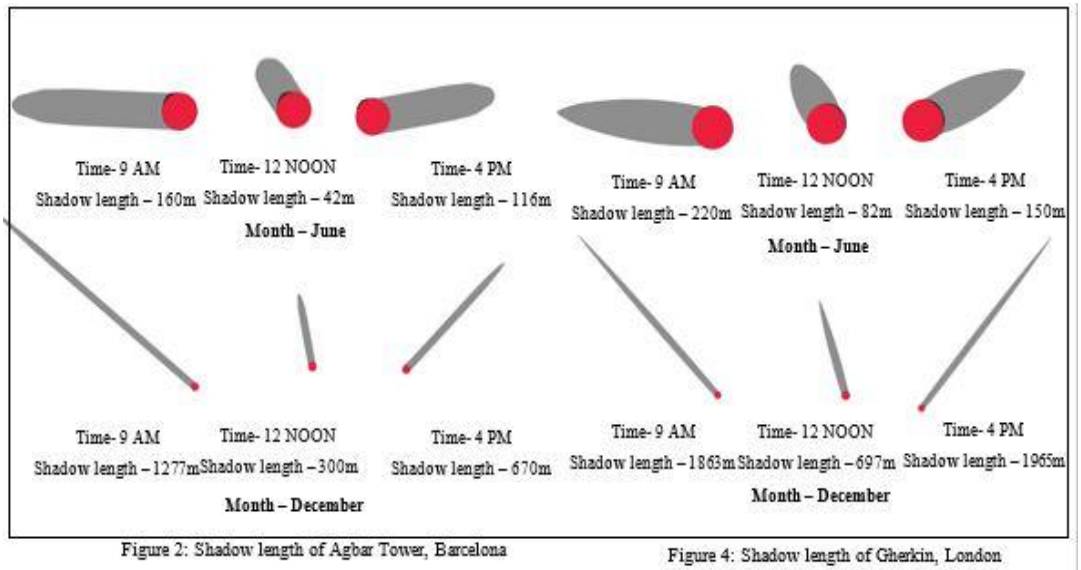

Figure 2: Shadow length of Agbar Tower, Barcelona

Figure 4: Shadow length of Gherkin, London

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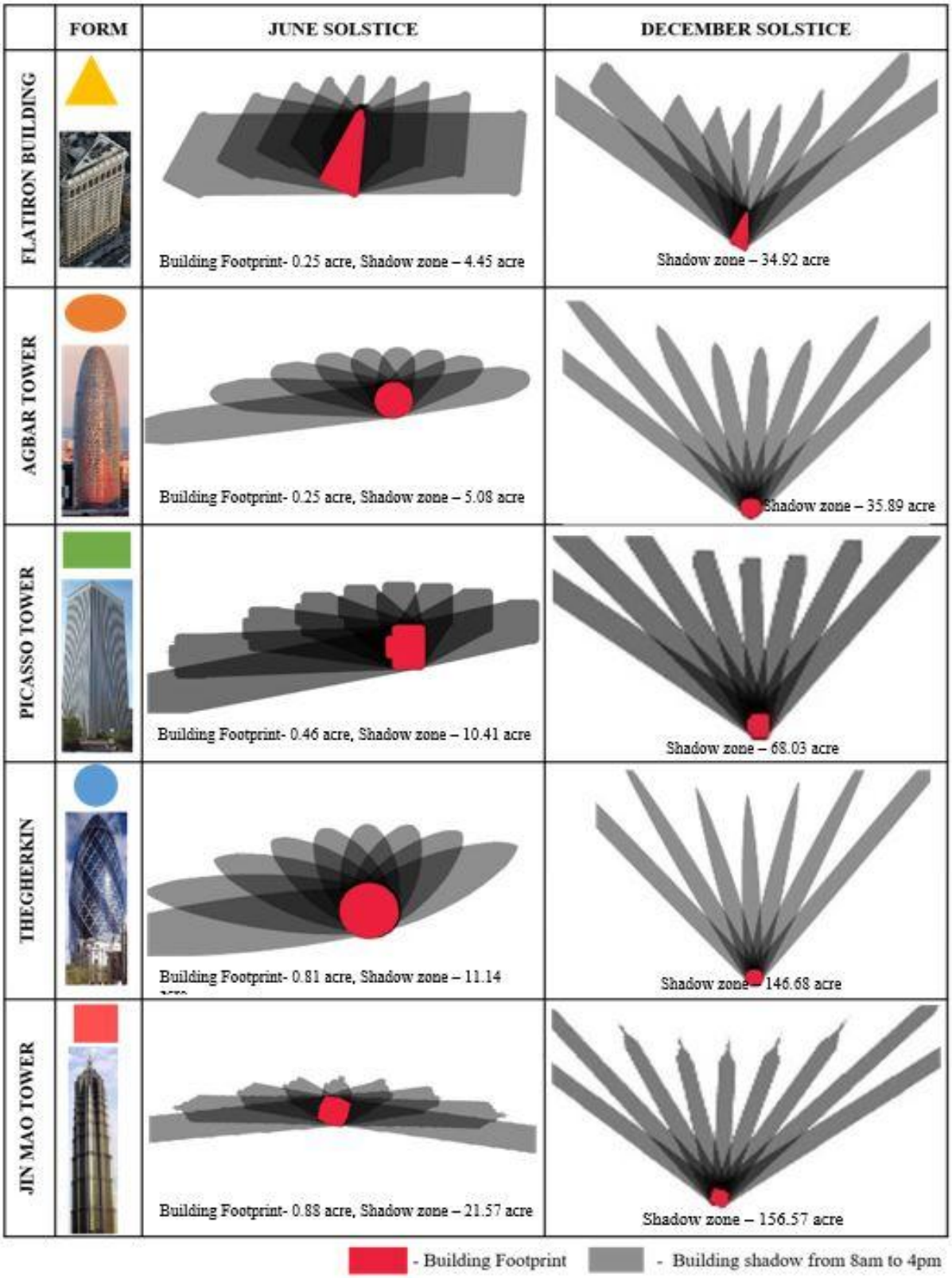

Chart 1: Shadow Pattern of all Five High rise buildings

Chart 1: Shadow Pattern of all Five High rise buildings

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3.4.6 Number of books and chapters in edited volumes published per teacher during the year

3.4.6.1: Total number of books and chapters in edited volumes / books published, and papers in national/international conference-proceedings during the year

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication	ISBN/ISSN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher	Link
1	Savita S Yadav	Experiments on Micellar Liquid Chromatographic Method for Simultaneous Determination of Atenolol and Aspirin in Bulk and Pharmaceutical Dosage Form	Trends in Pharmaceutical Research and Development / Vol 4			National	2021	9789390206667	BVDU, Poona College of Pharmacy, Pune	Book Publisher International, India	https://www.2pressrelease.net/experiments-on-micellar-liquid-chromatographic-method-for-simultaneous-determination-of-atenolol-and-aspirin-in-bulk-and-pharmaceutical-dosage-form/#page-content
2	Vividha Dhapte-Pawar, Piyush Mehta and Prathmesh Kenjale	Micropastics and Nanoplastics: Origin, Fate and Effects	Analysis of Micropastics and Nanoplastics in Food			International	2021	9781138600188	BVDU, Poona College of Pharmacy, Pune	CRC Press (Taylor & Francis)	https://www.taylorfrancis.com/chapters/edit/10.1201/9780429469596-1/microplastics-nanoplasticsorigin-fate-effects-vividha-dhapte-pawar-piyush-mehta-prathmesh-
3	Deepa Mandlik and Rajesh Mandlik	Therapeutic Implications of Cytokines in the Treatment of Inflammatory Bowel Disease (Page no.	Cytokines: Roles and Therapeutic Implications			International	2021	9781536190366	BVDU, Poona College of Pharmacy, Pune	Nova Publisher, USA	https://novapublishers.com/shop/cytokines-roles-and-therapeutic-implications/
4	Piyush P. Mehta, Atmaram P. Pawar, Kakasaheb R. Mahadik, Shivajirao S. Kadam and Vividha Dhapte-Pawar	Dry Powder Coating Techniques and Role of Force Controlling Agents in Aerosol (41-74)	Polymers Coatings: Technology and Applications			International	2020	9781119654995	BVDU, Poona College of Pharmacy, Pune	Wiley and Scrivener Publishing LLC, USA	https://onlinelibrary.wiley.com/doi/abs/10.1002/9781119655145.ch3
5	Piyush Mehta, Kakasaheb Mahadik, Shivajirao Kadam and Vividha Dhapte-Pawar	Advanced applications of green hydrogels in drug delivery systems (89-130)	Applications of Advanced Green Materials			International	2020	9780128204849	BVDU, Poona College of Pharmacy, Pune	Elsevier, UK and Woodhead Publishing	https://doi.org/10.1016/B978-0-12-820484-9.00004-0
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Chapter 6
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Experiments on Micellar Liquid Chromatographic Method for Simultaneous Determination of Atenolol and Aspirin in Bulk and Pharmaceutical Dosage Form

Savita S. Yadav[1*]

DOI: 10.9734/bpi/tprd/v4

ABSTRACT

Micellar liquid chromatographic method has been developed for the simultaneous determination of Atenolol and Aspirin in a bulk drug and pharmaceutical formulation. Chromatographic separation achieved isocratically on ODS hypersil C18 column (5 µm, 250 mm × 4.6 mm) and micellar mobile phase of 0.07M sodium dodecyl sulfate (SDS) pH 3 adjusted with phosphate buffer and 15% (v/v) 1-propanol as organic modifier in the ratio 70: 30 v/v and ultraviolet detection at 225 nm are used for the determination. Under these conditions, the studied Aspirin and Atenolol elute between 4.033 ± 0.02 and 6.042 ± 0.031 min at a 1 mL/min flow rate. Parameters such as linearity, precision, accuracy, specificity and robustness are studied as reported in the ICH guidelines. Linearity for Atenolol and Aspirin was in the range of 2-12 µg/mL and 4-24 µg/mL respectively. The mean recoveries obtained for Atenolol and Aspirin were 99.55 and 99.61% respectively. Developed method was found to be accurate, precise, selective and rapid for simultaneous estimation of Aspirin and Atenolol.

Keywords: Atenolol; aspirin; MLC; simultaneous determination; validation.

1. INTRODUCTION

Micellar liquid chromatography (MLC) is an efficient alternative to conventional reversed-phase liquid chromatography with hydro-organic mobile phases. Most MLC procedures uses hybrid micellar mobile phases containing a surfactant above the critical micellar concentration and a relatively small amount of organic solvent to increase the elution strength and improve the efficiencies. The anionic sodium dodecyl sulphate (SDS) is the most usual surfactant in MLC, but it also requires the addition of an organic solvent to decrease the retention times and increase the efficiency. In particular, positively charged basic compounds are strongly retained by the stationary phase modified by adsorption of SDS monomers and require the addition of a strong solvent, such as propanol or pentanol [1-3].

Atenolol (ATN), 4-(2-hydroxy-3- [(1-methylethyl) amino] propoxy] benzeneacetamide, is an antihypertensive, antianginal, and antiarrhythmic [4]. Aspirin (ASP) is chemically, 2-(acetyloxy) benzoic acid and exerts its antiinflammatory, analgesic and antipyretic actions. Aspirin and other non-steroid anti-inflammatory drugs (NSAIDs) inhibit the activity of the enzyme called cyclooxygenase (COX) which leads to the formation of prostaglandins (PGs) that cause inflammation, swelling, pain and fever [5].

Literature survey revealed that there are several methods available to determine ATN and ASP either alone or in combination with other drugs in pharmaceutical formulations and biological fluids using various analytical techniques such as spectrophotometric techniques [6-8], several methods based on separation techniques, including HPTLC [9-10], LC–MS [11-12] and HPLC [13-16] have been also

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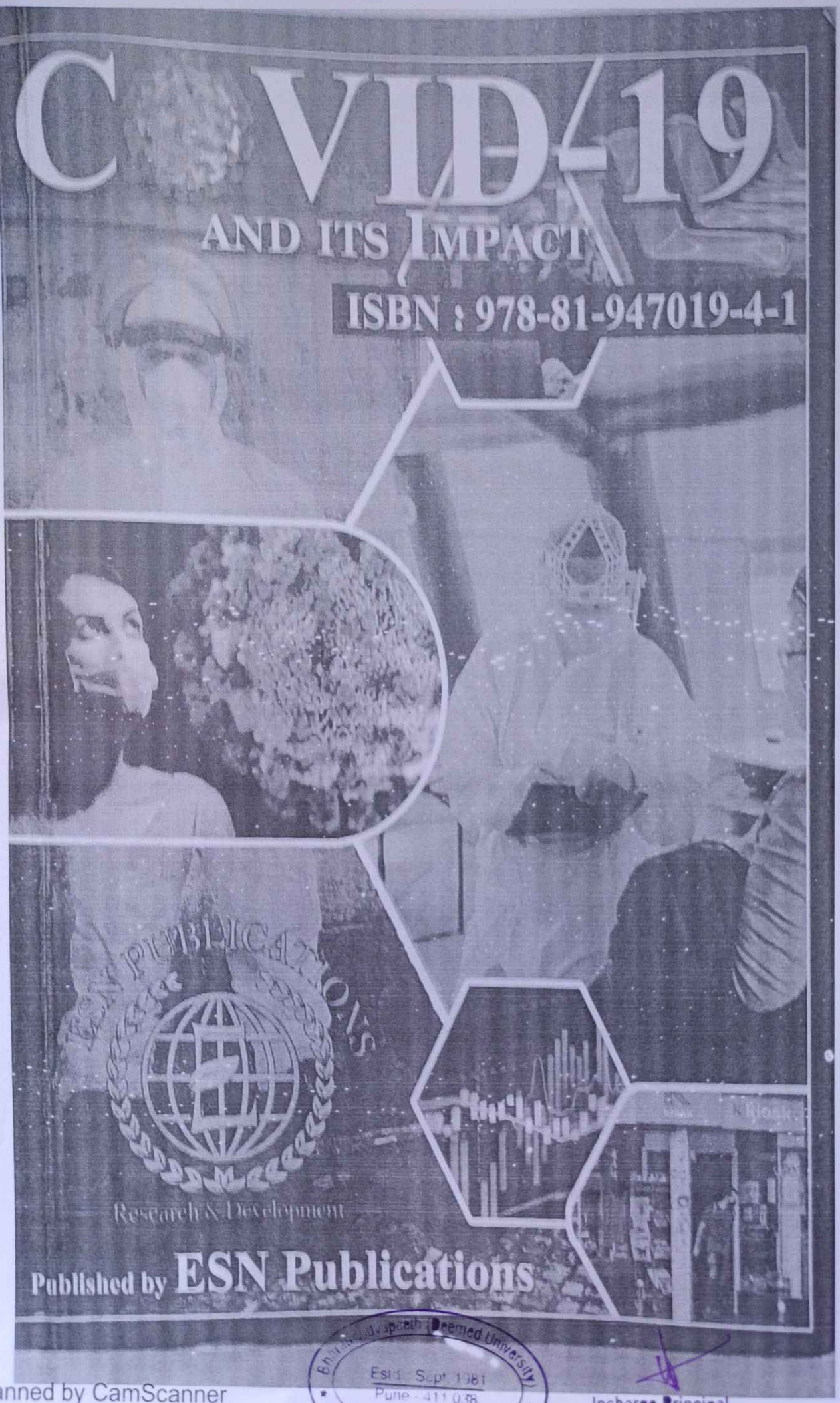

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CHAPTER 1

Microplastics and Nanoplastics
Origin, Fate and Effects

Vividha Dhapte-Pawar, Piyush Mehta and Prathmesh Kenjale

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1.1 INTRODUCTION

Plastic is a synthetic or semi-synthetic material with a varied range of consumer and industrial applications [1]. These synthetic materials are mostly fabricated from polymers built around chains of carbon atoms, mainly with hydrogen, oxygen, sulfur and nitrogen between the spaces [2]. The term "plastic" is derived from the Greek word "plastikos," meaning suitable for molding [1]. Global production of plastics has increased over the past years and is still enduring (Figure 1.1). Because of poor waste management practices, plastic in the environment, as well as oceans, is also increasing rapidly [3]. It is projected that around 60% of all plastics ever made have accumulated in landfills or the natural environment [4].

Nowadays, plastic items are being manufactured in all shapes and sizes, with the micron and submicron ranges considered to be "micro- or nanoplastics," also termed as "primary micro- or nanoplastics." While, on the other hand, in the environment, the breakdown of large plastic items into small micron or nano-sized fragments are termed as "secondary micro- or nanoplastics." They appear in various micro, as well as in nano, forms, such as fragments,

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Chapter 1

CURRENT VIEWS ON THE ROLE OF CYTOKINES IN THE REGULATION OF IMMUNE REACTIVITY AND THEIR ROLE IN PATHOLOGY OF THE IMMUNE SYSTEM

*Halyna Koval, Andrii Berbets**
and Oleksandr Yuzko
Bukovinian State Medical University, Chernivtsi, Ukraine

ABSTRACT

Cytokines are commonly considered as "language of intercellular interaction" since they send signals and commands to the cells to perform a certain function by the cell or tissue. Also, cytokines are participants and regulators of pathologic process, mostly of inflammation. Despite of not being antigen-specific mediators, in recent studies cytokines have demonstrated different patterns of production and interaction with other cytokines; therefore, cytokines can be considered as diagnostical markers and possible targets for therapeutic measures. The mentioned approach is

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long-term inflammatory processes IL-1, TNF, IL-6 and other cytokines accumulate in the blood [6, 7, 8].

There is a network of cytokine-specific membrane receptors in the human body. They are found in all types of cells which implement the function of cytokines in the organism [7]. Moreover, there are free soluble cytokine receptors in the blood. This is an important mechanism for controlling cytokine function, since the realization of a signal and the activation of a cell occur when a cellular "receptor-cytokine" interaction takes place, and binding of the cytokine molecule to the free soluble form of the receptor neutralizes it. After binding to the target cells' receptors, cytokines activate a complex cascade of intercellular signals. The most common of these pathways is the protein kinase transduction cascade, which is activated by a process known as phosphorylation, with most cytokines transmitting their signals through a separate family of tyrosine kinases called Janus or JAK kinases. Cytokine receptors activate many signaling pathways that determine the nature of the immune response and implement various types of inflammation [7, 8, 9].

Cytokines are the key modulators of all inflammatory processes in the body; they control all stages of the immune response. They affect proliferation, differentiation, migration and activation of most cells (B and T lymphocytes, as well as NK cells, monocytes/macrophages, granulocytes, mature neutrophils, mast cells, basophils and eosinophils) and interact with other molecules, by activation of factors of adhesion and by synthesis of chemotaxis factors in particular. In this case, cytokines and adhesive molecules produce a mutual regulatory effect. Hydrolases produced by various cells are able to "split" or to inactivate cytokines, and block their production. In addition, they are able to inhibit the expression of cytokine receptors, causing them shading, as well as to reduce the activity of adhesive molecules [1, 4, 7, 8, 10].

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Pro-Inflammatory Interleukins

Interleukins are the most common proinflammatory cytokines, in particular IL-1, IL-6, IL-8, IL-12, IL-15, IL-17 and IL-18. They are among the first factors responding to inflammatory stimuli; they are able to activate both cellular and humoral inflammatory response – activation, adhesion and aggregation of neutrophils and mast cells, lymphocyte proliferation, and antibody production by B-lymphocytes. The most common stimuli for the expression of genes coding the pro-inflammatory interleukins are infections, injuries, tissue damage, and exposure to toxins [2, 3, 10, 11, 12, 13, 14, 15, 16].

At early stages of the response to inflammatory stimulus the cellular and humoral environment is crucial, and the cytokine balance or imbalance induced by the activation of innate immune factors is considered to be an important factor determining the end result of inflammation. Among the factors of innate immunity, at the stage of primary recognition of pathogens, the main role is played by pattern recognition receptors (PRRs), which recognize pathogen-associated molecular patterns (PAMPs) and are mediators of cytokine production which is necessary for effective immunity. PRRs have evolved as conservative innate receptors with the ability to recognize specific microbial and some non-microbial determinants. Upon response to microbial PAMPs, most toll-like receptors (TLRs) induce activation of nuclear factor NFκB and cytokine production, predominantly via the MyD88-dependent pathway [17, 18, 19, 20].

The first cytokines released during inflammation are IL-1 and tumor necrosis factor alpha (TNF-α). In their turn, they activate cells to produce secondary inflammatory cytokines (IL-6, IL-8, IL-12, IL-15, IL-17 and IL-18) [1, 2, 10, 12, 13, 14].

The functions of proinflammatory cytokines are extremely multifaceted: activation of monocytes and neutrophils, lymphocytes, stimulation of secretion of numerous bioactive substances (prostaglandins, corticosteroids and hematopoietic growth factors, etc.), enhancing proliferation of poly- and unipotent progenitor cells, increasing production of procoagulant factors by endothelial cells, as well as increasing synthesis of fibrinogen and C-reactive

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protein, causing pyrogenic effect, regulating intensity of inflammation, intersystem integration of neuroendocrine regulation of the immune response etc. Induction of the cascade of protective reactions promotes the release of chemokines and cytokines of chemoattraction by surrounding cells, activating the migration of immune cells to the site of inflammation [1, 2, 10, 12, 13, 14, 15, 16, 23, 24].

Anti-Inflammatory Cytokines

Anti-inflammatory cytokines help to reduce immune responses and to alleviate inflammation, develop tolerance and maintain transition to the phase of restoring the structure and function of tissues damaged by inflammation [21]. The main anti-inflammatory cytokines are IL-4, IL-10, IL-11, IL-13 and IL-1 receptor antagonist (IL-1RA). Since inflammation is a fundamental response of the immune system and its successful completion means the elimination of pathogen and repair of locally damaged tissue, anti-inflammatory cytokines exert their anti-inflammatory activity by inhibiting the production of pro-inflammatory proteins such as IL-1β, IL-8, IL-12, TNF-α, GM-CSF and G-CSF. In particular: IL-10 inhibits the expression of major histocompatibility complex's (MHC) class II molecules, IL-4 and IL-10 reduce the activity of Type 1 T-helper cells (Th1 cells) by inhibiting the secretion of IL-2 and INF-γ by T lymphocytes; they also partially realize their action by inhibition of intranuclear transcription factor (NF-kβ), destruction of TNF receptors and activation of interleukin receptor antagonists [1, 13, 14, 21, 22, 23].

The interaction of immune pro-inflammatory and anti-inflammatory factors is an extremely "subtle game", because the effects of any cytokine depend on the timing of its release, the presence of synergistic or antagonistic elements, receptor expression and ability of tissue to respond [1, 2, 6, 21, 22].

The immune system is forced to choose between the need for aggression against millions of antigens and tolerance for its own structures. There is a dynamic balance between proinflammatory cytokines and anti-

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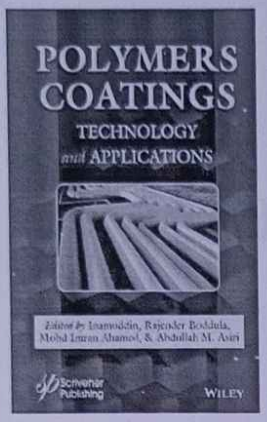

Polymers Coatings: Technology and Applications

Inamuddin Inamuddin (Editor), Rajender Boddula (Editor), Mohd Imran Ahamed (Editor), Abdullah M. Asiri (Editor)

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DESCRIPTION

The explores the cutting-edge technology of polymer coatings. It discusses fundamentals, fabrication strategies, characterization techniques, and allied applications in fields such as corrosion, food, pharmaceutical, biomedical systems and electronics. It also discusses a few new innovative self-healing, antimicrobial and superhydrophobic polymer coatings. Current industrial applications and possible potential activities are also discussed.

ABOUT THE AUTHOR

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3

Dry Powder Coating Techniques and Role of Force Controlling Agents in Aerosol

Piyush P. Mehta[1]*, Atmaram P. Pawar[2], Kakasaheb R. Mahadik[3], Shivajirao S. Kadam[4] and Vividha Dhapte-Pawar[2]

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Abstract

Presently, diverse methods have been well studied for the design and fabrication of versatile powder and particles. However, these techniques have few limitations on account of the need for complex manufacturing setup, the extensive volume of starting materials, and the use of toxic reagents which have a decisive impact on our ecosystem. Therefore, to surpass such issues, material scientists have explored single-step, eco-friendly dry powder coating techniques. Dry powder coating assists to develop powders and particles with miscellaneous functionalities. The present chapter underlines the importance of dry powder coating technique in the field of aerosols particularly dry powder inhaler. This chapter also contains a section detailing the process analytical techniques, the force controlling agents, advancement in medical device coating, and the use of numerical simulation in coating technology. This chapter is the first comprehensive account of dry powder coating techniques in the discipline of dry powder inhalers. Therefore, it can be of likely significance for both the industry as well as academia.

Keywords: Dry powder inhalers, aerosol, dry powder coating, mechanofusion, force controlling agents, cohesive-adhesive balance, deagglomeration, magnesium stearate

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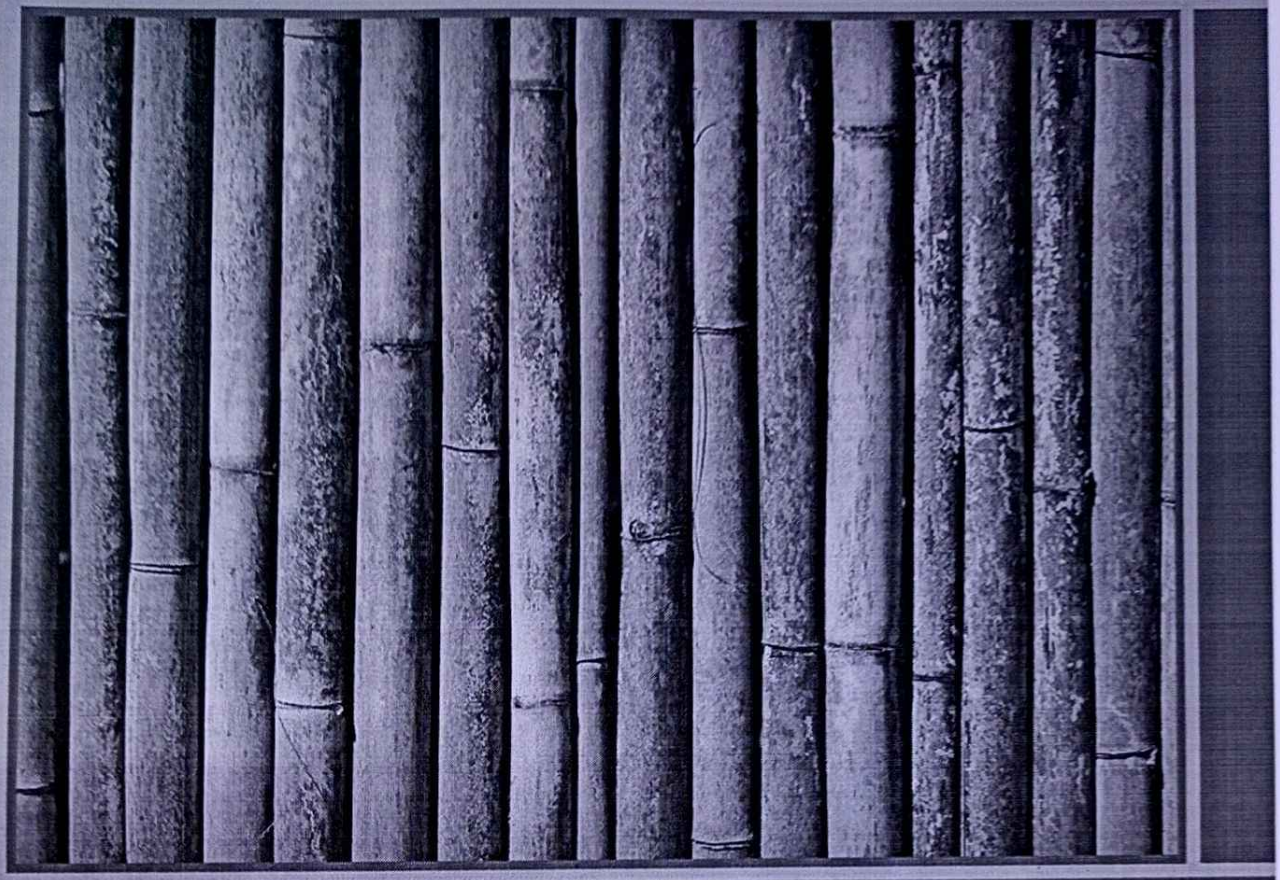

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Advanced applications of green hydrogels in drug delivery systems

4

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4.1 Introduction

Hydrogels are three-dimensional (3D), insoluble, crosslinked polymeric networks with diverse functions in several disciplines [1]. These 3D networks are often fabricated through chemical or physical reactions [2]. They are able to retain a large amount of water and biological fluids in their swollen state. The interface between the polymeric network and fluid medium is attributed to the hydration forces, capillary movement, and osmotic function. These are counter balanced by the swelling of polymeric networks; such a physical state defines the intrinsic features of hydrogel like mechanical strength, diffusion characteristics, and internal transport [3]. In a broader sense, hydrogels are polymeric 3D crosslinked network fabricated using a natural/synthetic polymeric substances that can absorb and retain a considerable amount of water or biological fluids [4]. Hydrogels have generated important applications in numerous fields like food additives, pharmaceuticals, cosmetics, tissue engineering, diagnostics, regenerative medicines, biomedical implants, purification of water and biomolecules, cell encapsulation, cellular immobility, biological adhesions, biomedical devices, biosensor, agricultural domain, electrical materials, and bioremediation of organic waste [4–6]. The scientific research and application fields of hydrogels are growing rapidly with broad scope for advances in pharmaceuticals sciences to transform the existing implications [7].

The importance and popularity of hydrogels can be recognized by the fact that over 200 research centers and institutes globally are investigating different aspects of this technology. The feasibility and opportunity of hydrogels for biomedical applications have been extensively summarized and discussed in several review articles, technical reports, and books [8]. PubMed displayed huge published articles (24471) from 2001 to date when explored for the term "hydrogels." Almost 25% of

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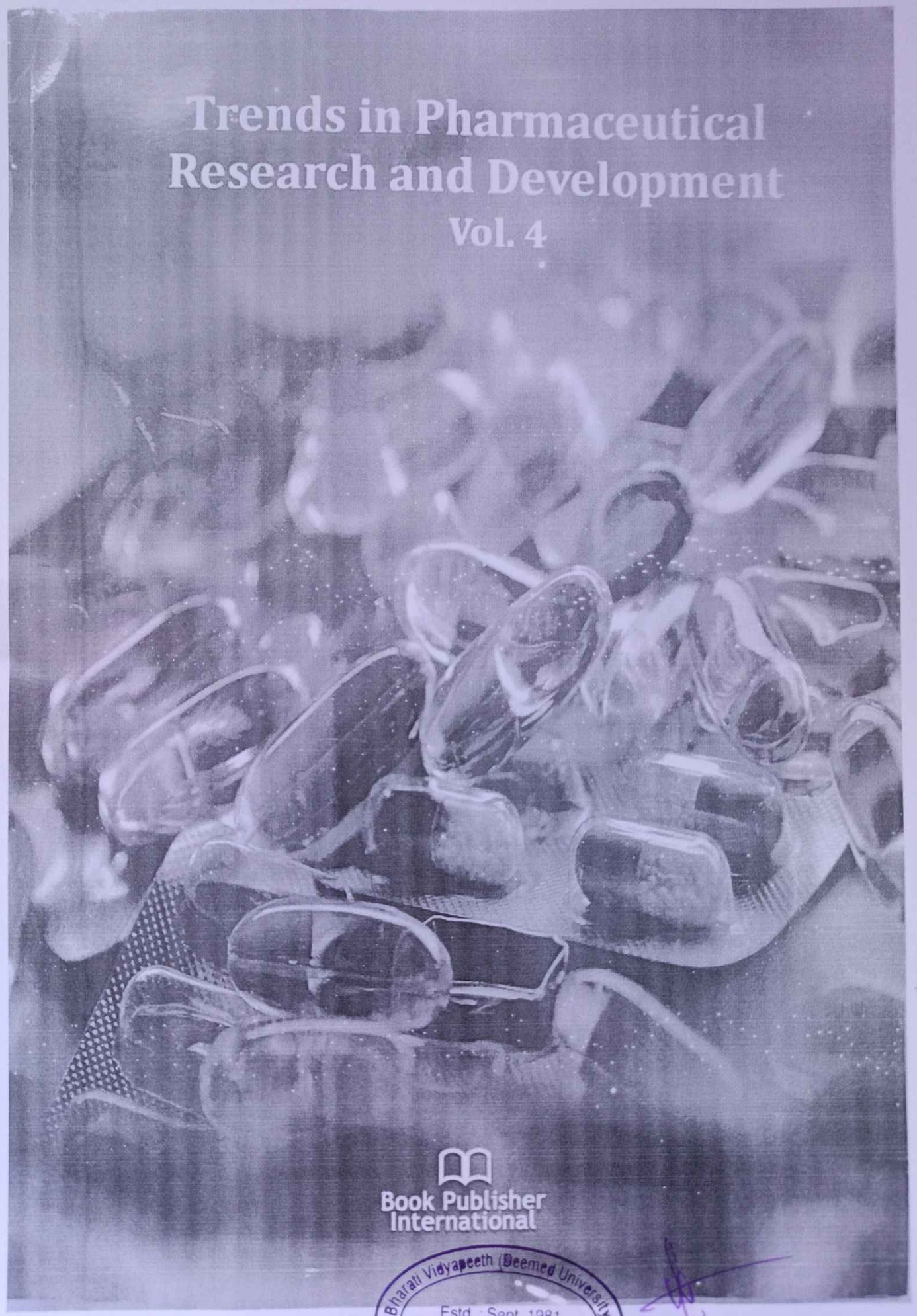

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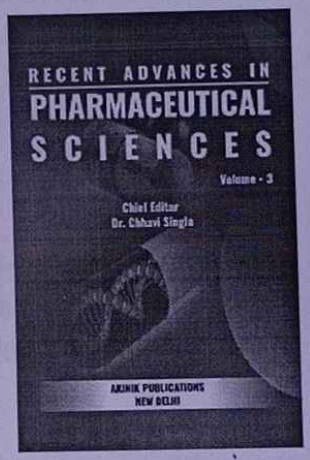

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Preface

Modern Technology revolutionizes the field of analytical instrumental techniques through amazing tools and resources, putting useful information at our fingertips. This field is fast growing and the analysts have to update their knowledge to the recent advancements. Over these years, as this branch has undergone technical innovations and enrichments, Newer instrumental techniques have undoubtedly added immensely to penetrative chemical estimations, not only of the active ingredient but also the quantification of related compounds or impurities in incoming chemicals, drug materials and formulations.

Pharma Industries emphasize the analytical section to ensure a zero defective approach as per Good manufacturing practices, which needs more accurate, precise, and robust techniques. Such reliable results are only possible with well established and validated analytical methods using instrumental techniques. The knowledge of instrumental principles, operational techniques, mechanisms involved and applications are to be inculcated to the young minds during their studies.

Considering the above facts, the present book of "Instrumental Methods of Analysis" has been designed. It covers most of the instrumental techniques which are useful in pharma industries for analysis of drug and drug products. The material presented here is mainly designed for students of Graduate/Postgraduate level in Pharmaceutical sciences and also for the researchers in the field of Pharmaceutical sciences who want to develop their understanding of modern techniques of Pharmaceutical analysis. This book is also useful as reference manual for Quality control chemists, Research and development personnels in Pharmaceutical Industry.

The design of each chapter is made in such a way to cover the introduction, principle, theory, instrumentation, functions of various components of instruments, and applications with special reference to pharmaceutical applications of various instrumental methods of analysis. In addition to basic concepts and widely used techniques, the recent developments and modifications in the conventional techniques are also included wherever it is applicable.

We are sure that the contents of the book will be more useful to academicians, students and research scholars in pharmaceutical sciences, analysts in industries and various analytical laboratories. We will be grateful to you for your kind suggestions for further improvements in the content of the book in future.

Authors

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Syllabus

Unit I

(10 Hours)

UV Visible spectroscopy

Electronic tranhsitions, chromophores, auxochromes, spectral shifts, solvent effect on absorption spectra, Beer and Lambert's law, Derivation and deviations. **Instrumentation:** Sources of radiation, wavelength selectors, sample cells, detectors Photo tube, Photomultiplier tube, Photo voltaic cell, Silicon Photodiode.

Applications: Spectrophotometric titrations, Single component and multi component analysis.

Fluorimetry:

Theory, Concepts of singlet, doublet and triplet electronic states, internal and external conversions, factors affecting fluorescence, quenching, instrumentation and applications.

Unit II

(10 Hours)

IR spectroscopy:

Introduction, fundamental modes of vibrations in poly atomic molecules, sample handling, factors affecting vibrations

Instrumentation - Sources of radiation, wavelength selectors, detectors - Golay cell, Bolometer, Thermocouple, Thermister, Pyroelectric detector and applications

Flame Photometry: Principle, interferences, instrumentation and applications

Atomic absorption spectroscopy: Principle, interferences, instrumentation and applications

Nepheloturbidometry: Principle, instrumentation and applications

Unit III

(10 Hours)

Introduction to chromatography

Adsorption and partition column chromatography: Methodology, advantages, disadvantages and applications.

Thin layer chromatography: Introduction, Principle, Methodology, Rf values, advantages, disadvantages and applications.

Paper chromatography: Introduction, methodology, development techniques, advantages, disadvantages and applications.

Electrophoresis: Introduction, factors affecting electrophoretic mobility, Techniques of paper, gel, capillary electrophoresis, applications.

Unit IV

(08 Hours)

Gas chromatography: Introduction, theory, instrumentation, derivatization, temperature programming, advantages, disadvantages and applications

High performance liquid chromatography (HPLC)-Introduction, theory, instrumentation, advantages and applications.

Unit V

(07 Hours)

Ion exchange chromatography: Introduction, classification, ion exchange resins, properties, mechanism of ion exchange process, factors affecting ion exchange, methodology and applications

Gel chromatography: Introduction, theory, instrumentation and applications

Affinity chromatography: Introduction, theory, instrumentation and applications.

✍✍✍

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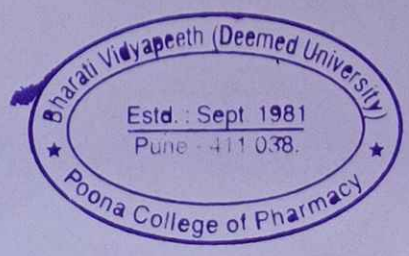

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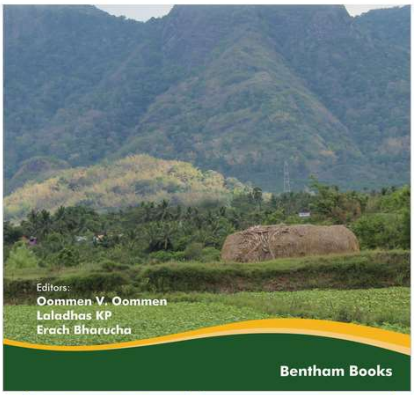

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Sample files for this Course

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Pivot Tables.

Creating and using a pivot table.

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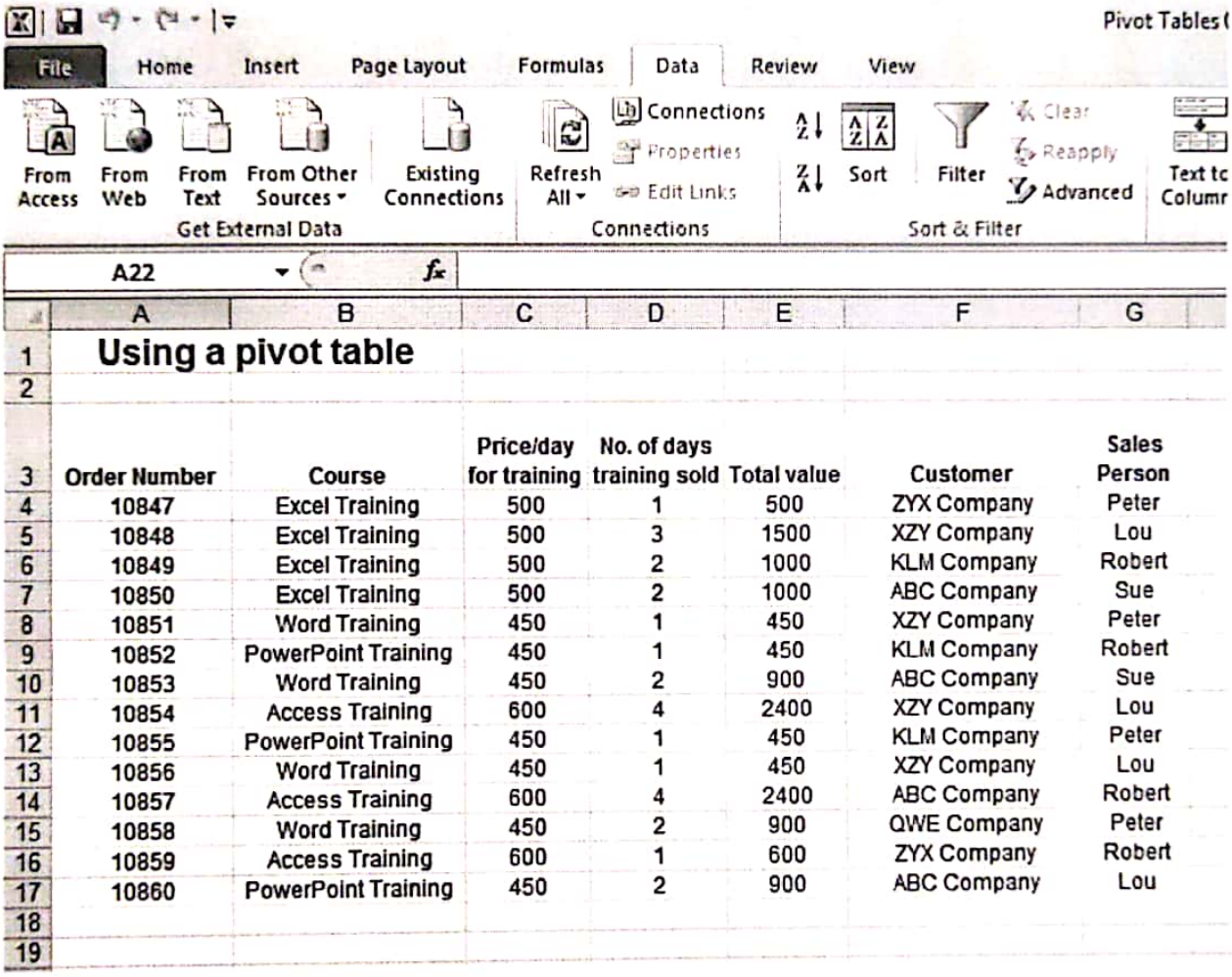

Using a pivot table

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10857	Access Training	600	4	2400	ABC Company	Robert
10858	Word Training	450	2	900	QWE Company	Peter
10859	Access Training	600	1	600	ZYX Company	Robert
10860	PowerPoint Training	450	2	900	ABC Company	Lou

- Click within the data table.
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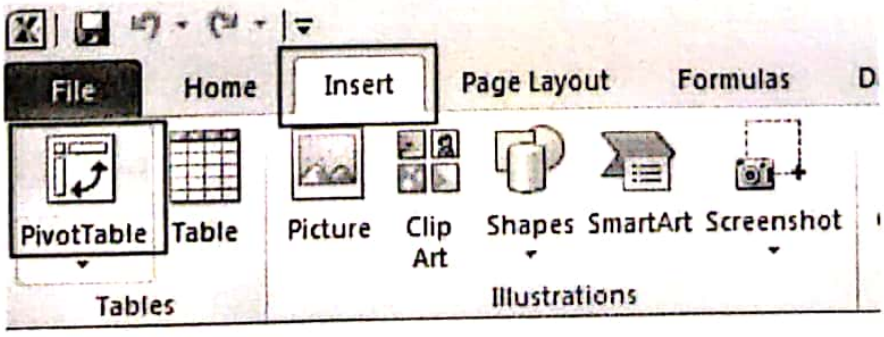

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Redefining Dalit Women's Empowerment: Socio-Economic and Political Realities in Contemporary India

DR.PUNYA SHAILAJA

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Jyoti Dharni

ABSTRACT:

The Indian constitution provides social, economic, and political justice and equality of status and of opportunity to all citizens and prohibits discrimination on the ground of race, religion, caste, and gender. It mandates that all men and women should be treated equally and equal protection should be given to all of them. As an inevitable but positive consequence of access to education, more women have been venturing into employment and workplaces. But it has also been observed that women face discrimination and sexual harassment at their workplace. This paper is an attempt to analyze the constitutional and legal provisions against discrimination and sexual harassment of women at work place in India with the help of judicial pronouncements, and also further analyse international conventions and other international document. The paper also gives an overview of the provisions of the codified law against sexual harassment at workplace currently in effect in India.

Key words: Constitutional law, discrimination, sexual harassment, International law, Work place,

1.0. INTRODUCTION:

The report of the United Nations published in 1980 states that – "Women constitute half of the world population, perform nearly two-third of works hours, receive one tenth of the world income and own less than one hundred percent of world's property. Women have, for time immemorial, been at the receiving end of discrimination in various forms. Despite self sacrifice and self denial being a part of their nobility and fortitude, they have been and are being subjected to all kinds of inequalities, indignities, and discrimination.

Sexual harassment at the work place is one such type of gender discrimination which impedes invisibly the capabilities of women to develop and to prove her capabilities in today's competing world. Apart from interfering with her performance of work, it also puts women to physical and emotional suffering.

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2.0. PROTECTION OF WOMEN UNDER THE CONSTITUTION OF INDIA

The Constitution of India, being the supreme law of the land, provides certain fundamental rights which are applicable to all citizens irrespective of sex in order to protect their interests. However, the Constitution also makes certain specific provisions to protect the rights of women. Article 14, 15 and 16 are all examples of fundamental rights that are aimed at providing gender equality and also uplifting the status of women. According to Article 14, state shall not deny to any person equality before the law and equal protection of law within the territory of India. Article 15(1) prohibits gender discrimination and Article 15(3) of the Constitution makes special provisions for women and children. It empowers the state to make special legislation to protect the interest of women and is a form of positive discrimination. Article 16 provides equality of opportunity in public employment by prohibiting discrimination against any person on grounds of sex, religion, caste, and place of birth.

The Supreme Court in Air India v. Nergesh Meerza has held that women shall not be denied employment merely on the ground that she is a woman as it amounts to violation of Article 14 of the Constitution. In this case air–hostess of Indian Air Lines and Air India have challenged the services rules which stated that "air –hostesses shall not marry for the first four years of their joining and that they will lose their jobs if they were to become pregnant. It was also stated that they shall retire at the age of 35 years, unless the managing director extends the term by ten years at his discretion".

The Supreme Court held that the second and third provision to be declared as unethical, callous, cruel ,detestable ,abhorrent ,unreasonable ,arbitrary ,unconstitutional and an open insult to womanhood. This judicial pronouncement greatly elevated the status of working women.

The new developments in equality also include affirmative action. The Courts have time and again emphasised that equality is a positive right and requires the state to minimise the existing inequalities and to treat unequal's or unprivileged with special care as envisaged in the Constitution of India.

The sexual harassment of women at work place by their male counterparts is a major evil of the modern society. In the landmark judgement of Vishaka v. State of Rajasthan, where a public interest litigation was filed before the Supreme Court seeking effective legislation to curb sexual harassment of working women, the Supreme Court in view of the absence of enacted law to provide for effective enforcement of the basic right of gender equality and guarantee against sexual harassment at work place, laid down guidelines and norms for due observance at all work places or other institutions, until a legislation is enacted for the purpose. These guidelines of the Supreme Court led

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to the development of a codified law dealing with the protection of women against sexual harassment at their workplaces.

Furthermore, the directive principles of state policy also envisages equal rights to work, equal pay for equal work, and adequate means of decent and dignified livelihood to both men and women. Article 39 (a), (d) and (e) 42, 44 and 45 specifically deal with the welfare and development of women. Therefore, it can be said that the Indian Constitution, which is declared as the law of the land, does in fact protect the rights of women.

3.0. INTERNATIONAL OBLIGATIONS WITH RESPECT TO PROTECTION OF WOMEN:

i. Universal Declaration on Human Rights, 1948

The declaration sets out the basic principles of human rights in an inclusive and wide-ranging approach. Articles 3 to 21 of the Universal Declaration on Human Rights enumerate civil and political rights of men and women in terms of equality and Article 22 to 28 specifies social and political rights. Article 2 of the Universal Declaration in Human rights states that "Everyone is entailed to all rights and freedom set forth in this declaration without discrimination of any kind ,such as race, colour ,sex ,language, religion ,political or other opinion, national or social origin ,property or other status. Therefore, no discrimination shall be made on the basis of the political, jurisdictional status of the country to which the person belongs." United Nation has attempted to ensure civil, political, social and economic rights to all human with special reference to women at international scenario.

ii. Declaration on Elimination of Discrimination Against Women 1976

The preamble of this declaration states that despite various conventions protecting the rights of women, the discrimination against women continues. Article 10 of the declaration states that "all adequate measures shall be undertaken to ensure equality of married or unmarried women with men in the social and economic fields, particularly–the right without discrimination on grounds of marital status, to free choice of profession and employment. Right to equal pay with men, equal treatment relating to work of similar treatment." With a view to prevent discrimination, the status of women is to be regarded with equality in respect of married or unmarried in public employment.

iii. Convention on the Elimination of All Forms of Discrimination Against Women 1976 (CEDAW)

The preamble of the Convention explains that, despite the existence of other instruments, women still do not have equal rights as men. Discrimination

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against women continues to exist in every society. Article 1 of the Convention defines the term "Discrimination against women" as "any distinction, exclusion, or restriction made on the basis of sex which has the effect or purpose of imparting or nullifying the recognition, enjoyment or exercise by women irrespective of their marital status, on basis of, equality of men and women of human rights and fundamental freedoms in the political economic, social ,civil or any other field."

The state Parties to the Convention are fully persuaded that discrimination is an important factor causing obstruction in the development of women with men at national and international level. It is directed that all state parties should take appropriate steps to eliminate discrimination against women which include adopting appropriate legislative and all other measure prohibiting all discrimination against women. They are also obligated to make legal provisions for protection of the rights of women on an equal basis with men.

In spite of such various conventions, we are yet to achieve desired result of protection of women at workplace from discrimination and harassment. The position of women in the modern society is really appalling. To achieve equality among men and women, we have to improve the fundamental educational system and also bring awareness in the field of women's rights.

4.0. THE SEXUAL HARASSMENT OF WOMEN AT WORKPLACE (PREVENTION, PROHIBITION AND REDRESSAL) ACT 2013

The guidelines issued by the Hon'ble Supreme Court in Vishaka's case were codified in the form of this Act which been enacted by the legislature with the objective of providing protection to women against sexual harassment at the workplace and for the prevention and redressal of complaints of sexual harassment. Following are the salient features of the Act;

1. Definition of 'sexual harassment'

The Act defines sexual harassment as "including any one or more of the following unwelcome acts or behavior: (i) physical contact and advances; or (ii) a demand or request for sexual favours; or (iii) making sexually coloured remarks; or (iv) showing pornography; or (v) any other unwelcome physical, verbal or non-verbal conduct of sexual nature." The Act further highlights certain circumstances which may amount to sexual harassment, if it occurs or is present in relation to or connected with any act or behaviour of sexual harassment,. These additional circumstances also indicate how certain forms of sexual harassment will also amount to discrimination against women at workplace.

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2. **Who can file a complaint alleging sexual harassment?**

As per the Act, complaint can be filed by an aggrieved female employee (whether regular, ad hoc, temporary or daily wage), probationers, trainees, apprentices, interns and any other female visiting company premises.

The law also makes provisions for friends, relatives, co-workers, psychologist & psychiatrists, etc to file the complaint in situations where the aggrieved woman is unable to make the complaint on account of physical incapacity, mental incapacity or death.

3. **Workplace**

Under the Act, ICC shall only deal with incidents occurring in the "workplace". Workplace may be within the premises of the Organization and also outside it, and it includes any place visited by the employee arising out of or during the course of employment including transportation provided by the employer for undertaking such journey.

4. **Internal Complaints Committee**

The Act places a responsibility on the employer to set up an Internal Complaints Committee (ICC) at each office/ branch of an organization, to hear address the complaints on sexual harassment at workplace. Failure to constitute the ICC can lead to imposition of fine as provided under the Act (up to INR 50,000).

5. **Complaint Mechanism and Inquiry**

(a) **Complaint**: An aggrieved woman who files a complaint has to submit 6 copies of the complaint along with supporting documents and names and addresses of the witnesses to the ICC within 3 months from the date of the incident and in case of a series of incidents, within a period of 3 months from the date of the last incident.

(b) **Conciliation**: Conciliation can be attempted before initiation of inquiry only at the request of the complainant. However settlement arrived at through conciliation cannot have a monetary basis.

(c) **Inquiry**: ICC will forward a copy of the complaint along with all supporting documents to the accused within 7 working days of receipt of complaint. The Accused is required to file his written reply to the complaint along with his list of documents and names and addresses of witnesses within a period of 10 working days from receipt of the Complaint. ICC should maintain a quorum of least 3 members including Chairperson during inquiry and the ICC should complete inquiry within 90 days. No representation by legal practitioner can be made before the ICC.

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(d) **Interim relief:** On written request of Complainant, ICC may recommend to the employer to grant interim relief to the complainant such as: the complainant not to report to accused, accused not to report about work performance of complainant, complainant/accused may be transferred to any other workplace, leave of 3 months to Complainant over and above usual leave may be granted etc.

6. Punishment

If on completion of inquiry, the ICC comes to the conclusion that the charges against accused are proved, then it may make any of the following recommendations in the form of punishment, to the employer

- Punishment prescribed under the service rules of the organization
- Compel the accused to issue a written apology to the Complainant; and/or
- Issue a written warning to the accused
- Reprimand or censure the accused
- deduct from the salary or wages of the respondent such sum as it may consider appropriate to be paid to the aggrieved woman or to her legal heirs

In line with the intention of the legislature, the Indore Bench of the Madhya Pradesh High Court imposed a penalty of Rs. 50,000/- on a reputed hospital for failing to abide by the requirement of constituting an Internal Complaints Committee under the POSH Act. The Court further directed that compensation to the tune of Rs. 25,00,000/- be paid to the complainant in lieu of the failure to address her complaint of sexual harassment.

Recently on February 2020, a Division Bench of M. Sathyanarayanan and R. Hemalatha, JJ of the Madras High Court, while addressing the issue of false complaints under the Act held that, "Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013 is intended to have an equal standing for women in the work place and to have a cordial workplace in which their dignity and self respect are protected, it cannot be allowed to be misused by women to harass someone with an exaggerated or non-existent allegations."

5.0. CONCLUSION

The implementation of the Act has brought both positive and negative impact in the society. This Act provides security to women in all sectors of work, including domestic work and it has also made workplaces more female

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friendly. Employers have become more aware about their limitation, duties, and responsibilities. The movements like MeToo that took the globe by a storm have brought forth the problems faced by women in their workplace and highlighted the need for stringency in the application of law that deals with the same.

However, it has also been seen that there have been several instances of false and malicious prosecutions being initiated by women under the POSH Act. Against such a background, it becomes essential to ensure that women are made aware of the objectives of the POSH Act, which would further guarantee that only genuine cases reach the judiciary for redressal.

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PSYCHO-SOCIAL ENVIRONMENTAL ISSUES OF EMPLOYEES AT WORK PLACE

Dr. Punya Shailaja

Dr. Sapna Kashyap

Nitya Publications, Bhopal

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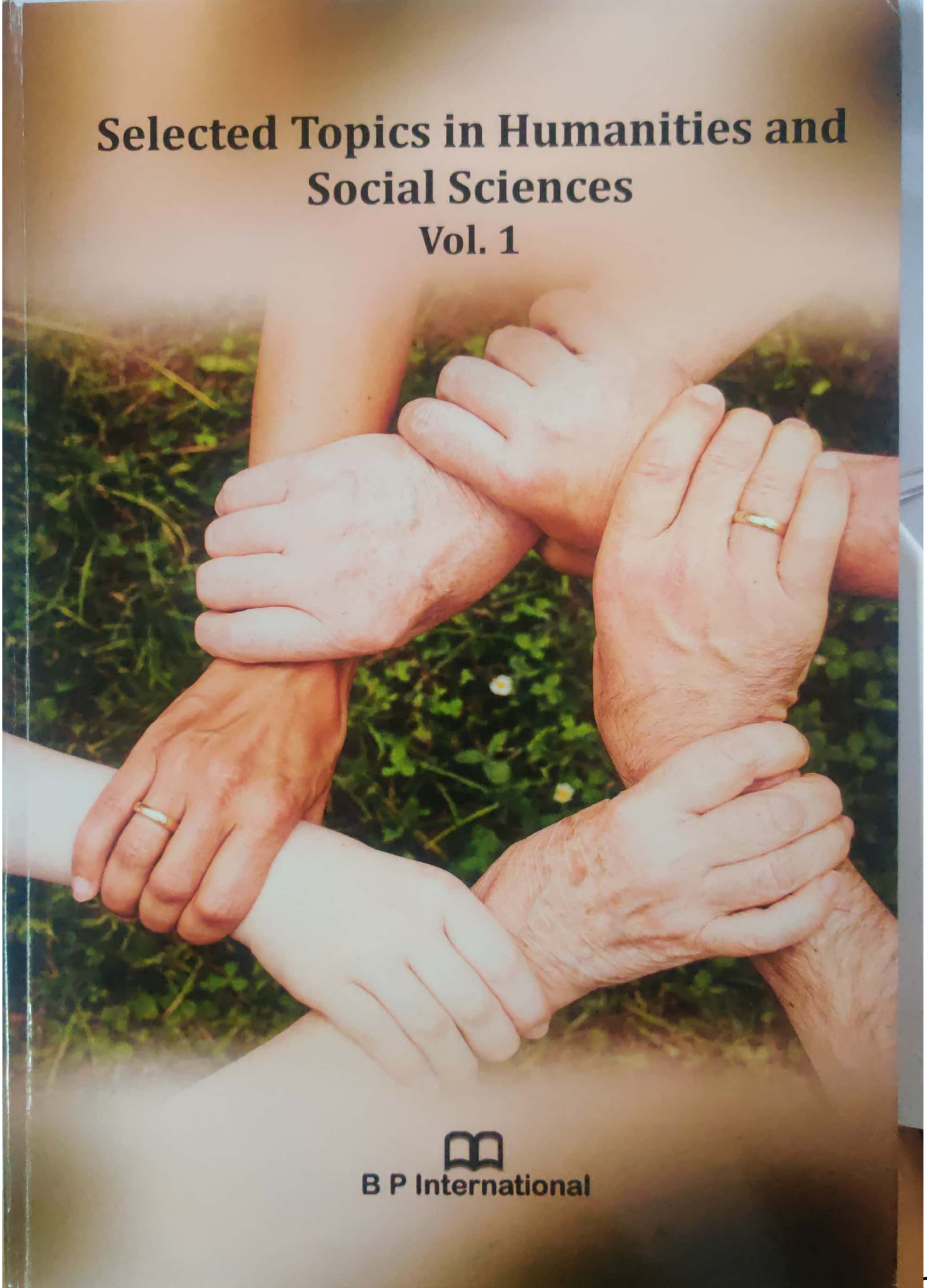

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Chapter 11
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A Socio-Legal Study of the Right of Aged People to Live in Dignity

Ujwala Bendale[1] and Vidya Dhere[1*]

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ABSTRACT

Modernization and globalisation have aided in the development of India as a technologically advanced nation, but certain constitutional ideals no longer meet the essence of time and the needs of the elderly to live in dignity. This article aims to highlight the social and legal issues that aged persons face in terms of living with dignity and deprivation of basic rights, as well as the provisions of the Maintenance and Welfare of Parents and Senior Citizens Act, 2007 (MWP Act) and its failure to protect the rights of aged persons in India. Issues and challenges related to the MWP Act's implementation are discussed, and remedies in the form of recommendations are pen down and attempted. Aged persons are vulnerable groups in the society and easily exposed to atrocities and exploitations.

Keywords: Aged persons; social justice; pension; shelter; medical facilities and MWP Act.

1. INTRODUCTION

The biggest strengths of Our Indian Constitution are democratic, economic, and social justice, but these principles must be reinvented and researched in the twenty-first century. Particularly, the concept of social justice, which the Constitutional framers believed was solely about providing equal opportunities [1], but which today must focus on modern societal demands, such as the rights of aged persons [2] to live with dignity. Research regarding quality of life among older people has predominantly focused on functional elements experienced at individual or dyadic level despite the complex interplay of factors that contribute to quality of life [3,4,5]. Examining personal beliefs about social justice in the way a society provides financial security in old age may reveal potential conflicts about the distribution of wealth [6]. The Indian Constitution through Article 21, 39 and 41 i.e. fundamental right and directive principles of state policy do recognize few of the rights and concerns but the right to health, shelter, sustenance and dignity of aged persons is ignored or unforeseen [7]. Globally several International Conventions [8] and declaration [9] have recognized significant human rights for the Aged persons [10] but because International laws are not mandatory and their implementation is weak adherence to it has been ignored , violated and overlooked in many countries and India is no exception to it. Only the Apex Court through its numerous Precedents has given recognition to several rights and invented right to live with dignity [11,12,13] through is its interpretation under Article 21 of Constitution [14].

2. RESEARCH METHODOLOGY

A purely analytical non empirical study is attempted by the researcher relying on significant precedents of Apex Court and books eminent authors.

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3. FINDINGS

a. The Union of India through the Indira Gandhi National Old Age Pension Scheme has fixed Rs.200per month for elderly person between age group 60 to 79 years and Rs. 500 per month for persons above 80 years of age [15].

b. The Union of India, State Governments and Union territory administrators has proved to be incapable in actively supporting the Indira Gandhi National Old Age Pension Scheme.

c. Inspite of Article 19(1)(e) and Article 21 of Indian Constitution and, Article 25(1)of UDHR and Article 11(1)of ICESCR expressly providing for minimum standards of living still the government has been unsuccessful in providing minimum standards of livelihood to the poor and Aged persons. Right to live with dignity implies right to adequate shelter [16], food and clothing to the every person including elderly and but in our over populated country this is mere a dream.

d. The National Program for healthcare of elderly provided healthcare facilities to senior citizens but has not succeeded to the mark because they have not been fully operationalised in some districts of India.

e. The Maintenenance & Welfare of Parents & Senior Citizens Act, 2007 (MWP Act) came as a boon for aged persons which requires under Section 19 the State Government to establish and maintain at least one old age home in every district in the country and Section 20 provides for medical support for senior citizens by the State Government.

f. MWP Act lacks its publicity, its awareness and advertising amongst the aged persons in rural and urban area [17].

4. CHALLENGES

a. The Pension Scheme and amount for elderly person is very inadequate and trivial to meet up the basic needs of survival.
b. The dawn for the Union of India, State Governments and Union territory administrators to work together for the proper implementations and planning of Pension schemes for Aged persons is yet awaited.
c. Right to shelter is subject to the economic budgeting by the State i.e the financial capacity of the State cannot be overlooked.
d. National Program for healthcare are not implemented effectively due to lack of coordination and cooperation between UOI, State Government and Union territory administrators.
e. Every old age home under Section 19 of MWP Act was to provide accommodation for 150 Senior citizens who are indigent but due to large population of indigent elderly the State is helpless to provide shelters to aged persons o live with dignity.
f. As the aged persons are unaware of their human rights guaranteed by Indian Constitution and MWP Act, its feasible for all to violate them.
g. Lack of Government support to the NGO's in spreading awareness leads to non publicity of rights of aged persons and also the MWP Act.

5. ANALYATICAL RESULTS & DISCUSSIONS

a. Pension should be realistic and viable at least half the minimum wages so that the aged persons can sustain themselves with dignity.
b. Humanitarian approach is required on the part of Government of this country. Pension and Welfare Schemes can be implemented properly only if Union of India, State Governments and Union territory administrators stand together against corruption and wholeheartedly think for the welfare not only of Aged persons but also the poorest of poor in this country.
c. Revised Integrated program for Senior citizens should be implemented to encourage productive and active ageing.

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d. Government must provide Grants for maintenance of aged persons /senior citizens homes.
e. All National Programs for healthcare and overall development of aged persons must be implemented with due earnestness which is possible only if Union of India, State Governments and Union territory administrators genuinely decide to implement them.
f. Effective coordination between various ministers and Departments of State Government will ensure the welfare of aged persons.
g. Well planned publicity of the rights of aged persons under MWP Act will help the aged to live their remaining life with dignity.

6. CONCLUSION

Aged persons are vulnerable groups in the society and easily exposed to atrocities and exploitations. Aged people are not mere objects to be thrown or dumped, as they grow older they need good people to take good care but reality is very harsh and the Government of India and people at large should work hand in hand to eradicate the violation of basic rights of aged persons. The Union Government must continuously supervise the working of State Governments and union Territories in spreading the awareness about rights of aged amongst the society; monitor the measures adopted for implementation of provisions of MWP Act and support in implementing the plan of action for the publicity of MWP Act.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Besides this nationally she is legal expert appointed by Bihar Public Service Commission for Bihar Judicial Service Interview Board and Rajasthan Public Service Commission for Rajasthan Judicial Services.
Internationally she is Distinguished Member of International Council of Jurists (London) 2017-2021 and has Visited Boston, USA in 2010 for Harvard Model United Nations HMUN) as Legal Advisor with students representing Seychelles.
She has publications in various National and International journals. She has organized, attended and co-ordinated various workshops and seminars at BVDU. To mention significant one is, in collaboration with CIPAM (DPIIT) Ministry of Commerce and Industry, India and has delivered lectures on Significance and Impact of IPR at various institutions of BVDU.

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She is an academician based at Pune. She is presently working at Bharati Vidyapeeth (Deemed to be University) New Law College, Pune as a Senior Professor and teaches Sociology and other subjects of law. She is designated as the Academic Coordinator for the undergraduate programme (B.B.A LL.B) in the institution and as the Director of Cultural Affairs. She also guides students pursuing LL.M. in completion of their dissertations. She has completed her Post Graduation in Sociology from University of Pune and Masters in Philosophy from Tilak Maharashtra Vidyapeeth, Pune. Pursuing her passion for law, she completed her LLB, LLM and Doctorate from Bharati Vidyapeeth Deemed (to be) University's New Law College. In addition, she has published her articles in international journals and journals indexed in Scopus and UGC Care. She has also participated in academic conferences, webinars and presented research papers. She has a keen interest towards examining the effectiveness of social welfare related laws and in furtherance to the same; she has also successfully completed a UGC funded minor research project titled 'Implementation of Senior Citizenship Act- A Socio- legal Survey in Maharashtra'.

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National Education Policy-2020

A Broader Perspective

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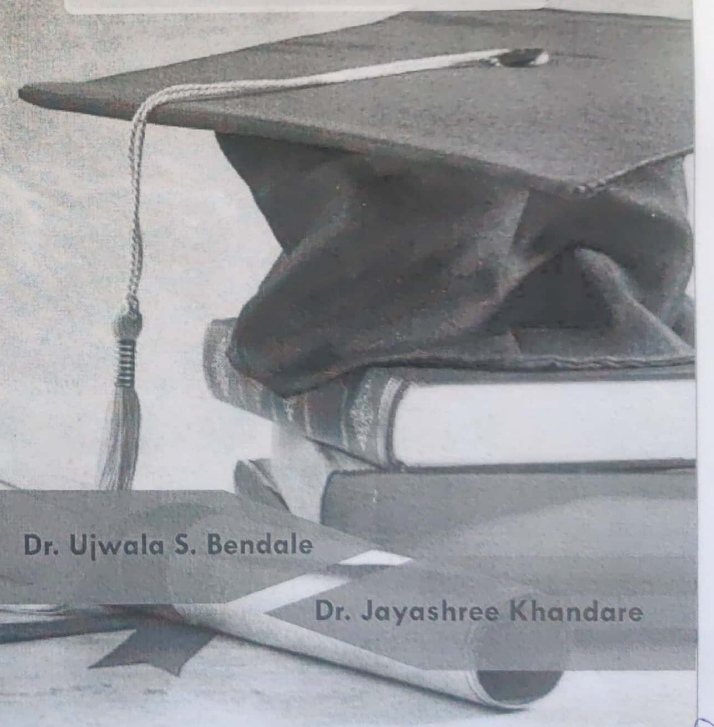
National Education Policy-2020

A Broader Perspective

Dr. Ujwala S. Bendale
Dr. Jayashree Khandare

National Education Policy-2020

A Broader Perspective



Dr. Ujwala S. Bendale

Dr. Jayashree Khandare

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Chapter-12

Right to Education in India: A Changing Dimensions in Contemporary Social Conditions

Dr. Vidya Vasantrao Dhere
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New Law College, Pune

Abstract

The article aims at analyzing the 'National Education Policy 2020' that has been drafted by the government to bring about changes in education system. The long awaited changes have brought to meet the changes in contemporary society. The policy has made efforts to blend traditional values of Indian society and the demand for modern technological development. The success of the policy will be clearly analyzed after it is implemented.

Keywords: *Access, Equity, Quality, Affordability, Accountability, National Education Policy 2020*

Introduction

Education in India has always been given priority since an ancient time that is evident from the social hierarchy where 'Brahmin' is placed at top. The duty of the Brahmin is to apply human intelligence to grace the life of society. The education was imparted to acquire knowledge about ultimate truth through meditation. The Varna system was grouping the society according to the profession they profess and the

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education was imparted accordingly. Education was basically meant to prepare the student to perform his dharma or duty allotted to him. There was concept of Gurukul in which the child stayed at the place of Guru to gain education. The Guru was in the position of observing the child, understanding his capacity and capability and molding him accordingly. The students learned through the method of critically analyzing the situation, attending seminars, memorizing, storytelling and asking questions. The education was according to the Varna a person belonged to. Of course, initially the person had the choice to profess any occupation of his choice. Later the occupational groups became rigid and they took the efforts to educate their youths to profess their occupation.

Formal education was introduced by Britishers to carry out the clerical work in their offices. The aim of education was not to enhance mental ability of the person, but to work in a bureaucratic setup. This led to associate education with job. The value education which was key to successful life during Vedic period, gradually got lost.

After independence, with the development of technology the nature of education system changed to formal type. The Indian Government accordingly realized the importance of formal education for national development. Many commissions and committees took initiative to reconstruct and solve the education policy to suit the modern society. The Education Commission was appointed in 1964 to advise the Government on issues related to education. Based on the recommendation of the Commission National Policy on Education was announced in 1968.

India has witnessed three education policies till date. The first policy came in1968, the second was in 1986 which was revised in 1992, and the third is the recent policy of 2020.

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Ministry of Human Resource Development, Government of India has put before us the National Education Policy 2020. The policy is divided into four parts. Part I contents directions relating to school education, part II is related to Higher education, Part III deals with other key areas of focus and Part IV describes the implementation of the policy under the heading 'Making it Happen'.

With the change in technology society too has changed considerably. It becomes necessary for all to cop up with the changing circumstances; accordingly society has to gain knowledge relating to developing technology. The education policy is framed to suit the requirement of the contemporary society. The first Education policy in India was framed in the year 1968 under the recommendation of various commissions like Kothari Commission, University Education Commission, and Secondary Education Commission. The aim of the Education Policy of 1968 was free and compulsory education to all, development of regional language and making it the medium of instruction at University level, promoting Hindi, Sanskrit and foreign language, uniform education structure throughout the country (10+2+3).

The aim and objective of this education policy were quite high but it could not achieve the objective as we can see that though there was free education the literacy rate did not increase, people remained illiterate. This policy included 10+2+3 system of education applicable to whole of India. It also included mother tongue as the medium. The National Policy on Education, 1968 marked an important step in development of education, particularly in the field of science and technology in the history of post independent India. Schooling facilities were provided to cities as well as rural areas. The common structure of education also helped in formulating universal system of education and was readily

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accepted. Though the policy was remarkable, it could not be circulated to the masses by the implementation machinery and so failed to some extent.

This education policy was revised twice in 1986 and 1992. Of course there was not much changes made in the revised version. In Education Policy of 1986, the focus of the Government was on modernization and IT education. The qualification of teachers, early childhood care, empowering women through education and adult literacy was on the agenda. The policy also promoted autonomy of Universities and Colleges which was not there earlier. This policy also emphasized on common education structure for the whole country, to promote equality among men and women, inculcate values of democracy and secularism. It aimed to eradicate kinds of disparities that existed in society that included scheduled caste, scheduled tribes and minorities. The institutions like UGC, NCERT, NIEPA etc. were made stronger in order to shape the education policy to suit the dynamic nature of society. The policy also aimed to inculcate values of secularism, socialism and democracy. In order to maintain the cultural tradition of the country they also felt the need of value education to be implemented. The objective of the policy was to make education striking to attract the student, to overcome shortage of qualified teachers and universality of education.

It is after thirty- four years India could introduce new education policy in 2020. The National Education Policy 2020, which is introduced, aims to provide proper infrastructure, establishing novel education center in order to attract the students who have left their education incomplete. It also aims to establish multidisciplinary universities and colleges so that in future there will be single stream of education. The single stream strategy will allow the students to freely choose

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their subjects of their interest from combination from any stream. There will not be any separate streams of education; all will be under one umbrella. The policy greatly promotes innovative strategy at primary and higher education level. The policy focuses on five issues:

1. **Access:** The policy aims at giving access or admission to all in the education field. Nobody is denied the right to education, it is made universal. The students should be enrolled according to schedule, the child should get access to education at proper age, and education environment should be maintained to enhance learning, the student should have equal opportunities to take advantage of the learning method provided to them.
2. **Equity:** All students should be treated equally and fairly. There will be no discrimination based on gender, caste, creed, family as far as possible to achieve at least minimum level of education so that there will be optimum use of educational potential of the individuals in society, it is equality. Equity is beyond equality, it focus on support system to cop up with educational barriers like students with average IQ can be provided with extra work to practice or students with language problem to be given support accordingly. Equity in education also means that ever student has equal chance for accomplishment in life the support of education. To bring the students at equal level there should be equity, in the sense that the student should get support according to his requirement. The policy aims at bringing equity.
3. **Quality:** The teaching should include practical application of facts which would allow the student to face realities of life. There should be conceptual

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clearance and indebt knowledge of the subject under study. Quality education also means that the child should be tolerant in society and find his own way to develop himself. The policy also aims at attaining sustainability through high quality education to all.

4. **Affordability:** The term affordability as mentioned is not clarified in the policy. Affordability literally means ever child can get knowledge without economic burden on them, which means the fees to be paid will depend on economic conditions of the parents.
5. **Accountability:** It means the student can trust the governing body, which ensures success after adopting their policy. The schools and colleges that run under the guidance of the government are accountable to them.

The main aim and objective of the Nation Education Policy, 2020 can be conclude with the help of the above five issues. The policy has brought about revolutionary changes in the education system. It has not only enhanced the importance of local language but it has also helped its sustenance. Due to western impact, local languages had a setback. The practical application of knowledge is a must which the policy stresses upon. The inter-disciplinary nature of knowledge will facilitate the student to choose the any subject combination. Choosing subject of their choice will definitely enhance the performance and contribute for the development of society. This policy has come up at the critical pandemic condition, where it has not yet possible to implement it. But taking into consideration the expectation and objective of the policy and the social condition prevailing in the society its implementation is a question. In order to have practical application of knowledge the ratio of teacher-student has to be revised. The question of affordability is not

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explained in the policy. If every student can afford education that means private educational institution may have to shut down as they require additional amount to maintain them. There is no provision for those institutions that are run privately.

The policy has not mentioned anything on extension program, those excellent researchers that will clear their graduations has to contribute to the national development; there should not be brain drain. The policy also focuses enhancing the distinctive capabilities of each student by the efforts of teachers and parents, that seems to be far fetch goal. Looking at ratio of student-teacher, and the work load on teachers it is impossible to have one to one interaction between them. It was possible during *'Ashrama'* system where the child used to be 24 hours under the observation of the 'Guru'.

Giving stress on understanding basic concepts is a welcome change as it will motivate the student towards critical thinking and bring innovations in the concern field. Promoting ethics and values is also a welcome change. The contemporary society demand value oriented social life, but it should accompanied by value based social environment otherwise there may arise role conflicts and frustration among the youths.

It is not possible for every child to become a researcher; research comes up with deep knowledge of the subject and continuous practice, it is also dependent on the nature of the person towards finding the truth. Inclusion of equity is necessary, but on one hand the policy emphasis on individual development according to their interest and capacities and on the other hand stress to bring the child on equal footing. There are different aspects of life requiring different talent; if

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such talent has to be enhanced, the policy should have provision accordingly instead of bringing them on equal footing.

Conclusion

To conclude, the policy looks good on paper but there has to be adequate machinery to implement. Certain aspects are practical and can bring about necessary changes but certain aspects are imaginary and a myth which though looks attractive will require immense academic set up to implement it. The policy is on paper, we can discuss it in more holistic manner after it is actually implemented.

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Centre for Professional Development presents

INTERNATIONAL CONFERENCE ON

EMERGING STRATEGIES IN ANTIMICROBIAL AGENTS AND BIO-INNOVATIONS

18th & 19th Dec'20

ABSTRACT BOOK

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TRANSCRIPTING BRIGHTER BIO FUTURE

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Department of Science & Technology
Government of Gujarat

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Centre for Professional Development

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MICROBIOLOGISTS SOCIETY
Microbes for Better Tomorrow
1996

We are delighted to welcome you to the two-day international conference on Emerging Strategies in Antimicrobial agents and Bio-innovations (ESAB) organized by Department of Microbiology, School of Science, RK University. It is indeed a very proud moment for us. All faculties, research scholars, students and other delegates from different disciplines of science are welcome to be a part of the conference. As you are aware, development & enrichment program for education and research have become increasingly important in the present-day context of the changing scenario in the scientific field. This appears to be the perfect time to reflect, review and assess our existing scientific study and make it at par to international standards. This international conference provides opportunities to the participants to present their research works before the scientific community, publish their research works in high impact journals and get ideas to carry out best research from a global audience. Furthermore, with the expansion areas of research and innovation in different sectors around the globe, it becomes imperative to send messages to all respective researchers and innovators that develops and create novel ideas among one and all.

We welcome you all once again to the international research conference on Emerging Strategies in Antimicrobial agents and Bio-innovations (ESAB). Experience our culture and have some warm memories.

Shri Denish Patel

Executive Vice President

RK University, Rajkot

My Dear Colleagues,

Greetings!

I am indeed very happy to note that the two-day international conference on Emerging Strategies in Antimicrobial agents and Bio-innovations (ESAB) is organized by RK University. Conferences of such nature provide a great opportunity to research fraternity not only to update knowledge and keep research workers obsessed with latest developmental scenario, in the respective field, but also act as an occasion for the resource persons/delegates/observers to interact with each other and to provide motivation to transform that idea of yours into a successful research. I take this opportunity to extend warm welcome to the resource persons, researchers, investors, faculties and delegates registered for the Conference. My compliments to RK University for taking such initiative and I hope that this conference would provide valuable, useful and informative ideas to the participant students, researchers and other experts. I heartily wish for the great success of the Conference.

Dr. T R Desai
Vice Chancellor
RK University, Rajkot

It gives me immense pleasure to know that the two-day international conference on Emerging Strategies in Antimicrobial agents and Bio-innovations (ESAB) is organized by RK University, where participants will get ample opportunity through Oral and Poster presentations and Discussion with the renowned scientist from the various countries. The conference will majorly highlight the recent advances in the field of Microbiology. Combining research and bio-innovation in a single platform takes education to next level. It is extremely relevant and need of the hour for researchers to get together and share their thoughts among all. We believe that international level conference by RK University will help in expanding research horizons, development of new ideas and innovations of researchers. I extend my best wishes to the organizers and participants of the conference.

I congratulate the Institute for organizing the international Conference and wish the program a grand success.

Shri N S Ramani

Registrar
RK University, Rajkot

Dear Delegates of ESAB,

In today's competitive, interactive global world, we cannot afford to rest on our laurels or become complacent. We need to be constantly in touch with the outside world and maximize the learning process.

In order to meet this need the School of Science, RK University is organizing International E-conference on 'Emerging Strategies in Antimicrobial Agents and Bio-Innovations' on December 18 & 19, 2020 in association with Gujarat State Biotechnology Mission (GSBTM), Gujarat and Microbiologist's Society, India. In line with our vision which is focuses on being a model of excellence through dynamic programs, innovative practices and research. The natural world has come under hassle from the demand of an emerging global health supplements to fights again various infectious disease.

In response to this challenge and risk, this international conference has been planned to improve the effectiveness of current research on antimicrobial agents which leads towards bio-innovations.

I hope that the participants will be greatly benefitted by enhancing their technical knowledge and contribute to this thrust area. I wish the conference a grand success.

Dr. Mayank Pandya
Conference Chair,
Dean, Faculty of Science
Director, School of Science
RK University.

Dear Delegates,

In the present time when, people are highly stresses due to their work culture , and put their health on second priority, they do not prefer to visit doctors for day to day medical conditions. This has resulted in increased practice of taking medicines course casually which is somehow come up as one of the major reason of developing antimicrobial drug resistance among microbes. The theme of this international conference is thus very relevant in present scenario to raise awareness among researchers and other stack holders within and beyond scientific community in order to address this issue. On behalf of the organizing committee of ESAB, it is indeed pleasure to organize the Two-day international conference on Emerging strategies in Antimicrobial Agents and Bio- Innovations (ESAB). The aim of the conference is to provide an international platform for Participants to interact and exchange ideas in the field of life sciences and allied branches. TESAB has been organized in association with Microbiologists Society, India. The conference was funded by GSBTM, Government of Gujarat. The association of renounced publication Houses has given a boost to our enthusiastic participants. In this Covid-19 Situation, Researchers were looking for a standard platform to present their findings from doorstep which also gives them reputed journal publications. RK University took initiative and provided a wide and diverse platform to students, researchers, faculties and industrial delegates to present their research findings. We received great responses in terms of participation across the globe. I hope that ESAB will be meaningful for each delegate with good publication, take home novel ideas generating from fruitful discussions and collaborations amongst each other. I take this opportunity to congratulate and thanks to the entire organizing team who have worked immensely to make the conference a grand success. I am highly grateful to all our resource persons who were happy enough for ready to share their knowledge in these pandemic conditions. Finally, I would like to thank the delegates of ESAB for their participation.

Dr. Vijay kumar

Conference Co-chair- ESAB

Associate Professor,

Head, Department of Microbiology,

School of Science,

RK University, Rajkot

Dear all,

Considering this conference as a stage to look at and determine regarding the most recent progress within the field of Antibiotics, Antimicrobial Resistance and Bio-innovations in this domain, I welcome you all at "Emerging Strategies in Antimicrobial Agents and Bio-Innovations (ESAB) 2020. This conference is going to provide you all a world stage for presenting research with reference to antibiotics, infections and exchanging ideas, and contributes to the dissemination of information in Antibiotics, Antimicrobials and Antibiotics Resistance for the advantage for both the academic and business.

While organizing this conference, we are aiming to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of Antimicrobial agents, Phytochemicals and Antibiotic Resistance. Nanoformulations emerged as a key player for efficient delivery of various antimicrobial agents. By adapting the nanotechnology approach the conventional and present strategies get a major boost in dealing with the problem of MDR.

ESAB 2020 is focused on the theme "Innovative approaches in the field of Antibiotics and Antimicrobials". ESAB 2020 is a conference designed in a way to provide an exclusive platform for upcoming researchers, scientists, students and educators to present and discuss the latest innovations, trends, and concerns, practical challenges encountered and the solutions adopted in the microbiology field. The two days of educational program will be composed of keynote talks, session speakers, and oral presentations on the latest developments in the key thrust areas. Our entire team has put immense efforts to bring together three highly reputed journals so that ignited minds of young researchers can take this opportunity and publish their high quality research articles with them. Since the announcement of the conference, we have received enormous responses in terms of participation across the globe.

In order to provide more opportunities to the researchers and academicians our team has worked out to find good journals and we came up with association with 3 highly reputed journals that is Journal of Applied Microbiology published by Society of Applied

Microbiology, Nanomedicine published by Future Publication book and Applied Microbiology

and Biotechnology published by Springer publication house. All of them having impact factor more than three and are indexed in Scopus. The researchers with high quality research articles can get their manuscript published directly into any of these journals provided they qualify the terms and conditions of respective journals.

I wish ESAB 2020 will be worth attending conferences for one and all, in all aspects. I express my gratitude to Microbiologists Society, India (MSI) and GSBTM, Gujarat for extending their support in the form of resource persons as well as funds for this conference. I also take this opportunity to congratulate and thank each and every member of the organizing team who have put in enormous efforts to make the conference a grand success. I am highly grateful to our eminent speakers who extended their generous support and became available at one call to share their knowledge. Finally, I would like to thank the delegates of ESAB 2020 for their participation.

Dr. Swati Goswami

Convenor ESAB 2020,

Assistant Professor,

SOS, RK University

Microbiologists Society, India

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Opposite to Govt. Ayurvedic, College,
Osmanabad- 413 501.
(M.S.), India.

Date- 15/12/2020

Message from Microbiologists Society, India

Welcome you all in the International conference on **"Emerging Strategies in Antimicrobial Agents and Bio-Innovations"on December 18 and 19, 2020"** organized by Department of Microbiology, School of life Science, R K University, Rajkot during to explore the scientific excellence growing in the field.

The goal of any conference is to bring together researchers, Managers, policymakers and other groups of scientific community, who are active in the related areas and to give them a forum for exchanging information through the presentation and discussion of paper dealing with wide variety of topics listed in the technical program. This conference will provide an excellent platform to eminent professional, academicians and young researchers to share and exchange ideas and aid in forging fruitful collaborations with international and national delegates.

I hope that, the deliberations of the participants will provide a road map for developing inter-disciplinary research programs in the coming years. For research scholars from diverse parts of world, this can provide valuable opportunities to getting exposed to cutting edge research themes in Antimicrobial and Bio-Innovations.

I wish the conference a grand success.

A. M. Deshmukh

The Use of Natural Products as Antimicrobial Agent in Control of Recalcitrant Infectious Microbes

By

Prof. A. Olajide Ajayi

Online lecture series - ESAAB 2020, RK University, India.
Director, Center for Bio-computing and Drug Development (CBDD).
Professor of Microbiology
Department of Microbiology, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria.
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Antimicrobial agents are vital in reducing the global burden of infectious diseases. Nevertheless, the proliferation of resistant pathogens diminishes the effectiveness of the antimicrobial agents. Hence, the need for dynamic approach in our health management systems. I have done a lot of research works on the use of Natural products for control of infectious diseases and surveillance of antibiotic resistant reservoirs. Both in my University community, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria as well as during my Postdoctoral Research fellowship program at University of Fort Hare, Alice, South Africa.

The *In vitro* demonstration of antimicrobial activity of natural products such as Honey, Alum and Medicinal plants and some Nanoparticles that emanates from this sources is vital for this purpose. Similarly, Systematic selection and control of aetiologic agents which conceptualizes on the antimicrobial susceptibility test and sample preservation is also considered. Complementary to this, the source and dilution of standard drugs such as Tetracycline or Chloramphenicol at concentration of 250mg emptied into 10ml sterile distilled water to make up the stock solution of 25mg/ml. whereby, 0.2ml of the standard drug was thereafter pipetted in the control wells. Standard used vary with each study. Let’s stay safe with good scientific guide.

In vitro antimicrobial effect of Ethanol and Hydrogen Peroxide consortium against bacteria taxa isolated from patients

Dr. Elham Jafarzadeh,
Ph.D (Microbiology Head of Medical Laboratory
Burn and accident Hospital,Government University, Iran

Purpose: health care associated and relevant members are a major source of infectious diseases caused by a variety of microorganisms. The application of various disinfectants is one of the most effective methods for reducing or eliminating microbial contamination. The objective of this study was to evaluate the antimicrobial effects of Ethanol and Hydrogen peroxide against bacteria taxa isolated from patients who were admitted in Burn and Accident hospital, Ahvaz Jundishapur University of Medical Sciences, southwest of Iran.

Methods: In order to evaluate the quality of disinfection, sampling was performed from different parts such as blood, wound and biopsy of patients who were admitted in hospital due to burn. Bacillus spp has been isolated from the environment.

For bacterial recovery and isolation, samples were enriched and cultured onto different microbiological culture media. Species identification was carried out using phenotypic and molecular methods (16S rDNA sequence analysis). In vitro activity of Ethanol and Hydrogen peroxide were determined by the broth microdilution method.

Results: According to conventional techniques Pseudomonas aeruginosa, Acenetobater spp, S. aureus and Entrobacter spp has been isolated of the patients followed by Bacillus spp from environment to determine MIC of Ethanol and Hydrogen peroxide consortium on the above isolates. The results showed the highest potent disinfectant to eliminate all the microorganisms including spores.

Conclusion: In conclusion, the results of the present in vitro study showed that the Ethanol and Hydrogen peroxide consortium had promising results for decontamination of the tested microorganism, and it is recommended for disinfecting health care associated and relevant members and environment. In this research use of appropriate concentration ethanol 70%, Hydrogen peroxide 0.1%, Silicon ester and some more preservatives has been considered to improve disinfection and protect the instruments and skin from side effects.

Key words: 16SrDNA gene, Ethanol and Hydrogen peroxide, health care associated, Silicon ester, Preservatives

Tapping Nature to Design Nanomedicine

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Nanoscale materials are present in nature that act as prism resulting in diffraction of light creating a myriad of colours in animal organs that include butterfly wings to plumes of peacocks. Similar materials with exotic shape and size with tunable physico-chemical and opto-electronic properties can also be fabricated in the laboratory using various physical and chemical methods. However, hazardous reaction conditions and toxic chemical reagents used in these methods render the synthesized nanoparticles unsuitable for biomedical applications. Hence, several environmentally benign biological routes have been designed to synthesize gold, silver, platinum, palladium, copper and bimetallic nanoparticles using virus, bacteria, fungi, algae and medicinal plants. As a part of our growing interest in the novel nanomedicine, we have developed methods to used various medicinal plants found in nature like Dioscorea bulbifera, Gnidia glauca, Plumbago zeylanica, Barleria prionitis, Gloriosa superba and many more for synthesizing nanospheres, nanohexagons, nanotriangles, and nanorods. Careful optimization of different reaction parameters like time, temperature, pH, concentration of metal salts may help in the synthesis of nanomaterials with well defined shape and size. Further, naturally occurring bioactive principles like curcumin, diosgenin and other flavonoids, phenolics, alkaloids may stabilize and enhance the anticancer, antioxidant, antidiabetic, antimicrobial, and antibiofilm activities of the biogenic nanoparticles. In view of the background, it can be concluded that there is huge scope for further research towards translation of the biogenic nanoparticles as potential nanomedicine in future.

Keywords : Nanoparticles, biological synthesis, medicinal plants, functionalization, biomedical applications

Combating Antimicrobial Resistance through Rapid Point-of-Care Tests

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One of the major reasons of the emergence of antimicrobial resistance (AMR) is the excessive use of antibiotics globally. The development of rapid point-of-care (POC) tests will ensure accurate and quick treatment of infections, and reduction in the use of antibiotics.

Developing a POC test for rapid detection of AMR is a challenge. The microbiological tests currently available for detection of AMR are constrained by long duration (24-72 h) as these require culturing the pathogen necessitating empirical therapy. Rapid tests for detection of AMR has the potentiality to reduce the empirical use of antibiotics by instituting specific therapy. Several rapid methods, which may partly circumvent the need to culture bacteria, are being developed to determine resistance/susceptibility. Among these, MALDI-TOF MS is already being used in several laboratories. Techniques which use imaging of bacteria are being developed at rapid pace. The use of flow cytometry and fluorescence-based techniques are also being developed. Genomics-based resistance-gene arrays have the potential to be integrated into a true point-of-care (POC) test for detection of AMR. The collaborating Departments of Microbiology and Biophysics at the University of Delhi South Campus (UDSC-AMR group) are developing a resistance-genes-array based method to detect presence of resistance genes in bacteria present in the urinary tract infections (UTI). This would be coupled to an algorithm-based recommendation of the most appropriate antibiotic therapy in accordance with the WHO guidelines. A very large database of antibiotic resistance genes termed CARD (Comprehensive Antibiotic Resistance Database) in conjunction with the in-house developed (Srivastava et al., 2014), CBMAR (Comprehensive Beta-lactamase Molecular Annotation Resource) is being used to develop the resistance-genes-array based POC test for detection of AMR.

Innovative systems biology and bio-computational approaches in understanding microbial bioremediation

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The systems biology is an emerging discipline and it has created lots of new avenues for carrying out innovative research and it has wider applications in microbial biotechnology. The efficient bioremediation of environmental pollutants is very significant towards sustainable perspectives and the tools of systems biology may be helpful in various ways. This field is gaining attention as these tools can be quite noteworthy in discovery of new genes and understanding the metabolic pathways involved in bioremediation. Here we describe, the diverse unique aspects of different core areas which might be beneficial for researchers towards their applications in developing the synthetic microbial consortium and a futuristic idea of co-cultivation of microbes for bioremediation. These futuristic techniques and some tools of metabolic engineering may also decipher the importance of CRISPR-Cas system for knock-in and knock-out of genes for attaining effectual bioremediation.

How bacteria prevent viral attack and invasion by foreign DNA: the role of restriction-modification systems

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Nucleoside triphosphate (NTP)-dependent restriction endonucleases are one of the most prominent bacterial defenses against invading bacteriophages (virus that attack bacteria) and other foreign DNA. These enzymes nucleolytically cleave foreign DNA and thus protect the host cell from bacteriophage infection and also control horizontal transfer of DNA, such as antibiotic resistant genes and pathogenicity islands. The nuclease activity of these enzymes is coupled to the hydrolysis of NTP by an inbuilt NTPase. Deciphering the mechanism of how these enzymes work has been hindered by a lack of structural information of them. We have been studying the mechanism of these enzymes by carrying out structural studies complemented by biochemical and biophysical studies. These studies have provided unprecedented insights into the molecular basis of the NTPases and their coupling to the nuclease. I will present the mechanistic details that have emerged from them, and discuss the possible physiological implications of these enzymes activities.

Era of Biomedicine Ayurveda & Traditional Medicine

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The modern world today has significantly developed and gone through various adaptations to bring out this new era of Biomedicine Ayurveda & Traditional medicine in the aspects of clinical research and human health. The talk conceals about the soul and spirit of each discipline of modern and ancient medicine. Challenges we face and the obstacles that are accompanied during the selection of which type of medicine must be preferred for the diagnosis and prognosis of the particular diseases and under what circumstances which one is getting better than other and why it is been considering as better one all the aspects have been covered in this talk. The most importantly each discipline scope and realities have been emphasized and ensured the pros and cons of each discipline in terms of human health and clinical research. Conspectus of the talk as follows:

- What is Biomedical sciences – Branches and Role
- Ayurveda
- Why Ayurveda
- Challenges and Realities on Ayurveda
- Scope of Ayurveda
- Traditional Medicine
- Need of Traditional/Alternative Medicine
- Round up of all the discipline

Antimicrobial Resistance and Aquaculture: An Emerging Threat

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Aquaculture is a major thrust area playing dynamic role in improving food security, poverty mitigation, employment and community progress. World Health Organization has declared that Antimicrobial Resistance (AMR) is one of the top 10 global public health threats opposite humanity. With high levels of international trade and direct connectivity to the aquatic environment, aquaculture may play a role in global AMR dissemination. Antimicrobial use is the key carter of resistance.

One of the AMR risks that is particularly relatable to shrimp farming is the high level of traditional integrated farming practices. Human and livestock-poultry waste is used to fertilize ponds in order to promote algal growth within the pond which the shrimp then feed on. This is not only common but also supported by many governments as being more environmentally and economically sustainable.

It is therefore vital to gather more existing data on AMR and antibiotic usage in aquaculture in order to establish where future efforts aiming to reduce this are best positioned. A coordinated approach, between experts in the aquaculture, clinical, environmental and social disciplines, from both the private and public sectors, will be crucial.

The Human beings are really facing a dreadful post-antibiotic catastrophe, which will be exacerbated if action not taken immediately and it is high time that we take it serious.

OP101

Immobilisation, characterisation and zymogram analysis of alkaline protease produced by *Bacillus cereus* FT11

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Abstract

The alkaline protease produced by *Bacillus cereus* FT 11 was partially purified by ammonium sulphate precipitation and immobilised in 3.5 % alginate beads. The characterisation studies of immobilised enzyme showed that it shows maximum activity at a temperature of 65 ^{0}C (450 U/ml), pH of 10.5 (295 U/ml) and protein substrate (casein) concentration of 3.5% (305 U/ml). The Vmax of immobilised enzyme was found to be 303 U/ml and Km value, 2.51 mg/ml, which indicates a high affinity of enzyme towards its substrate. The immobilized enzyme also showed stability at wide ranges of temperatures from 5 °C to 65 °C with 96 % residual activity and wide ranges of pH from 8.0 to 10.5 with 95 % residual activity. The enzyme was further purified by ion exchange chromatography method with DEAE cellulose as the matrix and the activity was analysed through zymogram with gelatine. The specific activity of purified enzyme was calculated to be 421 U/mg.

Keypoints: Alkaline protease, *Bacillus cereus*, Enzyme immobilisation, Ion exchange chromatography, DEAE cellulose, Zymography.

OP102

Antibiotic Resistance Patterns of Gram-Negative Isolates from Water: A Case Study of Nasik

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Abstract:

The aim of this study was to study antibiotic resistance in Gram negative isolates from various sources of ground water such as open wells, bore wells, hand pumps, water from river Godavari as well as waldevi and treated water by municipal corporation of Nasik, an important city of Maharashtra state of India. Water samples were checked for presence of antibiotic resistance in gram negative bacteria as many pharmaceutical industries like Glenmark, Glaxosmithkline are located in this area. Resistance was tested against amikacin, netilmicin, cefadroxil, sparfloxacin, ceftriaxone, ciprofloxacin, gentamicin, cefotaxime, cefoperazone, lomefloxacin, ceftriaxone + tazobactam and ceftazidime. Strains from drinking water sources were found overall more sensitive to the drugs under testing. Frequent resistance was observed for ceftriaxone + tazobactam (85%) followed by up to 50 % to ceftazidime, 25-35% to cefadroxil and netilmicin, up to 20% for ceftriaxone and cefoperazone, up to 6% for sparfloxacin and lomefloxacin while all isolates show highest sensitivity to ciprofloxacin and amikacin. Isolates of gram-negative organisms from hand pump water samples found to be more resistant to various antibiotics followed by isolates from river water, borewell as well as open well. Treated water samples from different locations showed varied results ranging from presence of most sensitive to highly resistant isolates. Majority isolates are belonging to family Enterobacteriaceae and from Pseudomonas spp. As anthropogenic activities are the main cause of development of resistance among bacteria, present research work may be beneficial by raising awareness among people regarding misuse of antibiotics.

Keywords: Antibiotic resistance, disc diffusion test, gram negative bacteria, Nasik city, treated water, groundwater, river water

OP103

Isolation of Potential Antimicrobial Compound from Actinomycetes Found in Soil Surrounding Medicinal Plants

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Abstract

Resistance developed by microorganisms against antibiotics is now a global threat. There is a need to look at alternate sources from which substances useful against various diseases can be obtained. Soil surrounding the medicinal plants possessing antimicrobial activity was screened in order to find soil bacteria capable of producing antimicrobial compounds and to isolate such compounds there from. Eleven antimicrobial medicinal plants from three regions of Saurashtra, Gujarat, India, were selected and soil surrounding those plants was collected. Soil samples were added to different media which were then incubated to reveal various bacterial colonies, whose characteristics were studied. Sixty-six isolates of Actinomycetes were obtained from the soil samples. Cross streak, agar well and disk diffusion methods were used for primary, secondary and final screening, respectively, of the antimicrobial isolates. Amongst all isolate GOS1 from the soil surrounding *Ocimum sanctum* in GirSomnath region was found to be most potent and subjected to TLC, Bioautography, biochemical tests, enzymatic activity, 16S rDNA sequencing and gel electrophoresis, which was confirmed to be *Streptomyces arenae* followed by optimization of various conditions. Isolation and characterization of compound was done by using UV, FTIR, NMR and Mass Spectroscopy. A novel benzodiazonin-3-one compound was isolated and characterized, which showed potent antimicrobial activity as compared to the reference standards by *in vitro* antimicrobial assay. Soil surrounding medicinal plants which themselves have well-known antimicrobial activity may be a rich source of Actinomycetes, which may produce compounds having antimicrobial properties. This can be an emerging strategy for researchers and clinicians to explore soil bacteria for the isolation of biologically active compounds for the management of various diseases.

Keywords: Bioautography, Characterization, Microbiology, Resistance, *Streptomyces arenae*

OP104

Characterisation, partial purification and application studies of pigment produced by *Chromobacterium violaceum* from paddy field

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Abstract

Violacein produced by *Chromobacterium violaceum* is a promising drug. In the current study a dark violet colour pigment was extracted from soil. Regular media used for their biosynthesis were nutrient agar, nutrient broth, peanut broth and coconut powder broth etc. For Violacein production, sesame powdered broth was found to be the good choice, when incubated at 40 °C, with pH of 4.0, at 24 hours of incubation with 8 mL inoculum. Best carbon, nitrogen and amino acid sources were found to be glucose, ammonium nitrate, and tryptophan. The pigment was extracted using acetone and purified using thin layer chromatography and column chromatography. The antimicrobial activity of violacein was studied, and found that effective against *S. typhi*, *S. aureus*, *Pseudomonas* sp., *Fusarium* sp., and *Geotricum* sp. The pigment extract was analysed by using UV-Vis spectrophotometer and a single peak was obtained at 579 nm. The dyeing activity of these pigments on fabrics, wood chips and candle was studied. Based up on the antimicrobial activity of the pigment, it was used for the study of soap production. Polymerase Chain reaction (PCR) amplification of DNA isolate was done using PCR thermo cycler and verified by Agarose Gel Electrophoresis. Molecular level characterization was done by Sanger sequencing and the sequences were compared in the BLAST search tool in the NCBI nucleotide sequence database and showed 76% sequence similarity with *Chromobacterium violaceum* strain NCTC9695.

Keywords: Antimicrobial activity, *Chromobacterium violaceum*, chromatography, PCR, pigment, Sanger sequencing, soap production

OP105

Preparation and Evaluation of Microsponges for The Topical Treatment of Acne Vulgaris

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Abstract

Microsponge based drug delivery system (MDDS) is one of the widely used systems of drug delivery that offers many advantages like high drug loading efficiency, ability to trigger the release of drug by a variety of triggers, better mechanical strength, good flow properties etc. One of the prominent fields of application of MDDS is topical drug delivery. The present work is aimed to develop microsponge based drug delivery system for the topical treatment of acne vulgaris. nicotinamide and clindamycin phosphate where selected as the drugs for this work. the microsponges of both the drugs were prepared separately. For the preparation of microsponges, ethyl cellulose was selected as the polymer and quasi emulsion solvent diffusion method was selected as the method of preparation. The preliminary studies were carried out to finalize certain process parameters and material attributes associated with this work. A 3^2 factorial design was applied for the optimization of microsponges. The amount of polymer was selected as X1 and starting time was selected as X2. These were the independent variables. As for the dependent variables, average particle size was selected as Y1, % yield was selected as Y2 and % drug diffused was selected as Y3. The results of all the dependent variables were found to be within the acceptable range. All the other selected evaluation parameters also provided satisfactory results. It was concluded that the microsponges of nicotinamide and clindamycin phosphate were prepared successfully. The future scope of this work can be described as to formulate a suitable topical dosage form that can incorporate the prepared microsponges and further that can be applied topically for the treatment of acne vulgaris.

Keywords: Microsponge, Topical Delivery, acne vulgaris, clindamycin phosphate, nicotinamide, quasi emulsion solvent diffusion method

OP106

Recent advances in *In silico* design of GLP-1 receptor agonists

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Abstract

The glucagon-like peptide 1 (GLP1) receptor is a vital drug target for type 2 diabetes. GLP-1 receptor agonist medicines (exanatide, lixisenatide, dulaglutide and liraglutide) are a type of incretin-based medicine for type 2 diabetes. We have surveyed in detail how in silico drug designing is helping to develop novel GLP-1 receptor agonist drugs. Their pharmacotherapy and adverse effects have also been examined. The authors feel that in silico method is a great supplementary tool in almost all the experimental studies on GLP-1 receptors and is extremely effective in classifying novel drug molecules that can act as GLP-1 receptor agonists.

OP107

Development of Topical Emulgel of Metronidazole and Mupirocin for Treatment of Diabetic Wound Healing

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Abstract

The objective of this study was to develop more retentive and effective drug delivery system for Mupirocin. The research is going on in achieving effective formulation. Mupirocin is an anti-microbial agent that is used to treat wounds healing process. First Screening of oil, surfactant and co-surfactant for SEDDS carried out. Solubility of drug is investigated in different oils, surfactant and co-surfactants by UV method. A drug is dissolved in oil in which the drug has a maximum solubility among the available, then surfactant and co-surfactant is added in which drug has a maximum solubility, mixed well on a magnetic stirrer. Transparent SEDDS is formed. Now Carbopol 940 and Polyacrylate sodium gelling agent is suspended in water and hydrated for overnight separately. For preparation of Emulgel set the various ratios of gel and SEDDS. The prepared Emulgel was evaluated. The result indicates that Emulgel gives better release, controlled release. The formulation F11 has more favorable responses such as % drug release about 99.27 %, average pH 6.7 ± 0.1 and Drug content 99.4 ± 0.11. Thus formulation F11 was preferred as an optimized formulation. The present Emulgel formulation delivers with good therapeutic efficacy of topical application. Mupirocin, Macroemulsion, SEDDS, Diabetic Wound, Antimicrobial Agent, Topical delivery, incorporated.

OP108

Evaluation of probiotic attributes of *Lactobacillus fermentum* 5898 under *in vitro* and *in vivo* conditions at molecular level

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Abstract

The important criteria for the microbial culture to be used as probiotic has been established which includes resisting the hostile acidic conditions of stomach and bile toxicity of duodenum along with ability to adhere to mucus and epithelial cells. Based upon this information, the present study was specifically undertaken to establish the probiotic attributes of infant feces isolated indigenous *Lactobacillus.fermentum* MTCC 5898 at the molecular level. The relative expression of *AtpD, Bsh, Mub* and *MapA* genes was checked under *in vitro* and *in vivo* milieu by reverse transcription-quantitative PCR. Further the expression of host *Muc-2* gene in mice was also assessed to test the *in vivo* functional efficacy. Under *in vitro* study, *AtpD* gene up regulated by 24 ±0.95 folds at pH 3 even after 1 hr of treatment. Likewise in presence of bile salt (3%), a significant increase ($P<0.05$) in expression of *Bsh* gene 3±0.3 was observed when culture was incubated for 3 hrs. Genes associated with bacterial adhesion (*Mub* and *MapA*) also enhanced their expression ($P<0.05$) significantly in presence of mucin than control. During *in vivo* trial on mice, expression of *AtpD* increased by 14.2±0.71 and 44.6±2.4 folds respectively after 30 min and 1hr of treatment likewise expression of *Bsh* gene increased by 4.5±0.4 folds. Furthermore, expression of *Muc-2* gene of host responsible for synthesizing mucin was also significantly increased by 3.7±0.25 folds. In conclusion, this indigenous Lactobacilli had shown the ability to survive in the harsh acidic & bile conditions of the gut along with good adhesion ability by increasing the expression of marker genes. As well as it also up regulated the *Muc-2* host gene which itself involved in the immunity of the host.

Keywords: Probiotic, F1F0-ATPase, Bile salt hydrolase, adhesion associated genes, Real-Time PCR

OP109

Studies on Antimicrobial and Wound healing activities of *Typha angustata* L. Inflorescence

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Abstract

Skin infection and topical wounds require special attentions as they make human and animal susceptible to different types of complications. Globally drug resistant micro-organisms are increasing. To get rid of the infections caused by resistant strains, alternative drugs are always looked for. Plants have often been the source for such alternative drugs. The inflorescence of *Typha angustata* L. has been traditionally used to heal wounds. The present study was initiated to schematically analyze wound healing potential of *Typha.* The aqueous crude extract from *Typha angustata* L. inflorescence was prepared using Soxhlet apparatus. The extract was concentrated under reduced pressure in a rotary evaporator at 40-60^{o}C. The ointment was prepared from *Typha angustata* L. inflorescence aqueous extract and applied on induced wounds (Viz., Excision, Incision and Burn) in albino Wistar rats. Ref drug..... To assess the wound healing ability of typha extract, histological studies were performed on animal's skin after 14 days of treatment in all study groups. Additionally, the antimicrobial activity of crude extract was determined against selected pathogenic strains causing wound related infections (*Staphylococcus aureus* (MTCC 96), *Klebsiella pneumonia* (MTCC 109), *Escherichia coli* (MTCC 443) and fungal pathogens *Candida albicans* (MTCC 183) and *C. Neoformans* MTCC-1347*)*.This was carried out to know the added advantage of *Typha* sp. in controlling organisms causing wound related infections. The results showed that plant extract exhibited similar antimicrobial activity when compared with standard antibiotics (Ampicillin, Chloramphenicol, Ciprofloxacin, Norfloxacin). Similarly, histological study also revealed better wound healing as compared to reference drug. Better reparative changes were observed in terms of neo-vascularization and collagen tissue deposition in treated animals as compared to reference drug treated and control group animals. Thus, the findings provide an evidence to consider *Typha angustata* L. inflorescence as alternative source in the synthesis of new antimicrobial drug for the treatment of wound and wound related infections.

Keywords: *Typha angustata* L. inflorescences, Antimicrobial, Wound healing

OP110

Optimization, production and partial purification of antibacterial compound from forest soil isolate *Streptomyces plicatus*

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Abstract

This study was carried out to optimize the culture medium for enhanced production of antibacterial compound and its partial purification from an actinomycete strain isolated from forest soils of Bastar region of Chhattisgarh, India. This actinomycete isolate was identified as *Streptomyces plicatus* on the basis of 16S rRNA sequencing and phylogenetic analysis. The effect of inoculum size, incubation period, pH, temperature, carbon sources and nitrogen sources on antibacterial activity against *Staphylococcus aureus* (MTCC 7443) and *E coli* (MTCC 3221) was optimized. *Streptomyces plicatus* showed highest antibacterial activity in terms of zone of inhibition (mm) with 1 % inoculum size after 4 days of incubation at pH 6 and 30°C incubation temperature. Mannitol and malt extracts were found to be best carbon and nitrogen sources for enhanced antibacterial activity respectively. The crude chloroform extract containing antibacterial compound was partially purified by silica gel adsorption column chromatography which showed UV active single spot of 0.5 Rf value on F^{254} silica gel thin layer chromatography. The purified compound exhibited broad spectrum antibacterial activity against several bacterial pathogens such as *Staphylococcus aureus, Bacillus subtilis, Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa* and *Klebsiella pneumonia.* While it showed highest antibacterial activity against *Staphylococcus aureus* with MIC value of 0.08 mg/ml. This antibacterial compound was identified as “Borrelidin” on the basis of spectral analysis such as UV-visible, FTIR and LC-MS.

Keywords: Streptomyces, bacterial pathogens, antibacterial activity, zone of inhibition, MIC

OP111

Synergistic association of organic acid with disinfectants against biofilm forming *Cronobacter sakazakii* strains

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Abstract

Cronobacter sakazakii is a Gram-negative, rod shaped, motile, peritrichous, non-sporing, opportunistic food borne pathogen. *C. sakazakii* has been known for its ability to survive extreme conditions and ability to form biofilm on diverse biotic and abiotic surfaces. Biofilm-associated bacterial infections represent one of the major threats to modern medical treatments. Biofilms play an important role in the antibiotic and antimicrobial resistance of encased bacteria. Therefore, it is important to devise new treatment scenarios active against microbial biofilms. The objective of this study was to evaluate the anti-bacterial and anti-biofilm efficacy of six organic acids including acetic acid, citric acid, formic acid, tartaric acid, malic acid and maleic acid along with different chemicals (disinfectants, surfactants and chelating agents) including NaCl, NaOCl, Tween 80, Tween 20 and EDTA either alone or in a combination of organic acid with disinfectants against *C. sakazakii*. The assays were performed on a 96-well microplate using a microdilution technique based on the checkerboard titration method. Synergistic combinations of organic acids with disinfectants were revealed. A dose-dependent anti-biofilm effect was observed for each combination as revealed by light microscopy and SEM analysis. In conclusion, we here present the first comprehensive *in vitro* testing of malic acid in combination with hypochlorite as promising combination against *C. sakazakii* biofilm development and eradication.

Keywords: *Cronobacter sakazakii*, antimicrobial resistance, biofilms, synergistic combinations

OP112

Probiotic Antimicrobial and Antioxidant attributes of Lactic Acid Bacteria Isolated from Homemade and Commercially Available Dairy Products

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Abstract

Probiotics are usually defined as microbial food supplements with beneficial effects on the consumers. Most probiotics fall into the group of organisms known as lactic acid producing bacteria. Some of the beneficial effects of lactic acid bacteria consumption include improving intestinal tract health, enhancing the immune system, synthesizing and enhancing the bioavailability of nutrients, reducing symptoms of lactose intolerance, decreasing the prevalence of allergy in susceptible individuals and reducing risk of certain cancers. The antioxidants mechanisms of probiotics have been reviewed in terms of their ability to improve the antioxidant system and their ability to decrease radical generation. Here, 30 lactic acid bacterial strains were isolated from homemade and commercially available dairy products and these were screened for their probiotic attributes as well as antimicrobial and *in vitro* antioxidant potential. Out of 30 isolates, the 17VSH1, 17VSH3, 17VSD1 and 17VSD2 cultures were found to be best suited on all criteria of probiotics as these were more or less tolerant to pH 2 and were also able to survive at 2% bile concentration and 17VSH2, 17VSH3 cultures having higher antioxidant potential compared to others. Thus, 17VSH3 can further be evaluated for health promoting attributes in mice model as it has shown ability to survive gut conditions where pH drops to nearly 2 and the bile concentration reaches upto 2%. The culture can also be screened for its antidiabetic and antihypertensive properties.

Keywords: Probiotics, Lactic acid bacteria, Antioxidant activity, Antimicrobial activity

OP113

Study of antimicrobial compounds from selected isolates

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Abstract

Aim of the present study to produce antimicrobial compound from different bacteria from various environment which are capable for production of higher antimicrobial compound and to check out in which parameters antimicrobial compound production and their activity should be higher. Now a day scientist takes a great interest in antimicrobial compound production due to its various agriculture, industrial and medicinal application.The microbial world is the largest unexplored reservoir of biodiversity. Different type of Bacteria is able to produce different type of antimicrobial compound which is useful in societies in different ways. We have find out 29 isolates from different soil sample using crowded plate techniques, among 3 isolates found to be antimicrobial compound producer against pharmacecutically risk associated *B.Subtilis, P.aeruginosa, S.aureus, Vibrio cholerae, and E.coli* . Among 3 isolates VMS-16 and VMS-c1 found higher inhibition activity accordingly against *S.aureus and Vibrio cholera.* At the initial screening of VMS-16 against *S.aureus* found 10.42mm zone of inhibiton. Morphological Charteristics of VMS-16 were studied and after 24hrs of incubation at pH 9 the inhibition activity gradually increased and have been 10.53mm.

OP114

In-silico method using Prodigiosin as potential PARP1 inhibitor for treating Triple Negative Breast Cancer (TNBC)

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Abstract

Bacterial pigment, Prodigiosin is a red coloured tri-pyrrole secondary metabolite obtained from *Serratia marcescens*. It is well-known for their ethano-medicinal applications. In the present investigation, *Serratia marcescens* MTCC 8708 was procured from MTCC, Chandigarh, India and the optimization of growth parameters for maximal production of prodigiosin was determined. It revealed a higher production rate at a temperature of 24^{o}C, pH of 7, at an incubation period of 48 hours with nutrient broth medium as a growth substrate. The extracellular prodigiosin pigment was extracted and purified using Column Chromatography and Thin Layer Chromatography (TLC). The purified form of prodigiosin was further identified through HPTLC analysis which confers for the presence of prodigiosin. The prodigiosin was found to possess a wide range of antibacterial effect against varied bacterial strains. Further, in our work an attempt was made to assess the therapeutic potential of prodigiosin on Triple Negative Breast Cancer (TNBC) through in-silico molecular docking analysis. Since PARP-1 inhibition is considered to be crucial target in the treatment of TNBC, an AutoDock 4.2 was employed to evaluate the binding affinities between prodigiosin and PARP-1 molecule. It showed that prodigiosin interfered with the amino acids (Tyr^{235} and Gly^{202}) of PARP-1 protein similar to control molecule [trans-4-(7-carbamoyl-1H-benzimidazol-2-yl)-1-propylpiperidinium (A620223)]. These interactions suggested that prodigiosin had similar binding affinities and docking fitness score like control molecule. Thus, it could be concluded that prodigiosin could act as a potential drug molecule for anticancer therapy. Further, prodigiosin could also be exploited for designing of newer drugs through the in-silico methods used in our study.

Keywords: TNBC, PARP-1 inhibitor, Prodigiosin, *Serratia marcescens*, Docking, Target-Ligand.

OP115

In vitro antimicrobial and anti-proliferative activity of crude methanolic extract of pigment from *Streptomycetes* on HT-1080 fibro sarcoma cell line

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Abstract

The ability to produce secondary metabolite like antibiotics is the characteristic feature of Streptomyces. Besides antibiotics, they are also seen to produce other bioactive compounds of economic importance like pigments, which are potentially used in textile, food, cosmetic preparations and pharmaceutical with remarkably appealing results. Considering the bioactivity of bacterial pigments and their safe applications as therapeutic agents for various human diseases, the microbial world has attracted the researchers to discover many such novel compounds. Under this backdrop extraction of such priceless molecule from microbial source was the aim of this work. Actinomycetes strain isolated from water sample was identified as *Streptomycetes* with conventional and molecular approach. The biological property of the metabolite as antibacterial, antioxidant and anticancer was evident from the liquid fermentation and further followed by spectroscopic and chromatographic analysis. The crude ethanolic pigment extract was shown to be antibacterial on gram negative human pathogens. Also it exhibited antioxidant and anticancer activity against two cancer cell lines i.e., HeLa and HT-1080. Pigments from bacteria can be effectively used as natural source of treatment against various human ailments. Our results provide insights into effective role of pigment as potent bioactive metabolite with effective pharmaceutical properties.

Keywords: Pigment, Antibacterial, Anticancer, Treatment.

OP116

Isolation, characterization and evaluation of heavy metal tolerant microorganisms from dredged bilge water for bioremediation potentials

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Abstract:

Marine pollution is the introduction of substances into the marine environment causing detorious effect to aquatic life and also to human beings. Bilge water is one of the causes for marine pollution. Bilge water is not exactly water but a mixture of variety of hazardous and non hazardous substances. It's a mixture of fresh water, sea water, oil, sludge, lubricants, chemicals, various inorganic salts and metals (e.g., arsenic, copper, lead, cadmium, mercury). Almost all the traditional physicochemical methods do not provide effective solutions for the elimination of metals from bilge water. But microbial bioremediation is a effective approach for elimination of heavy metals. In this study, two heavy metal tolerant bacteria were isolated from bilge water and were identified as *Pseudomonas aeruginosa* and *Serratia marcescens.* Then, the two bacterial strains were inoculated into nutrient broth containing bilge water. Initial and reduction amount of heavy metals were read by atomic absorption spectroscopy. *Pseudomonas aeruginosa* shows reduction of lead (70.58%), cadmium(14.15%) and mercury(25.29%). *Serratia marcescens* shows reduction of lead (81.69%), cadmium(44.6%) and mercury(69.64%). The isolated bacteria were effective for the remediation of heavy metals from bilge water.

OP117

Syntheses, characterization and anti–tubercular activity of some new 3,4,5-trisubstituted-1,2,4-triazoles

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Abstract

Triazole derivatives are an important class of heterocyclic compounds, specifically substituted and clubbed with thiazoles reported to possess a wide spectrum of biological activities such as antibacterial, antifungal, analgesic, anti-inflammatory, antitubercular activities and so on. In considering the fact discussed above a series of new substituted 4-amino-5-(4′-(4′′-chlorophenyl)-thiazol-2′-yl)-3-mercapto-4H-1,2,4-triazoles were synthesized with various substitutions at amino position and were screened for antitubercular activity. The starting material 4-amino-5-(4′-(4′′-chlorophenyl)thiazol-2′-yl)-3-mercapto-4H-1,2,4-triazole (MS-4) was synthesized by stirring 4-(4-chloro phenyl)-thiazole-2-carbohydarzide and carbondisulphide with alcoholic potassium hydroxide solution followed by refluxing with hydrazine hydrate in water. The parent compound was converted to the desired title compounds (MS -4 a-m) by reacting with various substituted aromatic aldehydes. All the new synthesized compounds were characterized by MP, TLC, UV, IR and representative compounds by ^{1}H NMR and Mass spectra and screened for antitubercular activity against *M. tuberculosis* H_{37}Rv using Isoniazid as standard by L.J Slope method. From the antitubercular screening it was observed that, the synthesized compounds exhibited mild to moderate activity compared to the standard. The compounds 3,4-dimethoxy(MS-4d) and dimethylamino(MS-4i) substitution on phenyl ring exhibited better antitubercular activity among the series.

Keywords: Synthesis; triazoles; antitubercular activity.

OP118

Bioprospecting marine-sponge associated fungi for antimicrobials

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Abstract:

The marine – sponge associated fungi are an interesting source of new secondary metabolites. The present study demonstrates exploration of potential of sponge-associated fungi for antimicrobial compounds. Total 20 and 15 fungal isolates were obtained from *Axinella verrucosa and Leucosolenia variabilis* respectively which were later screened for their antimicrobial activity. On primary screening, chloroform extracts of *Aspergillus* sp. exhibited inhibitory activity against laboratory strains, mainly against *Candida albicans.* The chemical investigation of isolated compounds was done using HRLCMS analysis resulted in isolation of wide array of secondary metabolites. In addition to a number of known secondary metabolites, few new compounds were detected which are to be identified.

Keywords: Marine sponges, sponge-associated fungi, secondary metabolites, Aspergillus sp., HRLCMS analysis, heterocyclic compounds.

OP119

Anti-microbial activity of Vegetables

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Abstract

Apart from being the source of energy, vegetables play many important role in protecting us from various diseases. This study sheds light on the antimicrobial activity of bitter gourd (*Momordica charantia*), jute (*Corchorus olitorius*) leaves and red spinach (*Amaranthus dubius*). Agar well diffusion method was used for the evaluation of Methanol, Ethanol, Acetone and Aqueous extracts of the samples. Potency of these extracts as anti-microbial agents were tested against *Streptococcus aureus, Bacillus subtilis, Klebsiella pneumoniae, Escherichia coli, Aspergillus niger and Penicillium notatum.* For the preparation of negative control 100 micro litre of the solvents were poured into the wells, while for positive control known antibiotic and anti-fungal agents of known strength were poured into the wells. Observations revealed that aqueous extract of bitter gourd has anti-fungal property as clear zones of inhibiton were observed. Aqueous extract of jute leaves retarded the growth of fungal strains making us predict that at higher concentration, the extract might act as an inhibitor. On the other hand aqueous extract of red spinach leaves showed antimicrobial activity only against *P. notatum*. Further investigation to determine the compound conferring antimicrobial property revealed tannins to be the predominant compound along with alkaloids in conferring the antimicrobial property. The knowledge from the above can be used in the preparation of compounds which have better therapeutic potential against known pathogens.

OP120

Management of Bacterial Vaginosis in early trimesters of pregnancy and its effect on pregnancy outcome: A Study on Pregnant women of Bundelkhand Region.

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Abstract

Bacterial vaginosis is polymicrobial gynecological infection among women of reproductive age group. The predominant lactobacillus vaginal flora is replaced with the faculatitive anaerobes including Gardenerella vaginalis, Staphylococcus epidermis, Mycoplasma hominis and other anaerobes. The occurrence of BV in pregnancy leads to adverse pregnancy outcomes such as premature rupture of membranes, preterm deliveries, chorioamniotitis and even post partum endometritis. A cross- sectional study was conducted on 182 symptomatic pregnant women of various reproductive age groups and including all three trimesters(0-9months), attending, Medical College of Bundelkhand Region. Amsel's criteria and Nugent scoring method was the clinical criteria performed for the detection and screening of bacterial vaginosis. The positive samples undergo for culture microscopy and Gram staining for observation of clue cells. Out of 182, the positive 47 patients were interrogated for history of pregnancy related complications and were prescribed for systemic antibiotic therapy which preliminary includes oral metronidazole/clindamycin in early weeks and also in combination of erythromycin. The cure rates of oral therapy (seven day course) have been 88% and 92% respectively for metronidazole and clindamycin. The study revealed systemic antibiotics afford to reduce BV, and also resulted in minimization of preterms (pre mature delivery) and PROM cases. Hence, early diagnosis of BV and implementing systemic antibiotic therapy in pregnant cases shall prove a benchmark in preventing adverse pregnancy results and lay better line of treatment for clinicians and patients.

Key words: Bacterial vaginosis, Gardenerella vaginalis, Amsel's criteria, Nugent scoring, clue cells, systemic antibiotic therapy.

OP121

Microbial contamination of drinking water in Uttarakhand, India: A review

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Abstract

Microbes are found ubiquitously including drinking water and affect our life directly or indirectly. They include non-pathogenic as well as disease causing pathogenic species. Many pathogenic microbes have found their way into drinking water which is a key resource of our food supply. Drinking water being transported through distribution networks are subjected to chemical as well as microbial contamination. Assessing drinking water quality is need of present-day situation. *Escherichia coli*, *Enterobacter*, *Citrobacter* and *Klebsiella*, are commonly found in contaminated water. Hence, regular monitoring of drinking water for pathogenic microbes is necessary to determine the level of contamination. A precise review of literature on microbial contamination of drinking water in Uttarakhand was conducted. The microbiological analysis of water quality shows that total coliform and faecal coliform contamination in raw water such as rivers and lakes is more than water treatment plants. Although ground water was found to be satisfactory.

Keywords: Microbial contamination, Water quality, Total coliform, *Escherichia coli*, *Enterobacter*.

OP122

Antimicrobial Metabolites from Halophilic Actinomycete *Nocardiopsis_sp. Al-H10-1* (KF384482) Isolated from Koliyak, Gulf of Khambhat, India

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Abstract

The overuse of antibiotics has resulted in the development of drug resistant, a major problem in disease curing processes i.e. development of drug resistance. The World Health Organization (WHO) released its first list of the most concerning pathogens for human health in 2017 which suggested that there are total 12 bacterial families which have developed multiple drug resistance and for which novel antibiotics are required immediately (WHO 2017). There is a requirement to explore some novel compounds to overcome this issue. Thus our study aimed at exploration of marine actinomycetes as a valuable resource for novel products with antimicrobial properties. The halophilic actinomycete *Nocardiopsis_sp. Al-H10-1* (KF384482) was isolated from saline water (20 m away from shore) of Alang coast (Gulf of Khambhat), Bhavnagar, Gujarat, India using a selective media - Starch agar media supplemented with 10% NaCl. The isolate Al-H10-1 was identified as *Nocardiopsis sp.* through rigorous morphological and cultural characteristics; the species was confirmed through 16s rRNA phylogenetic analysis (NCBI Genbank Accession number: KF384482). The antimicrobial potential of *Nocardiopsis sp. Al-H10-1* was assessed against a range of Gram-positive and Gram-negative bacteria as well as three fungi, there it demonstrated antimicrobial activity against four Gram negative bacteria and one Gram positive bacteria. Further we attempted to identify the active antimicrobial compounds using Gas Chromatography-Mass Spectroscopy (GC-MS). GC-MS analysis showed presence of 17 compounds which included antimicrobial compounds like 2, 4-bis (1, 1-dimethylethyl)-Phenol, Dibutyl phthalate as well as various types of alkanes and their derivatives. The broad spectrum of antimicrobial activity and confirmed presence of antimicrobial compounds makes *Nocardiopsis sp. Al-H10-1* a promising candidate for exploration of antimicrobial metabolites.

Keywords: Marine actinomycetes; haloalkaliphilic; antimicrobial activity; gas chromatography-mass spectroscopy, 2,4-bis (1,1-dimethylethyl)-Phenol, Dibutyl phthalate

OP123

Production and application of Halotolerant bacteria with golden yellow pigment from marine isolates.

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Abstract

The product's colour reflects its freshness and help to attract customers. Products from sectors such as cosmetics, food and medicinal beverages, etc. widely used natural and synthetic pigments. Studies found that synthetic pigments have some negative effects, such as hypersensitivity, carcinogenic, allergic and toxic to the organ. These increased natural pigment demand globally as they combat the bad effect of synthetic pigments and medicinal properties such as anti-bacterial, anticancer, antioxidant, antiviral, etc. Marine bacteria are well known for their pigment production viz. xanthomonadine, prodigiosin, violacein, anthracene, carotenoids, and flexirubin. We found 1 bacterium with a golden yellow pigment during the analysis of pigment producing marine isolates (UKR-18). The pigment from UKR-18 showed highest methanol solubility. UKR-18 demonstrated salt tolerance up to 17 % (w/v) NaCl concentration. Pigment production optimization UKR-18 showed that the highest production of pigment was 5% (w/v) NaCl concentration, 7 pH, 30 C temperature, 42 h incubation time, 2% (v/v) inoculum scale. The pigment characterization was carried out by the TLC, maximum absorbance, and FT-IR and results revealed that pigment from carotenoid family. The extracted pigment showed 61.2 % of DPPH scavenging activity. The extracted pigment also shows antimicrobial activity against *E. coli Pseudomonas, Bacillus* and *S. aureus* antimicrobial activity against the pigment. Extracted pigment successfully applied on cloths, candles and in bio-lip balm for dying purpose.

Key words: Pigment, halotolerant, antimicrobial and antioxidant

OP124

Antibiofilm and antivirulence efficacy of 2-hydroxy-4-methoxy benzaldehyde (2-HMB) against *Acinetobacter baumannii* infections: An *in vitro* and *in silico* analysis

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Abstract

Acinetobacter baumannii is considered to be a leading causative agent of nosocomial infections due to its increased antibiotic resistance and virulence. The ability of *A. baumannii* to form biofilms contributes to its survival in adverse environmental conditions including hospital environments and on medical devices. Hence, the present study explicated the antibiofilm and antivirulence efficacy of 2-hydroxy-4- methoxy benzaldehyde (2-HMB) against *A. baumannii* strains in a non-bactericidal manner. 2-HMB showed a concentration-dependent biofilm inhibition, which was evidenced through light and fluorescence microscopic analyses. The other virulence factors such as protease, extracellular polymeric substances production as well as swimming and swarming motility were also inhibited by 2-HMB treatments. Further, the 2-HMB treatment effectively reduced the mature biofilm formation in different time intervals within 6 h, 12 h and 24 h. The results of q-PCR analysis unveiled the down regulation of biofilm/virulence associated genes upon 2-HMB treatment, which was in correspondence with the *in vitro* bioassays. Further, the docking analysis revealed that 2-HMB shows strong affinity with Bap (biofilm associated protein), which regulates the expression of biofilm as well as virulence in *A. baumannii*. Thus, this study reports the feasibility of 2-HMB as a promising anti-biofilm agent against *A. baumannii* strains.

OP125

Endophytic fungi from Mangrove ecosystem of Kutch, Western India: A potent source of antimicrobial metabolites

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Abstract

With the increase in microbial disease and increase in drug resistant microorganisms, need for novel as well as more potent antimicrobial compounds remains constant. In this context, our study was aimed at exploration of mangrove endophytic fungi as a potent source of antimicrobial compounds. Total 13 halophilic fungal isolates were isolated from root sample of *Avicenia marina* collected from Kutch,Gujarat. They were able to grow in the range of 5-15% W/V NaCl. The antimicrobial spectrum of selected isolates was investigated against a range of Gram negative and Gram-Positive bacteria as well as two fungi. Three of the fungal isolates showed broad spectrum activity against the pathogens. The antimicrobial metabolites were further extracted using Ethyl acetate. The findings are interesting as only few endophytic halophilic fungi have been investigated for their antimicrobial potential till date.

Key words: Mangrove endophytic Fungi, Antimicrobial activity, Halophilic Fungi

OP126

Antagonistic activity of lactic acid bacteria on phytopathogenic isolates from bacterial-blight infected pomegranate fruits

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Abstract

Bacterial-blight is a major destructive disease of pomegranate caused by *Xanthomonas axonopodis pv. punicae*, recording about 60-80% loss of yield and quality of the pomegranate fruit in India. The management of the disease requires expensive chemicals and hence, there is a strong need to identify an eco-friendly and cost-effective procedure to combat the issue of bacterial-blight in pomegranate. Lactic acid bacteria (LAB) are popular probiotic organisms, known for their ability to produce antimicrobial substances that can serve as a substitute for conventional pesticides. This study explored the antagonistic activity of different LAB cultures against bacterial-blight causing phytopathogens. Three microorganisms were isolated, and characterized, from bacterial-blight infected pomegranate fruits from different orchards in Maharashtra. *L .plantarum*, *L .acidophilus* and *L.casei var. rhamnosus*, along with isolates from indigenous cow (Khillari) dung were tested individually and in combination, against the isolated phytopathogens. To identify the primary source of substances responsible for inhibitory action of LAB, their whole-cell broth, cell-free broth, and live-cells were used during the study. The antimicrobial activity was tested using agar well-diffusion assay. The samples were stored for 7 days at room temperature and also under refrigeration conditions. The inhibitory activity of stored samples was tested after 7 days against the pathogens. Whole-cell broth and cell-free broth of all the LAB cultures and cow dung isolates, individually and in mixtures, were observed to exhibit higher antagonistic activity against all the plant pathogens, as compared to live-cells. The whole-cell broth consortium of three LAB strains was observed to show the highest activity against the plant pathogens. The antimicrobial activity of the LAB consortium was observed to be consistent at refrigerated conditions as well as room temperature after 7 days of storage. Our results confirm the antagonistic activity of the metabolites produced by the LAB mixture against the phytopathogenic isolates from pomegranate fruits, with a shelf-life of 7 days.

OP127

Use of bioinoculants to reduce the onset of pathogen in MAPs

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Abstract

Fungal plant pathogens are among the most important factors that cause serious losses to agricultural products every year. Biological control of plant diseases including fungal pathogens has been considered a viable alternative method to chemical control. Successful application of biological control strategies requires more knowledge intensive management and commercial use. Application of biological disease control have been slow mainly due to their variable performances under various environmental conditions in the field. Majority of biocontrol products are applied against seed borne and soil borne fungal pathogens, including the causal agents of seed rot, damping-off and root rot diseases. Successfully Isolates on nutrient agar and EMB medium. The isolated pure colonies of these bacteria were obtained using selected medium. These bacterial isolates were analysed for the presence of anti-fungal activity against the *Fusarium oxysporum, Fusarium solani* and *Rhizoctonia solani* which was isolated from citrus fruit. Four different types of fungus were isolated from citrus fruit using PDA media. All the bacteria isolated from cattle excreta showed antagonistic nature towards the three selected phytopathogens namely *Fusarium oxysporum*, *Rhizoctonia solani* and *Fusarium solani* with varying degrees except 1A and 1D. The present study showed that isolated bacterial stain from cow and buffalo excreta showed antagonistic nature against phytopathogens and can be used to prevent diseases caused by pathogenic strains of fungus.
Keywords: Biological control, Chemical control, antagonistic activity, Plant pathogens medium.

OP128

In-silico molecular docking and ADME studies of some novel amino-pyrimidines as prospective inhibitors of *S. Aureus*

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Abstract

Universal use of antimicrobials and rapid development of resistance by the microorganisms to the existing drugs pose a major threat to public health. Hence there is an urgent need to develop novel antimicrobials. Aminopyrimidine derivatives exhibiting versatile biological activities have been widely used as important scaffolds in the field of drug designing. In this study, twenty aminopyrimidines were virtually screened via the molecular docking approach in order to identify potential antimicrobials against the most common disease-causing bacteria, *S. aureus*. *In silico* studies were done to detect selectivity of the novel isoxazole derivatives for the selected bacterial protein targets using 'Glide'. Molecular docking studies were conducted on four essential enzymes of *S. aureus*; Dihydrofolate reductase (PDB ID: 3SRW); DNA gyrase (PDB ID: 5BS3); Dihydropteroate Synthetase (PDB ID: 1AD4); Pyuvate kinase (PDB ID: 3TO7). The title compounds were subjected to energy minimization, followed by optimization and minimization of protein and generation of a 3-D grid at its active site. The ligands were subjected to molecular docking at both the Standard Precision and Extra Precision modes. Results for the docking of the title compounds with dihydrofolate reductase are quite encouraging. Study suggests that compound 2C (4-hydroxyl derivatives) is specific in binding to the active site of these enzymes. Compounds were also subjected to i*n-silico* pharmacokinetic screening. Predication of the ADME properties indicate that the compounds are dug-like and maybe considered as lead molecules.

Keywords: Molecular Docking, Isoxazoles, Glide, S.Aureus

OP129

Title: Bifunctional HPrK/P enzyme: A potential target for antibiotics discovery against resistant *Enterococcus faecalis*

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Abstract

Enterococcus faecalis is found ubiquitously in the gut of humans and animals and has emerged as a multi-drug resistant pathogen causing life-threatening diseases. Previously, the significance of cell-wall and –membrane efflux pumps, and drug target modification has been reported, while the importance of a phosphocarrier protein HPr and a bifunctional enzyme HPr kinase/phosphatase (HPrK/P) was found to be unexplored in the resistance acquisition. HPr is a small protein that is a component of the phosphoenolpyruvate-dependent sugar phosphotransferase system (PTS). HPrK/P is a sensor enzyme controlling the catabolite repression in Gram-positive bacteria and also regulates the virulence gene expression. Therefore, this study aimed to explore the role of HPr & HPrK/P in antibiotic resistance and effect of HPrK/P inhibitors on bacterial growth. The resistant *E. faecalis* was isolated from raw buffalo milk. FE-SEM and AST were done for characterization. qPCR and western blotting were performed to explore the resistance mechanism. Enterococcal HPrK/P was modeled on 1KO7 and 1KKL templates and virtual screening was performed. Furthermore, docking and molecular dynamics simulations were performed to study the interactions of the hit compounds with HPrK/P. The efficacy of screened hit molecules was assessed *in-vitro*. The resistant *E. faecalis* was found morphologically different. In concert with HPr-Ser(46) phosphorylation, enhanced expression of *hprk/p* was observed. Among the identified hit molecules, two compounds were predicted to have a good binding affinity and they also inhibited the phosphorylation of HPr and significantly reduced the growth of resistant *E. faecalis in vitro*. It concludes that HPr and HPrK/P play an important role in the resistance acquisition and identified inhibitors of HPrK/P open the new research avenue towards the development of novel antimicrobials against resistant Gram-positive bacteria.

OP130

The impact of the usage of antibiotics in animal feeds in Manipur

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Abstract

The problem of resistance to antimicrobial agents has become an emerging issue worldwide. Antibiotics were and are still used for preventing diseases in food animals and also as growth promoter. The growing human population depends more and more on animal based food for protein source which in return demands more advance method of food animal production, which includes the usage of sub therapeutic antibiotics as growth promoter and also for prevention of diseases. A total of 414 samples consisting of pork 50 (12.07%), chicken 86 (20.77%), beef 74 (17.87%), mutton 100 (24.15) and fish 104 (25.12%) were randomly collected from different retail meat shops located at Imphal, Manipur, India. All the isolates were tested against cefoxitin (30µg) and oxacillin (1µg) and classified as MRSA isolates. Antibiotic susceptibility test of randomly selected 136 MRSA isolates was done. Overall prevalence rate of MRSA was observed as 38/104 (36.53%) in fish, 33/86 (38.37%) in chicken, 26/74 (35.13%) in beef, 26/100 (26%) in mutton and 13/50 (26%) in pork. All tested MRSA isolates were found to be 100% resistant to cefoxitin followed by oxacillin and clindamycin but resistance to other antibiotics were variable. This study is the first in Manipur to determine the MRSA surveillance data from retail meat shops along with antibiotic susceptibility testing.

OP131

"Antimicrobial screening of Biosurfactant against multidrug resistant *Staphylococcus aureus*"

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Abstract

The present study focussed on screening of antimicrobial property of biosurfactant produced by bacteria on multidrug resistant *Staphylococcus aureus*. The study has revealed that *Staphylococcus aureus* is rapidly winning the race against commercially available antibiotics many of which are the first line of action. This gives the conclusion that inappropriate use of antibiotics needs to be checked and further novel sources of antimicrobial agents need to be explored. There were nine bacterial isolates obtained according to differences in their colonial morphology. Physical and functional characterization viz., oil spreading assay, microplate assay, drop collapse assay, emulsification index, CTAB assay and antimicrobial activity was performed. All the isolates exhibited a clear zone in the oil spreading test. The highest zones of displacement were obtained in kerosene oil. Since, blue halos were not produced around microplate wells after 24 hours, none of the biosurfactant possesses anionic property. The highest potential of emulsifying activity of 50% was obtained from biosurfactant producing isolate C2, in mustard oil. This isolate gave a maximum zone of inhibition of 20 mm against M9 antibiotic resistant isolate. The maximum zone of inhibition exhibited against M9 was 24 mm. C2 biosurfactant producing isolate exhibited the overall highest zone of inhibition against all isolates to be followed by A4 biosurfactant producing isolate. Thus, it can be said that the displacement activity, emulsification index and antimicrobial property are related to each other, i.e., higher the values of quantitative assays better is the antimicrobial activity.

OP132

Hesperidin methylchalcone, a citrus flavonoid inhibits the quorum sensing mediated infection of *Aeromonas hydrophila*: An *in vitro* and *in vivo* study

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Abstract

Few out of many bacterial pathogens are associated with the infections in cultured fishes worldwide. *Aeromonas hydrophila* and some other closely related motile aeromonads are responsible for the majority of infectious diseases in fishes. On the other hand, indiscriminate and over usage of antibiotics have led to the emergence of antibiotic-resistant bacterial strains resulting in a decrease in the effectiveness of antibacterial treatment. The development of resistance in bacteria is due to many factors; one such mechanism is called Quorum sensing (QS), which plays a vital role in virulence factor production and biofilm formation in pathogenic bacteria. Hence the interference in this QS system may result in the inhibition of virulence factor production and biofilm formation by *Aeromonas sp,*. Therefore, the present study evaluates the anti- QS and anti-infection efficacy of citrus flavonoid, Hesperidin methylchalcone (HMC) against aquatic pathogen *A.hydrophila* using *in vitro*, *in silico*, and *in vivo* approaches. The treatment of *A.hydrophila* with HMC commendably reduced the biofilm formation and virulence factors production such as hemolysin, lipase, and protease. Also, HMC significantly expressed their anti-QS activity against *A.hydrophila* by their inhibition action on EPS production, hydrophobicity formation, and swimming motility upon the treatment. *In silico* analysis was done and, it stated that HMC shows antagonist behavior, in which HMC could effectively interfere with the Ahy-R QS system, thereby expressing their anti QS activity against *A.hydrophila*. Succeeding *in vivo* analysis done by infecting the zebrafish resulted in the reduction of internal colonization as well as inhibiting the QS-regulated pathogenesis. Hence, this study suggests that the citrus flavonoid Hesperidine methylchalcone may be used as an anti-QS drug for *A.hydrophila* related disease in fish aquaculture.

OP133

Influence of climatic conditions on Dengue fever in Dist. Nashik (MS) India

Suvarna Deshpande Dr Ramesh Abdar

Aim: Influence of climatic conditions on Dengue fever in Dist. Nashik (MS) India.

Methodology: The study carried out the correlation with the Dengue fever and Environmental factors for the current year i.e. from January 2019 to October 2019 The study shows the exact Correlation between dengue fever patients and environmental conditions. The study is still going on and it will help in the management program to carry out vector control and source reduction.

Result: In the present study during study period data of a total of 4143 patient's data were collected from which 1043 are dengue patients, Elisa positive which is confirmatory with very low platelets, high fever and nausea vomiting, raised Creatanine SGPT, SGOT.

Interpretation: The climatic condition is always correlated with dengue fever. The monsoon prolonged till November accordingly dengue cases increases. *Aedes* mosquito source of development must be reduced. The program manages applied the control measures along with source reduction.

Key words: Aedes aegypti, Protozoan, Viral Diseases District Nashik India.

OP201

Medicinal Plants: A Wonder for Diabetic Wound Healing

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Abstract

In present study the ethanolic extracts of six plants viz. *Terminalia bellirica* (fruits), *T. chebula* (fruits), *Azadirachta indica* (leaves), *Centella asiatica* (leaves), *Curcuma longa* (rhizomes), *Phyllanthus emblica* (fruits) and two natural compounds viz. Honey and Aloevera leaf gel when screened in vitro for anti-microbial functions against commonly found wound associated microbial pathogens viz. *S. aureus, P. aeruginosa, P. mirabilis, E. coli,* and *C. albicans* exhibited significant antimicrobial effects. Antimicrobial properties of all these plants are attributed to the presence of phytoconsituents such as tannins saponins, flavonoids that are present in them. Among all the tested plants *Terminalia chebula* exhibited the strongest antimicrobial activity against *E. coli, S. aureus, P.aeruginosa, P. mirabilis,* and *C. albicans*. The plant extracts of *Terminalia bellirica* and *Phyllanthus emblica* also exhibited promising antimicrobial activities. It was evident from literature that antimicrobial effects of these plant extracts vary in different researches from different regions of the world. These variations are attributed to factors such as the nature of climate, soil composition, and age of plant part, vegetation cycle, stage, quality and composition of extracted products. Two natural compounds Honey and Aloevera leaf gel also exhibited significant antimicrobial effects against all the tested pathogens. Honey showed the highest antimicrobial effect against *P. mirabilis* which is comparable to that of reference antibiotic streptomycin. Honey was not found very effective against *C. albicans*. The antimicrobial effect of Honey may be attributed to the presence of flavonoids and other unknown compounds. Honey exhibited better antimicrobial activity than Aloevera leaf gel.

Keywords: *Terminalia bellirica, T. chebula, Azadirachta indica, Centella asiatica, Curcuma longa, Phyllanthus emblica*, Honey and Aloevera leaf gel, antimicrobial activity, flavonoids.

OP202

Studies on healing pattern of diabetic wound by applying extracts of medicinal plants.

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Abstract

In present study the measurement of progress of wound healing induced by reference drug, (10% povidone iodine ointment), three herbal test formulations viz., formulation I (10% Aloevera gel extract ointment), formulation II (15% Triphala extract ointment), formulation III (20% Polyherbal extract ointment) and normal and diabetic control group treated by simple ointment base in the excision wound model were studied.Excision wound model: - Model is applied to study two parameters viz. wound contraction and epithelialization period. Wound contraction was measured by tracing the raw wound area on a transparent polythene sheet at predetermined time intervals 0,3,6,9, 12, 15, 18 days. Results are reported as mean ± SD. Wound area was traced manually and photographed in each 3 days interval and healed area was calculated by subtracting from the original wound area.The results of the mean excision wound area of different groups on the day of wound infliction (day 0) were found to be 382.33±0.882, 380.667±3.52 385.667±1.855, 382.333±0.882, 382.667±0.333, 390.333±5 mm^2 in Group I, Group II, Group III, Group IV, Group V, Group VI respectively. The Group I was normal control animal's group, Group II was diabetic control animal's group and Group III, IV, V were herbal test formulations I, II, III treated diabetic experimental animals group whereas, Group VI was reference ointment (10% povidone iodine ointment) treated animals group. On the day 0 till day 6^{th} there were no significant wound contractions observed in both normal and diabetic control and diabetic experimental groups. On the 9^{th} day, significant wound contraction process started in experimental treatment groups. On the day 12, wound area were measured for diabetic experimental Group III test formulation I (10% Aloevera gel extract ointment) treated Group, Group IV test formulation II (15% Triphala extract ointment) treated Group, Group V test formulation III (Polyherbal extract ointment) treated Group. They have been found to be 86.667±3.844 mm^2, 78.333±1.452 mm^2, 61.667±1.764 mm^2 respectively, compared to 49.667±1.763 mm^2 obtained in reference ointment treated diabetic animals of Group VI. On the12^{th} day wound areas were measured to be 208.333±2.403 mm^2, 256.333±2.403 mm^2 in normal and diabetic control animals respectively. From 15^{th} day onwards, we have observed the complete closure of wound in polyherbal ointment (test formulation III) treated and reference ointment (povidone iodine ointment) treated groups. Complete closure of wound was observed in Group III 10% Aloevera gel extract ointment (test formulation I) treated Group, Group IV 15% triphala extract ointment (test formulation II) treated Group, on the 18th day. On the 18^{th} day, the average wound areas measured for normal control and diabetic control animals were found to be 79.667±1 mm^2 and 124.667±1.452 mm^2 respectively. The analysis of values obtained in this particular parameter shows that all three different herbal test formulations topically applied, have shown significant effect on wound closure.

Keywords: wound contraction, epithelisation, 10% Aloevera gel extract ointment, 15% Triphala extract ointment, Povidone Iodine ointment, 20% Polyherbal extract ointment.

OP203

Optimization of aerobic biodegradation of o-cresol by *Pseudomonas monteilii SHY* using response surface methodology

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Abstract

Cresols are organic aromatic methylated phenolic compounds which is widely used in the manufacture of pesticides, epoxy resins, dyes and pharmaceuticals, but also as a component of disinfectants and cleaning agents. Because of the wide use of cresols these are present in effluents from industries such as pesticides, oil refining, coal gasification, dye manufacturing, petroleum refineries, and petrochemicals pharmaceutical and resin manufacturing plants. The worldwide production volume of o-cresol is approx. 37000 - 38000 t/a. which is a huge contradiction as its permissible limit in the environment is 0.1mg/l. It is now proved that the biological degradation methods are much preferred over the chemical degradation methods due to many reasons. In the present research, an attempt was done to evaluate and validate the optimum cultural parameters for maximizing the removal efficiency of o-cresol. The bacterium which was isolated from petroleum contaminated soil capable of removing o-cresol from the minimal medium and identified as *Pseudomonas monteilii SHY* was used for the construction of response surface model. The optimized cultural conditions of the isolate were incubation temperature of 30±2°C, media pH of 6.8±2, and glucose concentration of 1.5±2 in minimal mineral medium. The degrading efficiency of the bacteria increased after optimization was increased from 85.13 to 94.35%. GC-MS analysis of the sample confirmed the degradation efficiency of the organism with no production of secondary metabolites.

Keywords: Biodegradation, Response surface methodology, optimization

OP204

Analysis of phytochemical composition and functional properties of selected edible leaves

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Abstract

Green leafy vegetables have been traditionally consumed as food worldwide. These leaves are significant reservoirs of nutrients required for normal physiology and metabolism. Nonetheless, edible leaves have also been associated with therapeutic benefits. The present study evaluates the phytochemical composition as well as functional properties of three edible leaves. Mustard leaves (*Brassica juncea*), Ceylon Spinach leaves (*Basalle alba*), and Pumpkin leaves (*Cucurbita moschata duchesne*) were selected owing to their economic affordability and easy availability. Qualitative as well as quantitative phytochemical screening displayed appreciable amounts of polyphenols and alkaloids in the samples. These leaves also displayed potent antioxidant actions, manifested by their capability of scavenging 2, 2-diphenyl-1- picryl-hydrazyl (DPPH) and hydrogen peroxide radicals as well as the presence of vitamin C. Interestingly, Mustard leaves exhibited the highest antioxidant efficacy. Moreover, Ceylon Spinach leaves depicted the greatest reducing power compared to the other samples. The green leaf extracts also showed anti-microbial action with Mustard leaves portraying the strongest inhibition against the growth of both gram-positive *Bacillus subtilis* (ZOI 18.5mm) and gram-negative *Escherichia coli* bacteria (ZOI 25.5mm). Additionally, the selected leaves were also found to increase the *in vitro* growth of probiotic *Lactobacillus acidophilus*, thereby indicating their prebiotic roles. The rate of probiotic acceleration was maximal upon addition of Mustard leaf extract followed by Ceylon Spinach and Pumpkin leaves respectively. Therefore, the studied leaves may be utilized for the prevention and treatment of several ailments owing to their functional benefits.

OP205

Hepatoprotective potential of *O. bracteata* Wall against Paracetamol induced toxic effects on HepG2 cell lines

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Abstract

Gojihva or Gaozaban is an Ayurvedic cum Unani Medicinal plant described with various properties such as cardiotonic, cough relieving and anti-asthmatic, treatment of fever, absorbent, anti-toxic, anti-inflammatory, wound healer, blood purifier, and diuretic. At least 7 different botanical sources are being considered as Gojihva by various scholars and commercially traded. A combination of phytochemical analysis and evaluation of traditional indications by biological assays will be effective tool in identification and quality assessment of Gojihva and preparations thereof. *Onosma bracteata* Wall., a perennial herb, is considered as the official species of *Gojihva* in Ayurveda and is one of the species considered as Unani *Gaozaban.* Thus, phytochemical analysis and hepatoprotective activity of the plant was carried out. The sequential extracts of plant namely pet. ether, chloroform, methanol and water were prepared using hot maceration method. The extracts were screened phytochemically for various class of compounds. Further, Thin Layer Chromatography systems were developed for the organic extracts. The extracts were screened for hepatoprotective action against paracetamol induced damage in HepG2 cell lines *in vitro* through MTT assay. Additionally, preliminary antioxidant activity of extracts was carried out through DPPH assay. The phytochemical investigation along with TLC profiles of extracts revealed presence of sterol compounds in Pet. Ether extract, chlorophyll in Chloroform extract and flavonoids/hydroquinone/phenolics in methanol extract. The pet. ether and methanol extract at concentrations 125 µg/mL & 250 µg/mL and water extract at concentration 125 µg/mL exhibited significant hepatoprotective activity compared to control group. Additionally, methanol extract showed good antioxidant activity at concentration as low as 31.25 µg/mL. The activity could be due to presence of benzoquinone compounds reported in plant. Further evaluation of methanol extract using various *in vitro* and *in vivo* models for hepatoprotective action and bioactivity guided phytochemical investigations can lead to discovery of new hepatoprotective agents.

OP206

Nutritional and therapeutic importance of whey based beverages over the years: A critical review

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Abstract

Beverages are highly acceptable as it serves as quick thirst quenching refreshment. Process of making whey beverage started in 1970's and till date different variety of whey making is going on. Whey is the liquid byproduct of making cheese or paneer which contains numerous minerals and vitamins. It is of two types: acid and sweet whey. Lactose the main nutritive value of milk is also present in whey. Today's fastest world makes us to think less about health, ready to drink such as whey beverage which possesses lots of health benefits itself like antimicrobial, antiviral, antioxidant, reduces obesity which can be a boon to human health. Research evidences shown by numerous researchers on nutritional health benefits on whey beverages makes it highly palatable in today's trends where liquid diet is preferred over solid diet for health concerned people. Whey beverages are prepared with different blends of fruits (watermelon, cranberry, strawberry) and vegetables juices, carbonated, fortification to enhance its dietary nutrients. Whey can be developed in different variety such as proteinised, deproteinised, non alcoholic, alcoholic and fermentation beverages. It can be produced as functional probiotic whey drink when ferment with bacteria and yeast strains. Whey is a rich source of protein which makes it a good supplement of protein for sports person and for common people too. Due to the presence of 70% lactose content in whey, it is preferred to be a suitable raw material for the production of alcoholic beverages which is known to be suitable for a wide range of consumers starting from children to old ones. It is also known to have a nutritional and therapeutic characteristic. This article will depict the varieties of whey beverage over the past years.

Keywords: *whey beverage, nutrition, different blends making whey as a base.*

OP207

Home remedies during COVID-19: A survey based study

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Abstract

A severe acute respiratory syndrome is an unusual type of contagious pneumonia that is caused by SARS coronavirus (SARS-CoV-2). Presently, the whole world is fighting with this coronavirus disease and scientists are putting meticulous efforts for discovering drugs and develop vaccines. Though, there are only few specific medical treatments are available for this deadly virus. The only way is to boost our immunity with natural products during COVID-19. A questionnaire based online survey has been conducted on home remedies during COVID-19 among a wide range of peoples (n-531) of different age groups (13-68years). People from various countries namely India, UK and, USA have participated in the survey. According to the survey, 71.8% of people are taking Kadha (basil, cinnamon, black pepper, ginger, and raisin) prescribed by Ayush Ministry, India for combating infection and boosting immunity. Most people (86.1%) think that there is no side effect of kadha while 13.9% think that there are some side effects i.e. acidity in the stomach, heartburn, constipation, diarrhea ulcers in mouth, high blood pressure. A total of 93.6% of people who participated in the survey think that spices and home remedies are helpful in curing coronavirus or other viral infection as well as boosting immunity. Most people are using various natural products namely tulsi drops, chyawanprash, vitamin C etc. for combating infection and boosting their immunity. Therefore, we conclude from the survey and available literature that spices and herbs play a significant role against corona virus/viral infections.

Keywords: Coronavirus, SARS-CoV-2, Kadha, Antiviral, Immunity boosters,

OP208

Quercetin mediated antibiofilm activity from *Clitoria ternatea* against pan drug resistant *Alcaligenes faecalis* DMR-19 biofilm

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Abstract

Quercetin was purified from floral extract of *Clitoria ternate* through MS-HPLC and its yield was maximised by response surface methodology. The antibiofilm and antimicrobial activities of purified quercetin was determined both by *in vitro* and *in silico* studies on *Alcaligenes faecalis*, a multidrug resistant bacterial strain isolated from the dental plaque of a periodontitis patient and identified through 16S rRNA sequencing . The minimum inhibitory concentration (MIC) was found to be 80 µg/mL for quercetin and 100 µg/mL for amoxicillin against the sessile communities of *Alcaligenes faecalis* DMR-19 .The role of quercetin in reduction of protein, carbohydrate and eDNA content of the exopolysaccharides (EPS) was tested. The outcome was confirmed by scanning electron microscopy (SEM), Atomic force microscopy (AFM), fluorescence microscopy and Fourier transform infrared spectroscopic (FTIR) studies. The anti-quorum sensing activity of quercetin was confirmed both by biochemical as well by photomicrographic studies. The sequence alignment indicated the involvement of LusR of *A. faecalis* in antibiofilm activity. Higher affinity of quercetin towards the receptor protein of *A. faecalis* than that of antibiotic proved its superiority over antibiotic.

Keywords: antibiofilm, quercetin, dental plaque, *Alcaligenes faecalis*, *Clitoria ternatea*

OP209

Antihyperglycemic Activity of Panchagavya Ghrita against Alloxan-Induced Diabetic in mice

Ranju Rajput

Abstract

Panchagavya ghrita (PGG) is an extensively used Ayurvedic formulation mentioned in various Ayurveda treatises and has broad therapeutic indications. *Panchagavya ghrita* is a kind of Snehapaka (oil or medicated ghee) that is prepared by processing ghee with milk, curd, urine, and dung extract (all cow derived products). The present study was designed to evaluate the antidiabetic activity of *Panchagavya ghrita* in alloxan-induced diabetes in mice. It is an important ingredient in many Ayurvedic preparations. Oral administration of *Panchagavya ghrita* (PGG) (200 mg/kg BW/day) for 28 days to alloxan-induced diabetes mice significantly reduced the levels of blood glucose and control the increased levels of Serum GPT, GOT, and ALP. Oral administration of *Panchagavya ghrita* for 28 days restored all these parameters close to control. The antidiabetic effects of *Panchagavya ghrita* was also compared with Glibenclamide. This study reveals the efficacy of *Panchagavya ghrita* in controlling diabetes, which can be attributed to its hypoglycemic nature. It is a very effective natural product, as well as the safest medicine provided by the mother cow.

Keywords: Diabetes mellitus, Panchagavya ghrita, Ayurveda, Glibenclamide.

OP210

Qualitative and Quantitative Analysis of Various Phytoconstituents in *Hyptis suaveolens* in different solvents

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Abstract

Plants have been utilized in conventional medication for a few thousand years. Plants represent the reservoir of secondary metabolites, responsible for its medicinal and aromatic properties. Relationship between the phytochemicals and the bioactivity of plant is essential to know for the production of compounds with definite actions to treat variety of health diseases and chronic ailments too. The plant *Hyptis suaveolens* from family Lamiaceae was selected for the study. This study is aimed to analyze leaf extract of *Hyptis suaveolens* qualitatively and quantitatively in term of their phytoconstituents. The extracts were screened for the presence of various phytoconstituents using preliminary chemical tests for qualitative analysis. For quantitative analysis total phenolic content was determined by Folin-Ciocalteu method using gallic acid as a standard, total flavonoid content by aluminum chloride assay using quercetin as a standard, total alkaloid content was determined by spectrophotometric assay based on bromo cresol green reaction using atropine as standard. The analysis revealed the presence of bioactive compounds such as alkaloids, glycosides, proteins, saponins, flavonoids, tannins and phenols in aqueous fraction. The ethanolic fraction contained glycoside, alkaloid, flavonoid, tannin, phenol, steroid and fats. In the methanolic fraction only alkaloid, steroid, saponin and proteins were present, whereas acetone extract contained glycoside, steroid, fats and resins. Maximum phytoconstituents were observed in the aqueous and ethanolic extract of plant. On quantitative estimation total phenol, total flavonoid and total alkaloid were observed high in ethanol fraction followed by aqueous extract. Among the extracts tested, ethanol extract of *H. suaveolens* leaves showed maximum amount of flavonoid content (2.98±0.52 mg/100mg), phenolic content (2.28±0.41 mg/100mg) and alkaloid content (0.77±0.33 mg/100mg) as compared to aqueous extract. In methanol extract only alkaloid content (0.21±0.12 mg/100mg) was determined. Hence the ethanolic and aqueous extract of plant shows many compounds and may have been used in traditional medicine for prevention of several diseases.

Keywords: *Hyptis suaveolens*, phytochemicals, TPC, TFC, TAC, gallic acid, quercetin, atropine.

OP211

Phytochemical analysis of certain medicinal plants Collected from Bhadravathi taluk of Shivamogga district, Karnataka

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Abstract

India as a abundant source of medicinal plants. In ancient Indian literature, the medicinal properties of many herbal plants have been recorded and the preparation has been found to be effective in treating diseases. Medicinal plants have antibacterial, anti-inflammatory and antifungal activities. The few examples of well known phytochemicals are flavonoids, alkaloids, phenol, glycosides, steroids and tannin these are present in medicinal plants. The current work includes four different medicinal plants they are *Tinospora cardifolia*, *Punica granatum*, *Moringa oleifera*, *Momardica charantia*, collected from Bhadravathi taluk of Shivamogga district. The main objective of the screening was to asses the presence or obsent of phytochemical constituents in all the chosen medicinal plants. The finding of this phytochemical study of these medicinal plants showed that the reducing sugar, flavonoids, phenol, alkaloid and terpenoid were found to be present in the medicinal plants described above. The phytochemical analysis of the plants is commercially very significant and is very important for the production of a new drug for the treatment of different diseases in pharmaceutical companies. The essential phytochemical properties identified by our study in the medicinal plants of the Bhadravathi taluk of Shivamogga district are expected to be very significant in the treatment of various diseases in this area.

Keywords: Medicinal plants, Phytochemical constituents, Plant extract, Preliminary screening.

OP212

Evaluation of anti-cataract activity of methanolic extract of *Pergularia daemia* (Forsskal) Chiov. leaves against glucose induced cataractogenesis in goat eye lens

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Abstract

Introduction: In Indian traditional medicine, various plants have been widely used as a remedy for treating Diabetic cataract. Cataract is a word derived from the Latin, cataracta meaning "waterfall" and dialect English, a cataract is called a pearl, as in "pearl eye". Cataract may occur due to over activity of aldose reductase enzyme, altered glycation and oxidative stress. Currently available therapeutic drugs include aldose reductase inhibitors, AGE inhibitors, antioxidant agents. Moreover, use of these drugs is associated with many adverse effects which limit their usefulness. Use of herbal medicines in such situations can be helpful. Multiple active compounds present in herb can provide a potential benefit without major adverse effects. One such potential herb is Utran leaves [*Pergularia daemia (*Forsskal.) Chiov.]. Methanolic extract of leaves of *P. daemia* are rich source of flavonoids like quercetin, kaempferol, formononetin. Flavonoid are plant derived compounds that promote the aldose reductase inhibition and may beneficial effect in cataractogenesis through polyol pathway. Flavonoids are found to show beneficial effect in inhibiting aldose reductase enzyme.
Objective: Present study evaluation of anti-cataract activity of methanolic extract of *Pergularia daemia* (Forsskal) Chiov. leaves against glucose induced cataractogenesis in goat eye lens.
Conclusion: The present investigation revealed that methanolic extract of *Pergularia daemia* (Forsskal) Chiov. significantly prevent the progression of cataract disease in in-vitro model of glucose induced cataractogenesis in goat lens. Phytochemical screening of methanolic extract of *Pergularia daemia (*Forsskal) Chiov. revealed that flavonoids present in plant, which might be responsible for aldose reductase inhibitory activity. Inhibition of Polyol pathway by inhibition of aldose reductase enzyme and potent anti-oxidant activity may have contributed to prevention of cataractogenesis in this in-vitro model.

KeyWords: Anti-cataract activity, *Pergularia daemia*, Quercetin, Kaempferol, β-sitosterol, Degree of opacity, Total protein level, Aldose reductase inhibition activity, Malondialdehyde level, Catalase activity, Glucose induced cataractogenesis in goat eye lens.

OP213

Bioprospecting the future in-perspective of amidohydrolase l-glutaminase from marine habitats

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Abstract

In current scenario a considerable attention is given to an enzyme L-glutaminase (EC 3.5.1.2) that belongs to amido-hydrolase class adherent to the family of serine-reliant β-lactamases & penicillin-binding proteins due to it's higher affinity to polymerize & modify peptidoglycan synthesis. However based on the catalytic proficiency L-glutaminase is characterized as a proteolytic endopeptidase that cleaves peptide linkage & emancipate various by product viz. ammonia along with glutamate. L-glutamine is considered as a key amino acid known to be involved in multiple pathways related to metabolism, mainly nitrogen metabolism. The present study is focused onto the recent development & aspects associated to the biotechnological applicability of L-glutaminase particularly from the marine habitat. Additionally, as far as the applicability of L-glutaminases is concerned, a majority of it finds applications in cancer therapy as therapeutic agents, especially for the acute lymphocytic leukemia. The *in-vitro* studies using L-glutaminase are found to be effective against various other human cancer cell lines including HeLa; Hep-G_2; MCF-7; HCT-116; RAW 264.7; L-1210 cells. L-glutaminase acts as a growth enhancer for probiotic bacteria. Apart from all these applications it also finds suitable applications in the fermented foods as a flavor enhancer particularly the umami flavor and content. There are very less explored naval bacteria particularly from marine habitats. However the few reported marine bacteria secreting L-glutaminase are *Pseudomonas fluorescence, Vibrio cholerae, Vibrio costicola, Micrococcus luteus K-3, Bacillus subtilis JK-79, Kosakonia radicincitans*. However the marine habitat are known to harbor a wide range of biomolecules viz. polysaccharides that includes Fucoidan, Heparin, Chondroitin etc. peptides, alkaloids, polyphenols and certain antibiotics that can be abundantly present and seems to be more useful in therapeutic treatment.

Keywords: L-glutaminase, Marine enzymes, Umami taste, Anti-cancer, Bioprospecting

OP214

Antimicrobial activity of Medicinal plants Against Human pathogen *salmonella paratyphi A* and *salmonella paratyphi B*

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Abstract

Regardless of the convenience of plentiful miscellaneous collection of synthetic products and high-throughput tactics for their biological testing, natural compounds twig at a major source for antimicrobial drug development. These compounds are exclusively treasured as they have endured natural assortment over time. In this study we concentrated on Ethnobotanical efficacy of Indian medicinal plants like *Ocimum sanctum*, *Phyllanthus emblica* and *Bryophyllum pinnatum* for defence against bacterial human pathogen *salmonella paratyphi A* and *salmonella paratyphi B.* Phytochemical screening of these plants was executed for constituents like alkaloids, flavonoids, tannins, steroids, glycosides, carbohydrates and aminoacids. The ethanol extract of these plants exhibited good activity against the human pathogens by agar well diffusion assay method and the MIC was recorded. Average mean zone of inhibition found by these plants ranged between 7mm to 12mm and 7mm to 10mm respectively for *salmonella paratyphi A* and *salmonella paratyphi B.* These results accomplish the antimicrobial potential of the medicinal plants and hence convey upkeep for the use of them in traditional medicine.

Key words: Antimicrobial activity, Ethnobotany , Inhibition, Human pathogen, Medicinal plants

OP215

Cytotoxic effect of topical oinment using triphala and tridax on a431 cell line

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Abstract

The present study was aimed to investigate the cytotoxic acity against A431 cell of Triphala & Tridax (TT) combo oinment. Cytotoxicity, morphological examination and detection of apoptotic efficiency of TT were assessed by different assay protocols. TT inhibited the growth of A431 cells in a dose dependent manner. IC_{50} concentration of TT was found to be 68.92 µg/ml. Comet assay confirmed that the damage in DNA due to action of TT. Fluorescent microscopy of comet assay visualized the apoptosis activity. Further more analysed the expression of apoptotic gene caspase -3 by western blot analysis. TT treated showed more expression compared to that of the control. DNA fragmentation also proved that TT Possess apoptotic activity against A431 cell line. In wound healing activity, migration of cells in the wound is much lesser, the control showed more than 60% and TT showed the 5 % migration of cells. This showed that the characteristic feature of proapoptotic nature.

Key words: A431 cell line, cytotoxicity, Triphala, Tridax

OP216

Optimization of cow products for fermented panchagavya production by Response Surface method

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Abstract

Panchagavya is mentioned in the scripts of Vedas and many ancients' texts such as Vrikshayurveda and Bhaishajya ratnavali. Panchagavya was traditionally used as biofertilizer, plant growth enhancer, antimicrobial agent and health wellness agent. Traditionally, Panchagavya is prepared using the five cow products namely dung, urine, milk, curd and ghee in a ratio of 10:6:4:4:1. For better panchagavya preparation, the amount and ratio of four cow products (dung:urine:milk:curd) was optimised by the central composite design (CCD) by keeping one parameter (ghee) as constant. The quality of fermented panchagavya was measured as gibberellic acid (plant growth promoting hormone) produced during the fermentation of panchagavya. Total 30 experimental runs with different ratio of cow products were prepared and allowed to ferment for 20 days at room temperature. The highest gibberellic acid (GA_3) production of 350.88 µg/ml was observed on the 15^{th} day of fermentation in standard run no. 18. The quadric statistical model was found significant and gave optimum solution of panchagavya containing dung:urine:milk:curd:ghee ratio of 18.0:7.44:2.91:8.41:1.0 with reference to GA_3 production (338 µg/ml). The same suggested ratio of five cow products was used to prepare panchagavya and 330 µg/ml of GA_3 was observed after 15 day. One control of traditionally reported ratio (10:6:4:4:1 for D:U:M:C:G) was kept along with optimised ratio, which gave 203.03 µg/ml of GA_3. Statistically optimised fermented panchagavya showed 1.62 times more GA_3 than the traditional panchagavya.

Keywords: Panchagavya, Gibberellic acid (GA_3), Central composite design (CCD), Response surface methodology (RSM).

OP 217

Assessment of antimicrobial potential of various leaf extracts of some traditionally used plants to combat emerging challenges of antibiotic resistance

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Abstract

Bacteria are normal micro flora in the environment and found ever where and are constantly being exchanged between animals and humans. Antibiotics are medicines used to prevent and treat bacterial infections. In any environment bacteria in the presence of any antibiotic try to change to survive. These changes can lead to antibiotic resistance. Antibiotics were considered as a boon as it helped to cure many bacterial diseases, but due to ill practice of self medication and use of antibiotics in countries without standard treatment guidelines, antibiotics are often over-prescribed by health workers and veterinarians and over-used by the public. Thus *Emergence* of microbial resistance is becoming one of the biggest threats in the form of super bugs for global health, food security, and development today. So it is strongly recommended to diminish the unethical utilization of antibiotics to limit the development of resistance strain of microbes and use of alternative measures and thus there requires tremendous efforts towards finding new chemicals, specifically herbals, for the development of new antimicrobial drugs. Three plants were selected to evaluate the possibility for novel pharmaceuticals having antibacterial potential against E.Coli, Streptococcus, *Staphylococcus*, *Bacillus subtilis and Pseudomonas*. Present study reports about the antimicrobial potential of Leaf extracts of these plants that were extracted in different solvent phases. All the three plants exhibited significant antibacterial activity against the five bacteria tested. Thus present study promises an interesting future for designing potentially active antibacterial agents from, *Cinamon zeylenicum*, *Cymbopogon citratus* and *Citrus limon* and supports the traditional advantages of the studied plants that offer the perspective to improve the management of food contamination, animal and human infection.

OP301

Recent advancements in formulation development of BCS class IV drugs

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Abstract

BCS class IV drugs (e.g. furosemide, acetazolamide, ritonavir) exhibit many characteristics that are problematic for effective oral and per oral delivery. Some of the problems associated include low aqueous solubility, poor permeability, erratic and poor absorption, inter and intra subject variability and significant positive food effect which leads to low and variable bioavailability. Also, most of the class IV drugs are substrate for P-glycoprotein (low permeability) and substrate for CYP3A4 (extensive pre-systemic metabolism) which further potentiates the problem of poor therapeutic potential of these drugs. A decade back, extreme examples of class IV compounds were an exception rather than the rule, yet today many drug candidates under development pipeline fall into this category. Formulation and development of an efficacious delivery system for BCS class IV drugs are herculean tasks for any formulator. The inherent hurdles posed by these drugs hamper their translation to actual market. The importance of the formulation composition and design to successful drug development is especially illustrated by the BCS class IV case. To be clinically effective these drugs require the development of a proper delivery system for both oral and per oral delivery. Ideal oral dosage forms should produce both a reasonably high bioavailability and low inter and intra subject variability in absorption. Also, ideal systems for BCS class IV should produce a therapeutic concentration of the drug at reasonable dose volumes for intravenous administration. This article highlights the various techniques and upcoming strategies which can be employed for the development of highly notorious BCS class IV drugs. Some of the techniques employed are lipid-based delivery systems, polymer based nanocarriers, crystal engineering (nanocrystals and co-crystals), liquid solid technology, self-emulsifying solid dispersions and miscellaneous techniques addressing the P-gp efflux problem.

Keywords: Bioavailability, BCS class IV, Dissolution rate, Permeation enhancer, Various techniques

OP302

Effect of natural extracts towards improved antiviral therapy.

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Abstract

Viral infections have caused wide-scale suffering and death globally throughout the history, very recent being the deadly Covid-19 infection. It is well known that viral infections are mainly transmitted between individuals through the respiratory and oral tract. Several chemical based antiviral substances, like sanitisers and disinfectants are availableto break this chain of transmission and prevent the development of disease. But these have some long-lasting side effects in humans e.g. depletion of beneficial microflora and making the skin rough and scaly on prolong use, contributing to gradual rise in antimicrobial resistance of the pathogens and also developing other dermal complications in the patients. On the other hand, the use of natural or herbal based antiviral substancescan actually address these drawbacks of the chemical compounds.There are few scoring points of these natural/herbal sanitisers and disinfectants, e.g. they are soft on skin and maintain it's normal texture without developing any dermal complications, the essential microflora on the surface of skin remains intact and there is no addition to antimicrobial resistance, even on prolonged use. Moreover, it is also cost effective as compared to chemical antiviral compounds.India has been traditionally known to possess a rich source of many plants and herbs with potent antiviral property being exhibited from various parts like leaf, stem, root and flowers. Some examples are garlic (*Allium sativum*), mint (*Mentha*), ginger (*Zingiber officinale*), malabar nut*(Justicia adhatoda*), bhringraj(*Ecliptaprostrata*), amla (*Phyllanthus emblica*), cinnamon (*Cinnamomum verum*),and pomegranate (*Punica granatum*). With this background, the idea of the ongoing current research is to look for somenew and potent natural or herbal antiviral extracts, which can be formulated into effective antiviral therapies, leading to better management of viral diseases.

OP303

Standardization of *Bignonia alliacea* by Modern Chromatographic Technique

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Abstract

Bignonia alliacea (Family- Bignoniaceae) is a climber known as Garlic vine. *Bignonia alliacea* possesses analgesic, anti-inflammatory, antitussive, antibacterial, muscle relaxant, uterine relaxant and hypotensive effect according to traditional claim as well as modern research. The leaves of *Bignonia alliacea* are used in coughs, colds, flu, pneumonia and constipation in tinctures and decoctions. It is also effective as a mosquito and snakes repellent. Pharmacognostic and preliminary phytochemical screening of aerial parts were performed. However, modern chromatographic techniques such as high-performance thin layer chromatography fingerprinting and gas chromatography-mass spectrometry analysis have not been studied. So, present study deals with setting up standardization parameters of the methanol extract of *Bignonia alliacea* leaves by High performance thin layer chromatography fingerprinting and gas chromatography-mass spectrometry chemoprofiling. Methanol extract of *Bignonia alliacea* leaves was prepared by maceration and further used for High performance thin layer chromatography and gas chromatography-mass spectrometry analysis. The mobile phase showing distinct spots in thin layer chromatography was found to be Chloroform: Methanol: Formic acid::5:1:2. The extract was further subjected to High performance thin layer chromatography fingerprinting where Rf and Area Under Curve were calculated. High performance thin layer chromatography fingerprinting of the methanolic extract showed six peaks at 254nm and three peaks at 366nm, whereas gas chromatography-mass spectrometry study structurally identified seven phytoconstituents. gas chromatography-mass spectrometry study of methanol extract of *Bignonia alliacea* revealed presence of seven phytoconstituents from *Bignonia alliacea.* Present work provides a simple technique for standardization and detection of adulteration of *Bignonia alliacea* leaf extract and preparations.

OP304

Studies on Effect of CO_2 Enrichment During Micropropagation of Banana (Grand Nain) Plantlets.

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Abstract

In the presented work, we have checked *in vitro* Growth and development of banana micropropagules under CO_2 enriched environment. Sucrose is the main source of carbon and energy during micropropagation of plants but its presence has also some side effect like, high contamination and depressed photosynthetic activity which leads to mixo- or heterotrophy in growing shoots and cause morphological/physiological disorders and high rate of mortality during hardening phase. Different concentrations of CO_2 (0 - 40 gm^3) in acrylic chambers was maintained using solutions of sodium bicarbonate ($NaHCO_3$), sodium carbonate (Na_2CO_3), potassium bicarbonate ($KHCO_3$), potassium carbonate (K_2CO_3) and potassium hydroxide (KOH). The carbon dioxide enrichment, promoted shoot multiplication and overall growth under *in vitro* conditions. The promotory effect of CO_2 was independent of the presence of sucrose in the medium. In present study we found that *in vitro* plants shown no response in shoot growth with 0% sucrose and 0 gm^{-3} concentration of CO_2, but when we provide both CO_2 and sucrose, an additive effect was observed producing maximum shoot number and growth. When combination of 10 gm^3 ambient controlled CO_2 concentration with 3% sucrose in medium was tried, maximum overall growth in terms of shoot number, length, fresh weight and dry weight was recorded. Significant increase in biochemical parameter (viz. photosynthetic pigments, total carbohydrates, total proteins and proline) and SOD enzyme was also recorded at …… concentration of CO2 was recorded. The present study highlighted the possibility of photoautotrophic micropropagation in banana and also open up the scope of new ways of tissue culture in other similar important horticultural and medicinal plants.

Keywords: Fruits Tree; *in vitro* growth; Photo autotrophic multiplication; hardening; Shoot Culture

OP305

Best From Waste: Bioactivity-guided Formulation Development from a Common Weed - *Commelina benghalensis*

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Abstract

Each year, tones of weeds are either burned or let to dry across India. *Commelina benghalensis*, also known as Sheshmool, is one such common weed. It has been used as a traditional medicine for humans as well as animals to treat constipation, stomach ulcers, sore throats, headache, leprosy, fever, snake bite and jaundice. It has also shown various other pharmacological activities. The present work attempts to utilize this weed by developing a formulation based on the investigation of its ethnomedicinal claims. The whole plant was successively extracted by solvents of increasing polarity, which served as the test extracts. Various parameters like Ulcer index and Ulcer protection for anti-ulcer activity, and fecal output for laxative activity (±SD) were measured using appropriate animal models (n=6) and analyzed for statistical significance. Methanolic extract was found more effective in both activities, followed by the aqueous extract, thereby supporting the ethnomedicinal claims of the plant. Phytochemical screening revealed the presence of important classes of phytoconstituents like phenolics, alkaloids, saponins, steroids & triterpenoids, flavonoids and carbohydrates. To accommodate the utility of both these pharmacological actions in a single formulation on the basis of the dose at which it was found to be most effective in the animal models, effervescent granules were prepared, which were also tested on the animal models and found to be equally effective. This bioactivity-guided research can pave the way for isolation of bioactive compounds and development of a standardized formulation of *Commelina benghalensis.*

OP306

Nanomolecules in cancer therapy: A Review

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Abstract

One of the most complicated disease and death cause is cancer since many decades. Many drugs and therapies are developed and some are underutilization to treat cancer. Recently anticancer molecules are either converted to or in progress to form nanomolecules. In this review, several anticancer nanomolecules with their properties such as solubility, stability, targeting, toxicity and metabolism has described along with possible materials to be used to develop nanomolecules.

Keywords: Cancer, nanomolecules, nanodrug, nanooncology, nanomedicine

OP307

A review on antifungal activity with natural plant and animal derived product in contradiction of dandruff instigating fungus *malassezia* spp.

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Abstract

Malassezia furfur, a lipophilic, dimorphic, and yeast-like fungus that is responsible in all age groups for human diseases such as dandruff, pityriasis and versicolar seborrheic dermatitis. As this yeast has been drawn in as the primary cause of the scalp disease known as seborrheic dermatitis or dandruff, furfur has increased significantly in recent years. Millions of people are affected by superficial fungal infections (SFIs) because these infections consist of dermatophytes, non-dermatophyte (NDM) moulds and yeasts. Some biomarkers such as malondialdehyde, squalene peroxidation, free or bound fatty acids indicate ratio of dandruff scalps as well as discriminate affected and non-affected zone of scalps in the same individual. Data showed that the dandruff occurrence decreased with age: 21.6% in the age range 15–24 years, 19.7% in the age range 25–34 years, 17.4% in the age range 35–49 years, 14.3% in the age range 50–64 years, and 11.7% among people over 65 years old. In addition, symptoms like flaking, itching, prickling, tightness and pain were identified by the affected individual. Chemical active compounds are available on the market to overcome these problems, but because of disadvantages such as hair fall, bioactive products are preferred by people. Different natural antidandruff remedies reported in Ayurveda and ancient literature include neem extract, lemon juice, cow urine, etc. In this study we reviewed on dandruff and its possible natural formulation have more efficacy toward *Malassezia* species.

Keywords: Antifungal, Dandruff, *Malassezia,* Natural remedies.

OP308

Pharmacological evaluation of medicinal plant Green chiretta (*Andrographis paniculata*): A comprehensive review

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Abstract

Green chiretta (*Andrographis paniculata*) belongs to the family *Acanthaceae*, which comprises 250 genera and about 2500 species. Green chiretta is a plant native to India and Srilanka. It is a herbaceous plant and is used in many traditional medicines/formulations owing to its diverse pharmacological properties. The leaves and the roots of the plant are generally used for medicinal purposes. The plant is traditionally used for the treatment of common cold, diarrhoea, fever due to several infectious causes, jaundice, as a health tonic for the liver and cardiovascular health, and as an antioxidant. It is also used to improve sexual dysfunctions and serve as a contraceptive. Green chiretta is th
e major component in a Siddha formulation, Nilavembu Kudineer which is used as a supplement to treat dengue and chikungunya. The phytochemicals present in Green chiretta includes a variety of ent-labdane diterpenoids, flavonoids, quinic acids, xanthones, and noriridoids. Angrographolide is the major phytocompound present in *Andrographis* plants. The present study presents a review on the analgesic, antibacterial, anti-fungal, antidandruff, anti-HIV, antifertility, antidiabetic, antihelminthic, antimalarial, antipyretic, antioxidant, insecticidal, nephroprotective and pupicidal properties of Green chiretta. The review focuses on the nanoparticle synthesis using Green chiretta via green synthesis and the antimicrobial properties of the nanoparticles. The review also gives an abstract insight on the chemical constituents present in the plant.

Keywords: *Andrographis paniculata*, Phytochemicals, Andrographolide, Pharmacological properties.

OP309

GC – MS Chromatogram and Antioxidant Potential of *in vitro* raised clones and mother plant of *Celastrus paniculatus* Willd an endangered medicinal plant

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Abstract

Background and Objective: *Celastrus paniculatus* Willd belongs to the family Celastraceae is well known for its broad range of biological activities due to the presence of rich variety of bioactive compounds. Because of its high pharmaceutical application it has been over exploited and is considered as an endangered species. The highlight of the study was to develop an efficient micropropagation protocol for the large scale production of *C. paniculatus*. The evaluation of antioxidant potential of different leaf extracts of both *in vitro* raised clones and mother plant was carried out. GC – MS analysis was employed for the identification of the volatile compounds of the same extracts.
Materials and Methods: MS basal medium supplemented with varying concentrations of NH_4NO_3, BAP and Kin (0.5 – 3.0 mgl^{-1}) were used for the shoot induction. Leaf solvent extracts such as petroleum ether, chloroform and methanol was subjected to total phenolic content assay, radical scavenging assay, reducing power assay, total antioxidant assay and total flavanoid content assay. The volatile compounds were identified by GC-MS analysis
Results: The maximum number of shoots was induced in MS medium with 1.50 mgl^{-1} of BAP with 4.67 ± 1.58 shoots. The extracts showed significant antioxidant activity in a dose dependent manner and were found to contain phenolic and flavanoid compounds. The methanol leaf extract exhibited the strongest scavenging property with IC_{50} 303.16 ± 3.4 in mother plant and 442.78 ± 3.2 in *in vitro* propagated plant. GC-MS analysis identified 14 compounds in mother plant and 13 compounds in *in vitro* raised clones. In mother plant most prevailing compounds were 17-(1,5-Dimethylhexyl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1Hcyclopenta [a] phenanthren-3-ol (17.18 %) and Benzene,1,3-bis(3-phenoxyphenoxy) (15.53 %), Where as in *in vitro* raised clones the major compounds were phytol(11.28%) and Tetradecanoic acid (8.25%).
Conclusions: The developed micropropagation protocol was successfully employed for the large scale production of the endangered species *C. paniculatus*. The study concluded that the methanolic leaf extracts of both *in vitro* raised clones and mother plant possesses significant antioxidant potential and further works are to be carried out for the utilization of the active principles for future drug developments.

Keywords: *Celastrus paniculatus*, micropropagaton, antioxidant activity, bioactive compounds GC-MS analysis,

OP310

Enhanced Ajmalicine Production in *in vitro* callus culture of *Rauwolfia serpentina* with silver nanoparticle elicitation

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Abstract

*Rauwolfia serpentina*is a well-known medicinal herb contained various pharmaceutically important alkaloids in their different parts. Overexploitation, indiscriminate use and poor cultivation method for propagation have led this plant in the category of endangered species. Overprice of these alkaloids due to its low yield in plants draw the attention of the researchers for the development of an alternative method for their commercial production. Ajmalicine, an antihypertensive, alpha-adrenergic antagonist and vasodilator drug, was targeted in the present study. Elicitation is now a well-established method for the enhancement of the secondary metabolites. In the present study, silver particles were reduced through EDTA and the formation of nanoparticles were evaluated and confirmed through UV-Vis spectroscopy, Dynamic light scattering (DLS), Zeta potential and Atomic absorption spectroscopy. DLS pattern confirms the small size nanoparticle (20-40 nm). Initially, callus lines were developed for high ajmalicine content in MS medium supplemented with NAA (2 mg/l) and kin (0.2 mg/l). Various concentration (.5, 1.0 2.0, 3.0 and 4 mg/l) of silver nanoparticle was evaluated for the elicitation of ajmalicine in these callus lines. ajmalicine content was evaluated after 12, 24, 48 and 72 h. Significantly higher ajmalicine content (3.4-fold) was observed in elicited calli (48 h with 3 mg/l of silver nanoparticle) as compared to non-elicited. Catalase and SOD were also observed significantly elevated to 0.8 and 1.5-fold respectively after elicitation (48 h with 3 mg/l of silver nanoparticle). The present study is the first report for the utilization of nanoparticle as an elicitor of secondary metabolites in *Rauwolfia serpentina* and it will add a significant contribution of the silver nanoparticle in the elicitation strategy for the elevated accumulation of ajmalicine in the calli of *Rauwolfia serpentina.* The developed method will be helpful for the commercial production of ajmalicine.

OP311

In vitro antibacterial activity of of pomegranate peel and garcinia gummi-gutta rind against seafoodborne pathogens

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Abstract

The present study was conducted to evaluate the antibacterial activity of methanolic extracts of pomegranate peel (PPE) and Garcinia gummi-gutta rind against five important foodborne pathogens (*Vibrio parahaemolyticus, Vibrio cholerae, Escherichia coli, Salmonella spp.,* and *Staphylococcus aureus*) related to seafood industry. The antibacterial activity was evaluated using both agar well diffusion technique and minimum inhibitory concentration (MIC) and the results were compared with commercial antibiotics. Results indicated that maximum antibacterial activity was shown by PPE against *V. cholerae* and *S. aureus* with zone of inhibition 20 mm and 24 mm respectively, while zone of inhibition of Garcinia gummi-gutta rind extact was 20 mm against the above organisms. Zone of inhibition by the extracts of PPE and Garcinia rind against *E. coli* was relatively low at 19 mm and 16 mm respectively. The MIC of PPE and Garcinia rind extract against the above pathogens vary widely with *E. coli* and *Salmonella* being more resistant (MIC - 0.625 mg/ml for both the extracts). *S. aureus* sensitivity varied with the type of extract. MIC value (mg/ml) for PPE against *V. parahaemolyticus, V. cholerae,* and *S. aureus* was 0.156 mg/ml and Garcinia rind extract against *V. parahaemolyticus,* and *V. cholerae* was 0.312 mg/ml and for *S. aureus* was 0.781 mg/ml. The zone of inhibition of PPE and Garcinia gummi-gutta rind exracts were comparable to the zone of inhibitions against standard antibiotics such as gentamycin, tetracycline, streptomycin and ciprofloxacin. The antimicrobial activity of PPE and Garcinia rind extract indicates that these can be utilised as a natural antimicrobial agent for controlling the microbial activity and may be used as sanitizers to reduce microbial contamination of seafoods during processing as well as a component of biodegradable food packing film in seafood industry.

Keywords: Garcinia gummi gutta, pomegranate peel, foodborne pathogen, seafood industry

OP312

Studies on Effect of Exogenous Application of Ascorbic acid on Growth, Photosynthetic Pigment and Oxidative Defence in 'Groundnut' (*Arachis hypogaea* (L.)) under Lead (Pb) Stress

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Abstract

Seed priming increases tolerance of plants against various environmental stresses. Although ample literature is available that depicts the beneficial effects of priming under different environmental stresses, the information on induction of tolerance to lead (Pb) stress through seed priming with ascorbic acid (AsA) is limited. Therefore, this study was performed to examine the effect of priming of groundnut seed with different concentrations of AsA (*i.e.* 50 and 100 mgL^{-1}), on physiochemical processes of groundnuts plants under Pb stress (0, 100 mgL^{-1}). Pb stress caused an extensive decrease in plant development and photosynthetic pigments. Contrarily, Pb stress showed ascend in the substance of total Carbohydrate, free proline, total soluble proteins and AsA. The POD, PPO, and SOD activity were recorded most elevated at 100 mgL^{-1} of Pb. However, plants raised from seed prepared and primed with AsA and water displayed better development and had higher chlorophylls, free proline, total proteins, total amino acids. Priming of groundnut seeds with AsA at 50 mgL^{-1} concentration prompted better tolerance to Pb stress in groundnut plants.

Keywords: Chlorophyll pigments, Growth, Ascorbic acid, Pb, Carbohydrate, Amino acid, Proteins, Antioxidant enzymes

OP313

Assessment of Antimitotic and Anti-proliferative Potential of Selected Medicinal Plants

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Abstract

Since ancient time plants have been used as an important source of traditional medicine and playing vital role in the indigenous system to cure different ailment due to presence of various bioactive compound *i.e.* alkaloid, saponin, terpenoids, tannin, glycosides, flavonoid etc. Antimitotis properties of plants would be the good source in search of development of drug for cancer . Study carried out to explore the phytochemicals and antimitotic and antiproliferative potential of methanolic extracts of *Plumbago zeylanica*, *Asparagus racemosus* and *Astercantha longifolia*. *Allium cepa* root experiment has been carried out to show the antimitosis properties. The antimitotic potential obtained was compared with referred anticancer standard drug (1mg/mL). Mitotic index has been calculated for antimitotic assay. Antiproliferative potential of *Plumbago zeylanica* has been checked out on yeast. Yeast was inoculated with sterilized potato dextrose broth and incubated at 37ºC for 24 hrs, referred as seeded broth. This seeded broth diluted with sterilized distilled water, to get 3×10^7 cells for antiproliferative assay and compared with standard drug Methotrexate (0.1mg/mL).The data was analyzed by using software GraphPad Prism with one-way ANOVA. A statistical difference of $P<0.05$ was considered significant in all three plants. Qualitative test of phytochmeical reveals the presence of nearly all phytochmeicals in all three plant. It revealed that *Plumbago and Astercantha* have comparatively rich in phytochemicals than Asparagus. *p* value of all three plants were obtained $p=0.0001$, all three plants show potent Antimitotic potential in *Allium cepa* root. The root extract of *Plumbago zeylanica* was show that the extract decrease number of yeast cells. It showed that there was a significant decrease in number of yeast cells treated with *P. zeylanica* root extracts. It is found that all three plant showed potent antimitotic activity as well as antiproliferative activity by *P. zeylanica* and having *p* value less than 0.05.

Keywords: *Phytochemical, Antimitotic, Anticancer, Antiproliferative, Medicinal plants.*

OP314

MONITORING UTILIZATION FOR THERAPEUTIC EVALUATION" A TOOL FOR USING ANTIBIOTICS RATIONALLY

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Abstract

Antibiotic resistance is an enviable consequence of antibiotic use which is a blend of evolutionary, natural, and use dependent phenomena. DUE studies are recommended for accessing the utilization trends of antibiotics to facilitate their rational use but resistance being a multi factorial phenomena can be only be managed by targeting its various aspects. This covers environmental social ecological evolutionary clinical community use and the related behavioral aspects.. Thus PDAA approach is used to ensure rational use which states that the drug use is affected by prescriber dispenser administrator patient and all are interlinked with respect to rational use The case with antibiotics is a bit different as they are linked with the potential of becoming resistant along with having risk of ADRs and toxicity occurrence. The toxic effects of antibiotics like gentamicin, amikacin are widely reported in literature and to manage these dose estimation have been advised for patients with liver or kidney ailments. Ironically in Indian scenario these drugs are widely used in inpatient scenario and least caution is taken in their dosing. Hence to rationalize their use some peculiar steps are needed to be followed to facilitate their rational use and prevent the emergence of resistance. Viewing this a concept of MUTE "Monitoring Utilization for Therapeutic Evaluation" which blends the aims of rational use, DUE, MUE and TDM goals to ultimately provide a safe and effective antibiotic therapy to the patient is conceptualized, This concept is an extension of Union therapy/Sayojya Chikitsa Initiative.

OP315

NEEM- ANCIENT REMEDY FOR PRESENT AILMENTS

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Abstract –

Neem known as Indica liliac is commonly used as a drug for various ailments. Records exits which certify its prehistoric use. US academy of sciences referred Neem as tree of 21 century. In ancient Siddha medicine the first plant mentioned is Neem or Margosa which certifies its ancient relevance. Almost every part of this plant possesses medicinal properties including leaves, barks flower and seed. It is also worshiped in India and traditionally used for antibacterial properties. It is an adaptable tree which can thrive in a wide range of climatic conditions. Presently it is flourishing in over 78 countries encompassing continents like Asia, Africa, America and Europe. In India found widely in UP, Tamil Nadu and Karnataka. It is used in infections like leprosy and UTI. Many studies have shown positive results against steptoccocus aureus and Pseudomonas aurogenosa. The tree is known as Green Gold in Africa. Hence this review was conducted to access the antibacterial role of Neem as per Union therapy/Sayojya Chikitsa initiative.

OP316

Effect of different doses of Phosphorus and Nitrogen on the nodular nitrate reductase activity in Albizia lebbeck Benth. Seedlings.

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Abstract

Different levels of Nitrogen and phosphorus fertilizers were applied in combination with a low and suitable dose of nitrogen to observe in nitrate reductase activity in nodule of Albizia lebbeck plants under pot culture condition in the nursery.Legumes are able to form a symbiotic relationship with nitrogen-fixing soil bacteria. The result of this symbiosis is to form nodules on the plant root, within which the bacteria can convert atmospheric nitrogen into ammonia that can be used by the plant. The maximum number of nodules per plant was recorded in the month of September. The highest number of nodules per plant was recorded in N 40 + P 100 kg/ha treatment during September and the lowest value in the control treatment. The nodular nitrate reductase activity was recorded from July to September and further followed a decline until December. With the onset of spring, nitrate reductase activity increased with the formation of new nodules from March onwards. In Nitrate reductase activity a large and small peak was recorded in the month of September and April/May respectively. N40+P100 treated plants performed best over others in respect of nodular Nitrate reductase. No activity was observed from December to February. On the basis of relative comparison of different doses of nitrogen and phosphorus on individual plants, it was observed that in most of the treatments low nitrogen and phosphorus doses i.e., N40+P100 showed comparatively higher biomass compared to higher doses. The best results were recorded in N40 + P100 Kg/h treatments.

Keywords:

Nitrate reductase, Nodule, Nitrogen & Phosphorus Fertilizer

OP317

Gamma irradiation processing: An effective tool for extending shelf-life of edible bamboo shoot (*Dendrocalamus asper*)

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Abstract

Bamboo shoot has attracted significant attention worldwide due to its nutritive value and health promoting properties. But a limitation is the short shelf life of the shoots which requires the shoots to be processed for long-term usage. Processing brings about changes in organoleptic and physicochemical qualities along with nutritional values but such studies are limited. Present investigation was performed to evaluate the potential of gamma radiation as a postharvest technology to preserve bamboo shoot. *Dendrocalamus asper* shoots were gamma irradiated in the dose range of 0.5 to 5.0 kGy followed by stored at 5^0 C temperature dipped into 2% NaCl solution. Acceptability of the irradiated product was assessed based on microbial, physicochemical and organoleptic attributes as well as induced radioactivity (food safety parameter). Study revealed that a dose of 2.5 kGy was sufficient to complete removal of microbial load from the bamboo shoot up to 4 log reduction when compared with unirradiated sample. No significant changes were found in physicochemical parameters including protein, pH, moisture, HCN content and minerals. Organoleptic evaluation for different parameters were lies within the acceptance criteria up to 240 days, hence a 2.5 kGy dose of irradiation had the best preservation effect on the bamboo shoots of *Dendrocalamus asper*. The result of this study suggest that irradiation could be a potential method for maintaining the quality of bamboo shoots during storage.

Keywords: Bamboo shoot, gamma irradiation, microbial analysis, organoleptic attributes

OP318

Phytochemical screening,Antioxidant and Antimicrobial activities of endophytic bacteria isolated from *Moringa oleifera* leaves

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ABSTRACT

A study was conducted to isolate and identify endophytic bacteria from the leaves *Moringa oliefera* plants collected from Calicut, Kerala, India. 16 endophytic bacteria were isolated from surface sterilized leaves and assessed for antimicrobial activities against clinical pathogens as well as fungal plant pathogens in well diffusion agar method and *in vitro* dual culture method respectively. Isolates identified as *Pseudomonas* sp, *Bacillus* sp showed significant antimicrobial activities against both pathogens. The antioxidant activity was estimated using DPPH assay and *Pseudomonas sp* showed higher activity than other endophytic isolates. Phytochemical screening was done by analysing the presence of total phenolic compounds, terpenoids, flavonoids, alkaloids and glycosides.

Keywords: Moringa, anti-oxidant activity, anti-microbial activity, endophytes.

OP401

Evaluation of antimicrobial and antioxidant activity of solvent extracts and zinc oxide nanoparticles from *Parmotrema perlatum* lichen

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Abstract

In the present study involved the evaluation of antimicrobial and antioxidant activity of the solvent extract and zinc oxide nanoparticles (ZnONPs) synthesized using *Parmotrema perlatum*. Extraction of *P. perlatum* was done by cold percolation method using different solvent. Qualitative and quantitative phytochemical analysis of different solvent extract suggested the presence of various phytochemicals like phenol, flavonoid and phenolic acid. ZnONPs synthesized using aqueous extract of *P. perlatum* and characterization of nanoparticles done by UV-Visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR) analysis and Transmission Electron Microscopy (TEM).Size of ZnONPs was in rang of 40 to 70 nm and spherical in shape. Antimicrobial activity was evaluated by minimum inhibitory concentration assay. ZnONPs and solvent extract both shows good antimicrobial activity with lower MIC against pathogenic microorganisms. ZnONPs also shows higher antimicrobial activity combination with antibiotic as compared to alone. ZnONPs and solvent extracts show good DPPH free radical scavenging activity. So, synthesized ZnONPs can be use as potential drug to treatment of various disease.

Keywords: Green synthesis; Zinc oxide nanoparticles; *Parmotrema perlatum*; Antimicrobial activity; Antioxidant activity

OP402

Resazurin Based Antibacterial Microtitre Assay of Silver Nanoparticles extracted from Betanin Pigments of *Beta vulgaris* L. And *Amaranthus tricolor* L.

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Abstract

Plant pigments are rich in many Phyto-compounds that have pharmacological importance. Nanoparticles producing from plant are a new technique in nanotechnology, where eco-friendly, cost-effective and non-toxic compounds are synthesized. The main aim of this study was to compare the efficacy of silver nanoparticles synthesized from betanin pigment extracted from *Beta vulgaris* L. and *Amaranthus tricolor* L. The study confirms abundant silver nanoparticles seen on *B. vulgaris* when compared to *A. tricolor*. The SEM images of nanoparticles showed the appearance of spherical shape with definite size. The FTIR analysis was carried out to identify possible biomolecules responsible in bio-reduction of silver ions and compare their compounds. FTIR and UV-Vis spectra showed that biomolecules, proteins and peptides, are mainly responsible for the formation and stabilization of AgNPs. These molecules interact with Phyto-compounds and form a stabilized complex. The antibacterial activity using resazurin dye showed 6.25±0.03 µg/ µl inhibition of *Bacillus* sp. and *E.coli* strains by the silver nanoparticles synthesized from *B. vulgaris*. These pigment could be used in textile industry for making the antibacterial garments.

OP403

Antimicrobial properties of Biosynthesised Gold Nanoparticles synthesised from Streptomyces spp. (PRO 15)

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Abstract

In recent years the nanoparticles have received a lot of interest in different fields of research. Nanoparticles are defined as solid particles ranging from 10-100 nm. The biological method for the synthesis of nanoparticles employs use of biological agents like bacteria, fungi, actinomycetes, algae and plants thereby providing a wide range of resources. Actinomycetes are microorganisms that share some characteristics of fungi and bacteria. Actinomycetes are ubiquitous organisms with unrivalled metabolic capabilities to produce a majority of antibiotics and enzymes. In present study, Biosynthesis of Gold nanoparticles from Streptomyces sp. strain PRO15 isolated from coffee estate soil of Kodagu, Karnataka. and their antimicrobial activity against different pathogens is presented. The Characterization of synthesised Gold Nanoparticles was carried out using UV-Spectroscopy, FT-IR, Dynamic Light Scattering (DLS) and Scanning Electron Microscopy (SEM). The synthesised nanoparticles were tested against *B.cerus, S.typhi, S.aureus, V.cholera, C.albicans, C.neoformans, F.oxysporium.* to evaluate the antimicrobial property. The biosynthesised gold nanoparticles have high clinical value and can further be used as Drug Carriers to treat different Diseases.

Keywords: Biosynthesis, Gold Nanoparticles, Actinomycetes, Antimicrobial activity.

OP404

Nanoparticles and pelletization: application and limitations

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Abstract

Nanomedicines are widely used nowadays because of their ability to improve solubility and dissolution. It was also explored for its role in improving permeability. Nanomedicines are combined in different dosage forms depending on type of drug, disease and target site. Herein, researches on nanomedicines in Pelletization are reviewed. Nanoparticles provide some unique advantages like high surface area and solubility enhancement. Problems associated with nanoparticles are its suspension stability, scaling up of process, drug loading in case of polymeric nanoparticles. Nanoparticles are sprayed on pellets in order to achieve sustained release and overcome the problem of aggregation associated with nanoparticle suspension. Nanoparticles are sprayed and then enteric coated to achieve controlled release in some research. Some researchers also produced evidence that nanoparticles often result in damage to the polymeric coating, and subsequently the rapid release of the drug substance. Therefore, it is important that various formulation and process variables are optimised to ensure that the coating polymer can withstand compression and remain intact during the tableting process. For the drugs which are used to treat local GIT infection or diseases, pellet formulation with solubility enhancement by complexation could help better compare to nanoparticles. Reason behind is nanoparticles may escape through membranes and enter in systemic circulation and objective when treating local infection is to keep drugs at local sites in GIT. One may carry out this study by comparing nanoparticle embedded pellets and drug complex pellets to prove this hypothesis.

OP405

Evaluation of physicochemical, phytochemical, biochemical and antioxidant properties of two medicinal plants *Cuscuta reflexa* and *Mimusops elengi*.

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Abstract

Medicinal plants are the treasure of various hidden chemicals. Plants have been an important source of medicine for thousands of years. Natural products are known to play an important role in pharmaceutical biology. Medicinal plants are getting the attraction of most of the researches for the evaluation of new drugs because of the polyvalent action and lesser side effect of plant products. Many important phytochemical, biochemical, antioxidant and antimicrobial properties have been evaluated from *Cuscuta reflexa* and *Mimusops elengi* in the present study. From the data derived it seems that these two plants can become source of medicines for many diseases and disorders.

Keywords: *Cuscuta reflexa*, *Mimusops elengi*, physicochemicals, phytochemicals, biochemicals antioxidants

OP406

Novel nanopore controlled porosity osmotic tablet for type 2 diabetes mellitus

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Abstract

The present research work aims towards the formulations of nanopore controlled porosity osmotic tablet of metformin for type 2 diabetes mellitus by nanosuspension coating method. Metformin hydrochloride (HCI) is an oral anti-hyperglycemic agent shows 50 -60% of absolute bioavailability with a relatively short plasma half-life of 1.5–4.5 h. In this study, Sodium chloride and mannitol were added as osmogen and pore former as nanorange with various concentrations to the core tablet. The effect of different formulation variables namely concentration of osmogen in the core tablet and % pore former on *in vitro* release was studied. The results revealed that the release of metformin hydrochloride was directly proportional to concentration of osmogen and % pore former. Fitting the release data to the Korsmeyer equation exhibited that diffusion along with erosion could be the mechanism of drug and scanning electron microscopic results shows that the drug release takes place through these nanopores of the core tablet. Hence the novel nanopore controlled osmotic tablet could control the release of metformin hydrochloride for 12 hrs thus can achieve better patient compliance in the treatment of diabetes mellitus.

Keywords: Novel Nanopores, Osmogen, Pore former, Osmotic tablets, Factorial design, Type 2 Diabetes Mellitus, Metformin Hydrochloride

OP407

Plant Mediated Green Synthesis, Characterization and antimicrobial activity of Silver Nanoparticles

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Subject: Nanomedicine

Abstract

Objective: The study was aimed to formation, characterization and antimicrobial activity of silver nanoparticles from two different herbal plants.

Methods: The qualitative analysis of plant extracts was performed to determine the presence of secondary metabolites. The plant mediated silver nanoparticles were synthesized. The color changed into brown color indicating the formation of AgNPs. The characterization of synthesized AgNPs was carried out by different methods such as UV-Vis Spectra, SEM, Particle size analysis, Zeta potential analysis, XRD and FTIR. The antimicrobial activity of synthesized silver nanoparticles also examined against bacteria.

Results: The UV wave length of AgNPs is from 420nm to 450 nm. The FTIR results show that AgNPs contains the functional groups. In antimicrobial activity of all AgNPs synthesized by Two plants inhibits the growth of bacteria. The XRD pattern clearly confirmed that the synthesized silver nanoparticles are crystalline in nature. SEM results shows that synthesized silver nanoparticles are round in shape.

Conclusion: The green synthesis of nanoparticles shows that cost-effective, environmentally friendly, and safe for human therapeutic use. Color change, UV-Vis spectra, TEM and XRD analysis confirmed the stability of synthesized AgNPs.

Keywords: Green Synthesis, Sliver Nanoparticles, Zeta potential, SEM, XRD, Antimicrobial activity

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OP408

Synthesis of herbal nanoparticles using *Origanum vulgare* extract, its characterization and anticandidal activity

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Abstract

Nanotechnology is a new discipline with wide applications including medicine and pharmacology industries. Several methods and reducing agents have been employed to synthesize silver nanoparticles, but reactive chemicals elicit toxicity and unwanted effects on the human and biological systems. Silver nanoparticles have excellent medical and nonmedical properties and application compared with other metallic nanoparticles.

The objective of this work was to synthesize silver nanoparticles from *Origanum vulgare* extract and to determine their anticandidal activities against *Candida albicans, Candida glabrata and Candida tropicalis*.

In this study, simple and economical procedure was adopted for silver nanoparticles synthesis. Dry *O.vulgare* was processed to obtain aqueous extract. Different parameters like pH, temperature, time and concentration of $AgNO_3$ were standardized for synthesis of nanoparticles. Synthesized nanoparticles were characterized by UV-Visible spectroscopy and Scanning Electron Microscopy. Anticandidal activity was performed by agar well method.

The progress of silver nanoparticles biosynthesis was observed by UV-Visible spectroscopy. The peaks maxima were observed at 450nm. SEM helps to determine size and shape of synthesized silver nanoparticles. *O.vulgare* silver nanoparticles show strong anticandidal activity against Candida.

O.vulgare mediated silver nanoparticles could be applied in the fields of medical and pharmaceuticals for formulation of new drugs.

Keywords: Nanotechnology, Silver naoparticles, Anticandidial, *Origanum vulgare*

OP409

Green synthesis and Characterization of Sliver nanoparticles by Bacteria and analysis of antimicrobial activity

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Subject: Nanotechnology

Abstract

The emerging infectious disease and the development of drug resistance in the pathogenic microorganisms is a matter of serious concern. Development of green nanotechnology is generating great research in order to develop ecofriendly nanoparticles. The use of nanoparticles is gaining impetus in the present century as they possess defined chemical, optical and mechanical properties. In present study green synthesis of nanoparticles by various microbial cultures have been done. Various parameters such as Concentration (1 to 5 mM), Time (3 to 5 Hours), Temperature (40 to 70 ^{o}C) and pH (4 to 9) were optimized for the production of silver nanoparticles. Visible, Ultra violet spectrum, Fourier transforms infrared (FT-IR), Dynamic light scattering (DLS) and Scanning electron microscope (SEM) were achieved for conforming and characterizing the biosynthesis of AgNPs. The antimicrobial activity of silver nanoparticles synthesized using both pellet and supernatant against various human pathogens.

Keywords: Green Synthesis, Sliver Nanoparticles, Optimization, SEM , Antimicrobial activity

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OP410

Mycogenic Synthesis of Copper oxide Nanoparticles and Their Potential Against *Alternaria* Blight Management

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Abstract

In today's world, scientific community is facing major problem for controlling pathogenic microbes and in management of plant diseases. Among different plant diseases, *Alternaria* blight is one of the catastrophic killer of oilseed crops. Substantial crop losses, reduction in yield and oil content occurs due to foliar pathogen *Alternaria brassicae*. As fungicides used for disease management have negative effects on soil health and deleterious for human beings. Hence, it is necessary to look for disease management options through other alternatives rather than fungicides. In the past decade, reports of nanotechnology in phytopathology have been grown exponentially. Therefore, there is a need to look for source of synthesis and reliable metal oxide nanoparticles for control of *Alternaria* blight disease. There are different route of synthesis of nanomaterials such as physical, chemical and biological processes, but biological synthesis has achieved priority because of its ecofriendly nature and easily available resources. Biological sources of nanoparticles includes the use of microbes but the main attention has been focused towards the use of *Trichoderma* because it produces secondary metabolites and several studies suggested that trichogenic nanoparticles enhance disease suppression capability. Despite this, among different metals such as silver, copper and Zinc, Copper oxide nanoparticles is a logical choice for plant disease management because copper metal have certain novel features such as it inhibits spore germination of plant pathogens and activates defense system of plants. The current review will provide two directions, one in which biogenic copper oxide nanoparticles can be utilized for *Alternaria* blight management either as nanoparticles alone, acting as protectants and secondly act as curative agents in fungicide form.

Keywords: Mycogenic , Protectant, Curative, Trichoderma , Copper oxide nanoparticles

OP411

Design and characterization of chronomodulated pulsatile therapeutic system of lisinopril for early morning surge in blood pressure

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Abstract

Lisinopril is an angiotensin-converting enzyme (ACE) inhibitor, primarily used for the treatment of hypertension, congestive heart failure, and heart attack. It belongs to BCS class III having a half-life of 12 hrs and 25% bioavailability. Hence to enhance the bioavailability of lisinopril and to extend the release on early morning, the present research work aimed to formulate and characterize a press coated an immediate release granule (IRG) containing crospovidone and croscarmellose sodium as superdisintegrants and pulsatile release mini tablet coated with ethyl cellulose and eudragit RS100 as hydrophobic polymers. Immediate release granules were prepared by wet granulation method and characterized for micromeritic properties such as bulk density, tapped density, Angle of repose and carr's index, and the tablets were evaluated for its hardness, thickness, weight variation, friability, drug content uniformity, drug polymer compatibility and in-vitro drug release study. The results revealed that this system would be beneficial for diseases showing chronopharmacological behavior where night time dosing is required or for the drugs having high first pass effect or having site specific absorption in GIT, or for drugs with high risk of toxicity or tolerance. This also improves patient compliance by decreasing dosing frequency.

Keywords: Pulsatile drug delivery system (PDDS), Hypertension, Superdisintegrants, Lisinopril, Hydrophobic polymers.

OP412

Gold Nanoparticle based Ethyl Cellulose Turmeric Gold Nanocapsules: Application against A549 Lung Cancer Cell Line

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Abstract

More than 2 million new lung cancer cases were found across the globe, while the number is 67795 in 2018. There are several treatments to deal with lung malignancy, among all of them ethno-pharmacology drawn a significant consent. Turmeric is one of them with very low water solubility. Polymeric nanocapsules of turmeric may deal challenge of solubility. Turmeric has a potent anti malignant property. Cytotoxicity of polymeric turmeric gold nanocapsules on A549 human lung cancer cells has been examined. The recent analysis was focused around the green synthesis gold nanoparticles from aqueous root extract of *Curcuma longa* L. and gold nanoparticles (AuNPs) and ethyl cellulose-based nanocapsules in presence of *Curcuma longa* L. and their cytotoxic impacts on normal cell line and A549 lung malignant growth cell line. UV-Vis, FTIR, TEM and EDX the green synthesized AuNPs and Gold nanocapsule. In the application experiment, the IC_{50} of turmeric-gold nanocapsules treated A549 cells were seen as 40µg/ml compared with gold nanoparticles treated A549 cells showing IC_{50} of 60 µg/ml affirmed by MTT assay. Further, apoptosis study was observed in turmeric gold nanocapsules-treated A549 cells. The gold nanoparticles and polymer with turmeric (gold turmeric nanocapsule) brings about a viable complex which shows increasingly intense anticancer movement on lung malignant growth cell line than only green synthesized gold nanoparticles.

Keywords: Turmeric; Gold Nanoparticle; Gold Nanocapsule; Ethyl cellulose; A459 Lung Cancer Cell Line.

OP413

Anticancer attribute and DNA damage protection potential evaluation of silver nanoparticles obtained through green synthesis approach using Cassia fistula fruit extract

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Abstract

The aim of this study was to synthesize silver nanoparticle using *Cassia fistula* fruit extract followed by its characterization using UV-visible spectroscopy, FTIR, Zeta Potential and HR-TEM SAED. FTIR analysis was done to enable the in-situ analysis of interfaces to investigate the surface adsorption of functional groups on nanoparticles. The surface charge of the AgNPs was analyzed by zeta- potential analyzer. The morphology and crystal structure of silver nanoparticles have been determined using high-resolution transmission electron microscopy (HRTEM) and selected area electron diffraction (SAED). The color change from light to dark brown indicated the reduction of $AgNO_3$ from the extract. Synthesized nanoparticles were studied for its DNA protection potential using salmon sperm DNA exposed with generated free radicals. Its cell cytotoxicity potential using 60 cancer cell lines were analyzed. The derived nanoparticle was found to be extra potent in the renal cancer panel against TK-10 cell-line and also showed high DNA damage protection potential against generated free radicals.

Keywords: *Cassia fistula*, silver nanoparticle, cytotoxicity potential, DNA, HR-TEM SAED, renal cancer

OP414

UTI management through Nanoantibiotics

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Abstract

The injudicious usage of antibiotics has been found to lead to an upsurge of antimicrobial resistance in uropathogens. Such an increasing antimicrobial resistance challenges the present empiric antibiotic therapy used for urinary tract infections (UTIs), which are the second most common infections globally. It has been reported that multi drug resistant (MDR) uropathogens endure in the intestine after UTI resolution and cause recurrences after periurethral infection. UTIs constitute the maximum morbidity and mortality throughout the world, though still being the most neglected infections. The current antibiotic therapy does seem ineffective against the MDR uropathogens like *E. coli*, *P. aeruginosa*, *K. pneumoniae* etc., and needs an alternate treatment that may help in delimiting the era of antibiotic resistance in uropathogens. Nanotechnology represents a stupendous field of science where miniature size materials are exploited with their best efficacies. Nowadays nanotechnology has been employed in various fields like biomedical, health science, optics, environmental science, medicine etc. as it's a fascinating field for research community. Nanoparticles synthesized by green synthesis methodology represent a better choice for curing MDR infections where plant biomolecules conjugate with metal oxides and provide them stability. Such nanoparticles conjugated with plant biomolecules also exhibit antimicrobial activities and delimit the growth of MDR uropathogens by binding their plasma membrane and inhibiting various crucial cellular mechanisms, thus, resulting into the death of pathogenic microbes. The authors have synthesized nanoparticles using the plant *Bryophyllum pinnatum* by green synthesis method and characterized the synthesized nanoparticles using several spectroscopy techniques. All the resulting nanoparticles exhibited antibacterial activity against several MDR uropathogens. Thus, these nanoparticles have the potential to act as a future nano antibiotic.

Keywords: Antimicrobial resistance, *E. coli*, Multi Drug Resistant, Nanoparticles, UTI

OP415

Antimicrobial synergistic effect of zinc oxide nanoparticles in combination with antibiotics

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Abstract

The development of antibiotics has played considerable role in combating dreadful infections. The improper use of antimicrobial agents has resulted in multidrug resistant organism (MDR) raising a global public health concern. The unpredicted threat demands new strategies for combating antibiotic resistance. Nanotechnology has achieved worldwide attention in last few decades due to its wide range of applications. Recent developments in nanotechnology have employed nanoparticles with exotic shape, size and desired properties as a new line of control against MDR microorganism. Numerous studies have focused on use of zinc oxide nanoparticles (ZnONPs) as it possesses well known inhibitory and bactericidal effects. ZnONPs have being explored as novel group in theranostics for targeted drug delivery, as sensors for detecting ecological pollutants and also nanofertilizers. Furthermore ZnONPs have antifungal, antidiabetic, antiinflammatory, wound healing, antioxidant and optic properties. The present study aimed to determine the antimicrobial activity of ZnONPs in combination with antibiotics against reference strains of microorganisms such as *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* using agar well diffusion method. The efficiency of ZnONPs was compared with standard antibiotics such as ampicillin, streptomycin, rifampicin and chloramphenicol. The results of the study confirm that the ZnONPs may serve as promising antibacterial agents.

Keywords: Nanomedicine, zinc oxide nanoparticles, multidrug resistance, antimicrobial synergy.

OP416

Toxicological evaluation of Triphala nanocolloids in zebrafish embryos

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Abstract

Nanocolloids are widely used for several application. Based on the exposure of nano products from production to reusing, disposing, human exposure to nano products and its toxicity has become a great concern. Zebrafish is a widely sort model organism due to its size and egg collection is easy compared to other models. Large number of embryos, their transparency and availability are some of their highlights. Their transparency helps in easy examination of its internal organs. Since 70% of the zebrafish genomes resemble with human genome, the findings from zebrafish can be translated to human being. Combination of three herbal mixtures, Triphala (*Terminalia belerica*, *Emblica officinalis*, *Terminalia chebula)* was utilised to synthesize Triphala nanocolloids (TNc). Due to the combination of silver and the triphala extract, TNc can be a potent compound in the medicinal field with multiheaded application. Utilizing Field emission scanning electron microscope, HRTEM biophysical characters of nanocolloids were confirmed. In order to use the green nanocolloids as effective antibacterial agent, the present study was undertaken to evaluate the toxicity of green nanocolloids in Zebra fish embryos. Hence the embryos were treated with TNc and the toxicity was checked considering their mortality rate, hatching rate and heart rate upto 144hpf. The results indicate that the compound is not teratogenic and has no toxic effect at lower concentrations in the treated embryos. The present research work suggests that the TNc affected the embryo hatching and caused mortality at very high concentration of 200µg/ml.

Keywords: Silver nanocolloids, Triphala, Zebra fish model, Toxicity, hpf, Teratogenic

OP417

Cytotoxicity on Melanoma and Renal Cancer of silver nanoparticles synthesized using *Carissa carandas* leaves extract and it's free radical DNA damage protection potential Studies

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Abstract

The aim of this study was to synthesize silver nanoparticles using *Carissa carandas* leaves extract and analyse its DNA damage protection potential by free radicals which leads to various metabolic diseases like cancer, rheumatoid arthritis etc. *C. carandas* belong to a species of flowering shrub which is a member of family Apocynaceae. Its fruits are commonly used to make Indian pickles and spices. The UV-Vis spectra peaked at 473nm and color change from light to brown color confirmed the formation of AgNPs. Selected area electron diffraction (SAED) pattern confirmed the crystalline nature of synthesized nanoparticles. High resolution scanning transmission electron microscopy (HR-TEM) analysis revealed the average size of particles to be 10.83 nm. Fourier transform infrared spectroscopy (FTIR) revealed the presence of functional groups in *C. carandas* leaf that was responsible for the reduction and capping process of nanoparticles. *In vitro* DNA damage protection potential by free radicals was analysed along with it's single dose response studies against NCI-60 cell-lines and was comparable growth inhibition against melanoma cancer (M14) cell-line and renal cancer (TK-10 & UO-31) cell-lines. The synthesised nanoparticles exhibited *in-vitro* DNA damage protection activity. Thus this can have the potential to be an anticancer drug and for treatment of various metabolic disorders. Although further analysis is still to be done.

Keywords: *Carissa carandas*, nanoparticles , HR-TEM SAED, DNA, melanoma cancer, renal cancer

OP418

Potential use of microbes as bio Nanofactories: current trends, challenges and future perspective materials for sensor and biomedical Applications

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Abstract

The prospectives of the bio nanotechnological based microbial biosynthesis of nanoparticles for several technical applications are increasing significantly including their high potential as antibacterial material, use in health care and diagnostic sensors. In recent past metal nanoparticles have added immense popularity to their characteristic feature of physical , chemical and biological properties by behaving as promising material for imposing a great impact on sensors and medication. Microbial sources producing the metallic nanoparticles creats interest due to its metabolic activity. This review gives an understanding about microbial biosynthesis of nanomaterials by microorganisms, yeast, molds, and microalgae for the fabrication of sensor gadgets and analytical and curative applications.The main focus is on the research works where knowledge, challenges, and potential behavior of microbe-mediated biosynthesis is illustrated and various aspects like characterization methods are covered. The inherent unpredictability of the microbiological organization needs a greater code of behavior to be standardized to obtain nanomaterials since bacteria are capable of producing nanowires, exopolysaccharides,and nanocellulose whereas yeasts ,microalgae and molds behave differently The paper considers the growing technological demand , development of reliable process for the microbial synthesis of metallic nanoparticles and establish these as nanofactories , the current trends and the challenges faced and future perspective materials for sensor and biomedical Applications.

Keywords: Microbes ,Metallic Nanoparticles, Sensors, Health care, Biomedical

OP419

Microgel: as a drug delivery system

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Abstract

Microgel encapsulation delivery system is used to encapsulate the bioactive components isolated from the food. The need of encapsulate the bioactive component is to maintain its native state and to make it more bioavailable. Bioactive components are used as a drug to show its biological activities. To overcome this issue microgel encapsulation is better option as compare to another emulsifying system like liposome, microemulsion, nanoemulsion. The main advantage to use the microgel is we can incorporate bioactive molecules before or after making the gel. This is helpful when someone deals with temperature sensitive compounds. One also benefited with size, structure, permeability and interfacial properties of polymers to encapsulate the bioactive compounds. Use of various methods according to the microgel formulation like antisolvent precipitation, injection, coacervation, thermodynamic incompatibility, and templating methods is having another advantage as we can use it according to our interested bioactive compounds and biopolymer. Microgel formulation having the properties like loading capacity, retention or release and bioactive protection can be used for the efficient drug delivery system. This kind of properties can be useful for efficient delivery of our bioactive compounds at its specific site so that it can absorb directly, to perform its role into its respective site. Hence, we can increase the half-life of the bioactive molecules and make it more bioavailable.

Key words: Encapsulation, Bioactive compound.

OP501

Isolation and Characterization of multidrug resistant bacteria from soil sample using culture dependent approach

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Abstract

Multidrug resistance can be defined as resistance shown by a microorganism to at least one antimicrobial drug in three or more antimicrobial categories. Although somewhat resistance against antibiotics in some bacteria is a natural phenomenon, yet the development of multi resistance in microbes against different classes of antimicrobial is troublesome. It is considered to be one of the major emerging threats to human welfare due to rapidly increasing mortality rate because of antibiotic resistance globally. Recent studies have shown that antibiotic resistance genes are widespread throughout the globe and for combating multidrug resistance effectively it is essential to understand how multi drug resistance exists in natural environments. Various studies have suggested that soil is a major reservoir of antibiotic resistance genes and use of antibiotics in clinical as well as non-clinical settings has not only created selective pressure for antibiotic resistant microbes but also created ideal environment for the proliferation of antibiotic resistance microbes. Distribution of antibiotic resistome across soil microbiomes which can be clinically important is not well understood. In the present study we propose to investigate a composite soil sample collected from various sites from a hospital ground located at Kakryal region of Jammu and Kashmir by culture dependent approach to get a better idea about the natural distribution of antibiotic resistome in clinically setting and how it concerns the present scenario. Composite soil sample was collected from the hospital site and antibiotic resistant microbes were isolated using standard protocols. Screening of microbes for drug resistance was done using nine different antibiotics. So far, we have isolated 33 antibiotic resistant bacteria from the hospital soil sample and the MDR strains are being characterized. This study will help us to understand the natural composition of antibiotic resistome of the soil found in clinical settings and help us to determine the path to be followed in future for tackling the threat of antibiotic resistance.

Keywords: Multidrug resistance, Antibiotic resistance, Mortality rate, Antibiotic resistance genes,

OP502

Characterisation Of Beta Lactamase Enzymes And Their Inhibition By Phytochemicals

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Abstract

Objective: The present study is aimed to test the effect of phytochemicals from commonly available plants against β lactamase containing multidrug resistant bacteria.
Methodology: Retrospective clinical samples (Urine and Pus) were collected from hospitals and private labs in and around Sivakasi, Virudhunagar and Kovilpatti at Tamil Nadu, India. Multidrug resistant strains isolated from the collected samples were assessed for the presence of β-lactamase enzyme through phenotypic and biochemical characterization tests. Beta lactamase enzyme activity was detected using penicillin and Ceftazidime as substrate. K_m and V_{max} value was calculated for the beta lactamase enzymes using Graph pad prism software. Forty different plant extract were prepared from five different plants (*Ocimum sanctum, Catharanthus roseus, Allium sativum, Punica granatum* and *Aegle marmelos*) using (Hot and cold) and solvent (Methanol & Petroleum ether) through mortar & pestle, soxhlet and sonicator. All the extracts were tested qualitatively and antagonistic effects and beta lactamase inhibition of phytochemicals were tested against selected *Escherichia coli, Klebsiella* sp. and *Pseudomonas* sp.
Results: *E. coli* strain U1C showed the maximum level of betalactamase activity (3.96U/ml/hr) with Penicillin as substrate and *E.coli* strain U3 showed maximum level of beta lactamase activity with Ceftazidime as substrate (3.269U/ml/hr). The plant extracts showed the presence of phytochemicals at variable levels. Majority of the methanol extractions, Hot water extraction and coldwater extraction showed higher inhibitory activity. The presence of amino acid Arginine- a potent antibacterial activity component is present in twelve different extracts out of fifteen extracts containing amino acid. Beta lactamase inhibitory activity is reported in ten extracts against *Escherichia coli*, fourteen extracts against *Klebsiella* sp., six extracts against *Pseudomonas* sp. *Allium sativum* extract is found to inhibit β-lactamase production in *Escherichia coli* and *Pseudomonas* sp. *Ocimum sanctum* extract is found to inhibit only β-lactamase production in *Klebsiella* sp. Two extracts of *Catharanthus roseus* are found to inhibit β-lactamase activity in *Pseudomonas sp. Allium sativum* extract shown high inhibition against *Escherichia coli* at 3ml concentration. FTIR analysis of the extract showed the presence of aromatics as functional groups in all extracts except in *Aegle marmelos* extract. Nitro compounds is present in *Punica granatum* and *Allium sativum* extract.
Conclusion: The findings reported that the phytochemicals from *Allium sativum* can be used as either potent antagonistic compound or as alternative to Clavulanic acid (β-lactamase inhibitor). The antagonistic activity is high in combination with antibiotics
Financial support: The Project has been financially supported by UGC under Minor Project Scheme (2016-18)

Keywords: Antibiotic resistance, Phytochemicals, *Allium sativum*, β-lactamase inhibitor.

OP503

Unravelling Soil Antibiotic Resistome by Functional Metagenomics

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Abstract

Antibiotic resistome is a pool of all the antibiotic resistant genes or gene clusters of bacteria present in a specific niche or location. Soil is one of the most significant niche of resistance genes for antibiotics, which have the capacity to spread across different ecosystems and can be transferred to disease causing bacteria threatening human as well as animal health.
Antibiotic resistance or Antimicrobial resistance (AMR) is a multidisciplinary research area and poses great danger to global health and threatens to nullify all the advances made so far in this research area. Antibiotic resistance is an intricate challenge with numerous driving forces like antibiotic misuse and over-prescription, change in climate, population dynamics, travel and trade. So, a very dynamic approach is required for getting some reliable information on the international occurrence and spread of antibiotic or antimicrobial resistance which is extremely essential to overcome this problem otherwise we will again land into post antibiotic era. Till date scanty information is available about the overall distribution, origin and diversity of these resistance genes, especially for the uncultivable bacteria. So, to address this problem Metagenomics may serve a very promising role. Metagenomic approaches based on Function or sequence of these resistance genes have already identified some novel antibiotic resistance genes and this information may lead to better knowledge of these resistance determinants in usual as well as clinical settings. With this background we at SMVDU are trying to address this emerging health issue using functional metagenomics for mining novel resistant determinants. We have constructed metagenomic libraries of diverse soil samples in *E. coli* and screened them for the presence of ARG's using function-based approach. So far, we have identified clones resistant against different antibiotics like Rifampcin, tetracycline and streptomycin.The antibiotic resistant clones have been characterised and further studies will reveal the potential of these ARG's in the spread of antibiotic resistance.

OP504

Isolation, characterization and antibacterial activity of lactic acid bacteria (lab) with probiotic potentiality from fresh idli batter

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Abstract

Idli is traditional fermented rice and black gram based breakfast food and can be a potential source of probiotic microorganisms. The current study explores two probiotic LAB strain, characterizes their probiotic potentiality and tested for antibacterial efficacy against pathogenic bacteria. The indicator strains subjected to antibiotic susceptibility test in order to determine the multiple antibiotic resistance (MAR) indices. The antibacterial activity of isolated LAB strains was determined by agar-well diffusion method. The isolation and identification of LAB strains was executed through several biochemical tests, 16S rRNA sequencing and phylogenetic analysis. Safety profiling of isolated strains was determined using antibiogram, DNase and gelatinase tests. Pathogenic strains had MAR indices ranged 0.2 – 0.9. The zone diameter of inhibition (ZDI) ranged 6 – 12, 8 – 16 and 8 – 21mm for increasing concentration (25, 50 and 75µl/well respectively) of LAB against pathogenic bacteria. Several biochemical tests and analysis of 16S rRNA sequencing revealed that LMEM1001 and LMEM1002 have maximum (96.81% and 95.20%, respectively) similarities with *Lactobacillus pentosus* and *Lactobacillus plantarum*, respectively. The idli lactobacilli acquired might be used as the valid candidates of probiotics, and bio-therapeutics against bacterial infection to humans. However, further studies are necessary to discover the dose dependence of such native lactobacilli, to be used as the alternative therapeutics, in combating bacterial antibiotic resistance.

Keywords: Probiotic bacteria*;* antibacterial activity; LAB; Idli batter; 16S rRNA sequencing, Phylogenetic analysis

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OP505

Multiplex pcr – a molecular modality for rapid detection of *ctx-m-15, aad a1* and *qnr s1* genes among drug resistant clinical isolates of enterobacteriaceae in kanchipuram, south india

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Abstract

Multidrug resistance is a potential threat to the mankind. The prevalence rate of multidrug resistant bacteria is worrisome and has gained significant attention globally. Hence it becomes imperative for clinical laboratories to identify these multidrug resistant pathogens for appropriate therapy. It is equally important to detect the resistance mechanisms which would aid in understanding and development of new therapeutic options. This study was carried out to identify the prevalence of multidrug resistant Enterobacteriaceae from clinical samples recovered from Kanchipuram district. The study was also implicated in designing of novel primers using primer3 tool and standardizing a Multiplex PCR targeting *ctx-m-15*, *aadA1*, *qnrS1* genes in the isolates. Of the 60 clinical isolates studied, 14, 13 and 12 isolates harbored *ctx-m-15*, *qnrS1 gene* and *aadA1*genes respectively. Among these, 2 isolates carried both *ctx-m-15* and *qnrS1* genes and 3 isolates were found to carry both *ctx-m-15* and *aadA1* genes and 1 isolate was found to be positive for both *aadA1* and *qnrS1* genes. None of these isolates harbored all the three targeted genes *qnrS1* and *aadA1*, *ctx-m-15*. The present study will aid in detecting drug resistant genes like *ctx-m-15*, *aadA1*, *qnrS1* in clinical isolates with higher sensitivity and specificity and also reduces the cost of reaction than that required for uniplex PCR. The prevalence rate of drug resistant genes among Kanchipuram district alert us for the measures needed to be undertaken to control the spread of drug resistant genes in community.

Keywords: Enterobacteriaceae, Multidrug Resistance, CTX-M-15, AADA1, QNRS1 genes, Multiplex PCR.

OP506

Novel approaches to identify and combat Antibiotic resistance

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Abstract

Antibiotics have always been one of the wonderful discoveries of the 20th century. The remarkable genetic capacities of microorganisms have exploited the overuse of antibiotics by humans to manipulate the resistance gene sources. They have also made use of the horizontal gene transmission to establish several resistance mechanisms for each and every antibiotic used either clinically, agriculturally or environmentally. Of growing importance is the use of nanoparticles, which have antibacterial mechanism different from that of the antiobiotics, to combat multidrug-resistant bacteria. The contribution of microbiota in the development and dissemination of antibiotic resistance is also equally important. Metagenomics that helps to detect uncultivable or culture-resistant microorganisms also play a role in understanding the antibiotic resistance mechanisms and the presence of drug resistant microorganisms in diverse environments. The concepts of antibiotic resistomes and functional metagenomics too have shifted the focus of understanding antibiotic resistance. The synergistic effect of bacteriophage combined with antibiotics also has profound impact on antibiotic resistance. Thus, the present review addresses the growth of antibiotic resistance, the mechanisms involved and the need and role of novel genetic and biochemical approaches to tackle the emerging superbugs combined with multidisciplinary comprehensive efforts.

OP507

Emerging provision by superbugs to tackle the last resort therapy: Colistin

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Abstract

Polymyxin 'E' is considered the last resort therapy against MDR bacteria, commonly known as colistin. Against multidrug resistance gram negative bacterial infection particularly *Escherichia coli*, *Klebsiella pneumoniae*, *Acinetobacterbaumannii* and *Pseudomonas aeruginosa* play a very crucial role in front line fighter, which are increasing worldwide. Chromosomal mutations and plasmid-mediated genes are associated mainly in this resistance in the molecular label, besides the immunological adaptation. So here in this review we extensively detailed about colistin as a drug in 21st century antibiotics, activities spectrum with diverse resistance mechanism of bacteria against colistin, emerging approaches of colistin from discovery to tackling MDR. Chromosomal and plasmid mediated genes are involved in resistance. Except that we also put some light on challenges & new advents with both old weapons like phage therapy and new approaches like Phage display, drug repurposing. This study will provide an aerial dimension to understand both in the therapeutic and clinical aspect of this drug and the information enable the researcher to find a way to tackle the MDR bacteria in forthcoming days as well.

Keywords: Polymyxin 'E', Colistin, MDR, *Klebsiella pneumoniae, Acinetobacter baumannii* and *Pseudomonas aeruginosa*

OP508

Neem- ancient remedy for present ailments

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Abstract

Neem known as Indica liliac is commonly used as a drug for various ailments. Records exits which certify its prehistoric use. US academy of sciences referred Neem as tree of 21 century. In ancient Siddha medicine the first plant mentioned is Neem or Margosa which certifies its ancient relevance. Almost every part of this plant possesses medicinal properties including leaves, barks flower and seed. It is also worshiped in India and traditionally used for antibacterial properties. It is an adaptable tree which can thrive in a wide range of climatic conditions. Presently it is flourishing in over 78 countries encompassing continents like Asia, Africa, America and Europe. In India found widely in UP, Tamil Nadu and Karnataka. It is used in infections like leprosy and UTI. Many studies have shown positive results against steptoccocus aureus and Pseudomonas aurogenosa. The tree is known as Green Gold in Africa. Hence this review was conducted to access the antibacterial role of Neem as per Union therapy/Sayojya Chikitsa initiative.

OP509

Modulation of Quorum Sensing and biofilm formation by furfural derivatives

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Abstract

Drug resistance in pathogenic microbes is a major challenge as conventional antimicrobials are losing efficacy for the treatment of infectious diseases. Opportunistic pathogens like *Pseudomonas aeruginosa* and *Candida albicans* are known to produce virulence factors and form intractable biofilms which are key confront for treatment. Therefore, recent research focuses on discovering novel drug targets to combat drug resistance. One such promising drug target is cell-to-cell communication systems known as Quorum Sensing (QS). QS is a cell density dependent mechanism used by microbes to modulate virulence factor production. Hence potential quorum sensing inhibitors could be developed as next generation anti-infective drugs. Furfural is an essential part of pharmacological building blocks, used in the synthesis of pharmaceuticals. Like furfural, its derivatives also have a high demand for different applications. Keeping in view of its pharmacological importance, the present study investigated the anti QS and anti-biofilm properties of Meldrum acid and Barbituric acid derivatives of furfural (MAF and BAF) against *C. violaceum*, *P. aeruginosa* and *C. albicans*. MAF and BAF at sub-MIC concentrations exhibited significant quorum sensing inhibitory activity in *C. violaceum*- a biomonitor strain of QS, as seen by inhibition of violacein pigment production and biofilm inhibition. MAF also exhibited anti-biofilm activity in *P. aeruginosa* PAO1. Further, in *P. aeruginosa* inhibition of virulence factors including motility, pyocyanin production and elastase B activity were also observed. Gene expression studies showed down regulated expression of lasI, rhlI and pqs A, QS genes of *P. aeruginosa*. MAF also improved the survival of *C. elegans* infected with PAO1, established the anti-infective role in a whole animal model of pathogenesis. MAF significantly reduces the germ tube formation of *C. albicans* – a potential pathogenicity feature of this fungus. These results suggest that furfural derivatives could serve as a promising strategy in the management of microbial infections.

Keywords: Quorum sensing, Biofilm, Virulence, Furfural derivatives

OP510

Combating multi-drug resistance mastitis causing pathogens using natural bioactive compounds

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Abstract

Antibiotic therapy has become a principle strategy for mastitis treatment because prolonged usage of antibiotics could result into emergence of antibiotic-resistant pathogens. As alternative therapeutic approaches, natural products represent a promising source of bioactive molecules in those essential oils (EOs) and medium-chain fatty acids (MCFAs) have attracted much attention due to their hordes of biological properties, including antibacterial activities. The objective of our study was to examine the *in-vitro* efficacy of eight EOs and three MCFAs either alone or in combination against standard antimicrobial resistance strains, including *Staphylococcus aureus* ATCC 700698, *Klebsiella pneumonia* ATCC 700603, and ESBL- *E.coli* FcW5. Antimicrobial activities were determined by agar disc diffusion assay; subsequently, minimum inhibitory concentration and minimum bactericidal concentration were determined by broth microdilution technique. The nature of potential interactions was determined by fractional inhibitory concentration indices (FICIs) for EOs and MCFAs. The MIC values confirmed that all the tested pathogens are variably susceptible to both EOs and MCFAs. Among EOs carvacrol (CAR), trans-cinnamaldehyde (TC), and thymol (TH) showed strong antimicrobial activity with MIC value range from 0.3-0.75 mg/mL and for MCFAs it ranged from 0.5-3.2 mg/mL. When assayed in combination the FICI values were reduced to range between 0.56 and 2.5, indicating synergistic, additive, and indifferent interactions. The most significant combination was observed between CAR and OA; CAR and DA; & TH and OA ($P<0.05$). The synergistic interactions were further confirmed through time-kill plots. Based on these results, CAR and OA was found to be more significant in terms of killing time ($P<0.05$). Moreover, bacterial surface charge, and membrane integrity assays were carried out to investigate antimicrobial mode of action of CAR and OA. Results suggest that CAR and OA when used in combination offers a significant additive antimicrobial activity against the bacteria tested, acting on the cell surface and causing the disruption of bacterial membrane. Therefore, these molecules are interesting alternatives to conventional therapy used for the control of mastitis caused by resistant pathogens in the large animals.

OP511

Silver decorated myconanoparticles control growth and biofilm formation in uropathogenic *E. coli*

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Abstract

Nanotechnology involves the synthesis of nanoparticles that has been used in therapeutic application for treating diseases. In this present study we have adopted the synthesis of myconanoparticles from the extracellular extract of endophytic fungi *Penicillium sclerotiorum*. Endophytic fungi were isolated from the healthy leaves of *Tamarindus indica*. The genomic DNA from endophytic fungi was isolated and ITS region was amplified by polymerase chain reaction (PCR) using universal fungal primers ITS1 and ITS4and sequenced for the identification of endophytic fungal isolates. *Penicillium sclerotiorum* extract were used for the synthesis silver nanoparticles (PsNps) and were characterized by UV-Vis spectroscopy, Fourier transform- infrared spectroscopy (FTIR), Zeta potential, FE-SEM and Energy- Dispersive X-ray analysis (EDAX). Antibacterial activity of PsNps was tested against the antibiotic resistant uropathogenic *E.coli* and ATCC (25922) strain of *E.coli*. The antimicrobial activity showed that the PsNps inhibited growth, biofilm formation in both the strains of *E. coli*. The expression of gene encoding CTXM-15 was down regulated in resistant strain of uropathogenic *E.coli.* Our results suggest that the PsNps could be used as an alternative source for the antibiotics.

Keywords: *Tamarindus indica*, Silver nanoparticles, CTXM-15 gene, Antimicrobial activity

OP512

Reward of gut microbiome habor antibiotic resistance in cotton worm *Spodoptera litura*. L

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Abstract

A lepidopteron cotton member *Spodoptera litura* is a polyphagous pest, damages variety of crops. Their vigorous eating patterns and huge multiplication becomes a massive task to control them. At the same time a range of pesticide with high resolution was increasing, certainly this may cause environment pollution and affect the non-target organisms. Hence eco-friendly approach of pest management has to be established for controlling such pest. The present investigation portrays the reason for resistance claimed in the pest due to the gut microbial community and it acts as a reservoir of resistance. To authenticate the resistance harbor by gut microbiome, the commercial antibiotics were tested against the gut suspension. Tetracycline, rifampicin and chloramphenicol were elected as the efficient zone producer against the gut suspension. Further an antibiotic resistant gene was isolated. The antibiotic resistant gene isolated was subjected to Phylogenetic analysis which revealed the < 95 % similarity towards the RPO E (Sigma E factor) gene in *Enterobacter cloacae*, which is responsible for Antibiotic resistance (RPO E). Rpo E template was translated, targeted with selected antibiotics such as tetracycline, rifampicin and chloramphenicol, tetracycline showed highest affinity in both *insilico* and *invitro* analysis. A smart molecule has been targeted to knock down the antibiotic resistant gene which may be coupled with the tetracycline for effective eco-friendly pest control strategy. The antibiotic resistance of RPO E was identified in the gut of *S. litura* and it may be mimicked by a target drug, But any effective target drug designed and administered to control the lepidopteran insects can be modeled with the backbone of tetracycline for the stability of target drug and also to evade the colonization resistance created by the host microbes.

Keywords: Insect gut, antibiotic resistance, Tetracycline, rifampicin and chloramphenicol ; RPO E; Sigma E factor ; *Enterobacter cloacae, Spodoptera litura.*

OP513

SXT *int* harboring bacteria as effective indicators to determine high- risk reservoirs of multiple antibiotic resistance in different aquatic environments of western coast of Gujarat, India

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Abstract

Unregulated use of antibiotics in the current age has led to the development of multiple antibiotic resistant (MAR) strains. Especially in this pandemic scenario, where antibiotic abuse is at its peak, completely restricting entry of antibiotics in natural waters is next to impossible. Dealing with multiple antibiotic resistance in natural water bodies, thus becomes even more difficult. Certain transposons and integrons play crucial role in dissemination of the multiple resistance genes in environment even without antibiotic stress, leading to occurrence of multidrug resistance in the inherent flora of such water bodies. Assessment of these water bodies with respect to these genetic elements in the inherent bacteria is necessary to device strategies for combatting multidrug resistance (MDR) in aquatic ecosystems. The study describes SXT element as an indicator of MDR incidences in diverse water bodies. Further, high risk zones in terms of MDR reservoirs were determined and necessary treatment may be done to counter further dissemination of such elements. The comparative analyses of diversity indices and antibiogram of SXT *int* positive bacteria from four types of aquatic environments depicted prominent differences owing to their characteristic features of physicochemical properties and anthropogenic influences. On the basis of obtained results and correlation analyses, it can be concluded that presence of SXT *int* positive bacteria may reflect presence of multiple MAR determinants in the studied aquatic environments.

OP514

Development of rapid assay for detection of β-lactam resistant *E. coli*

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Abstract

Research gap in the development of diagnosis for Antimicrobial Resistant (AMR) bacteria has been a huge challenge. As per the global guidelines by European food safety authority (EFSA), Codex Alimentarius Commission (CAC), Food and agriculture organization (FAO) and One health monitoring programs, *E. coli* has been declared as the indicator organism for antimicrobial resistance in gram-negative bacteria. In the present investigation two approaches were made for the detection of β-lactamase producing *E. coli*. The first approach was based on the use of Iodometric test. The basic principal behind this test was the hydrolysis of β-lactam ring of antibiotic by the β-lactamase by *E. coli*, which results in the production of reducing product which interacts with starch iodine on paper strip and change its color from dark blue complex to colorless. The developed enzyme based strip could successfully detect ESBL producing *E. coli* within 5 hours at 37°C at antibiotic breakpoint concentration employing CLSI guidelines. On the other hand, the second approach was based on the growth of β-lactam resistant *E. coli* in *E. coli* selective medium (ECSM) and interaction of marker enzyme with specific chromogenic substrate which indicate presence/absence of antibiotic resistant *E. coli*. A test protocol was developed for the rapid detection of ESBL, AmpC and Carbapenemase producing *E. coli* under similar optimized conditions within 5 -6 hours. The developed technology will be available in vacuumed packaged kit prototype containing functionalized discs. The current project will fill up the research gap on rapid diagnostics as point of care (POC) test for detection of multi, extensively and pan drug resistant *E. coli* in 3 different settings i.e. human, animal and environment.

OP515

Combating Multi Drug Resistance Using Green Nanofabric Technology

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Abstract

Nanotechnology; the new era of science has shown many distinct features along with vast application in the field of medical, pharmaceuticals, agriculture, industrial, textile, water treatment etc. Green synthesis of nanoparticles is environment friendly, cost effective and easy to synthesize. The current study represents green synthesis of iron oxide nanoparticles using *Carica papaya* leaves extract with its antimicrobial property and nanofabrication. UV-Visible spectroscopy was performed at 200-260nm wavelength followed by FTIR showed major bond stretching in –C-H, -C-C-, -C-O-, -C=C- and aromatic ring. SEM analysis revealed the size of nanoparticles were approximately 50nm and spherical in shape. The synthesized iron oxide nanoparticles were used to coat the fabric and antimicrobial activity of coated fabric was checked. Maximum zone of inhibition was observed in *K.oxytoca ATCC 43165, B.subtilis MCC 2244 and E.coli MCC 2246* There is a need to discover a new antimicrobial compound due to the antibiotic resistance developed by the bacteria rapidly; the increasing health concern worldwide. As, cellulose is the good medium for the growth of microorganism, hospital acquired multidrug resistance bacterial-infections are common in critical care patients. Hospital-acquired infections (HAI) have been recognized for over a century now as a critical problem affecting the quality of healthcare. This modified antimicrobial nanofabric aid a great impact on multidrug resistance, hence combat hospital acquired infections with nanofabric technology with longer durability.

Keywords: Nanotechnology, Iron oxide nanoparticles, *Carica papaya*, Multidrug resistance, nanofabric,

OP516

Antimicrobial resistance trend and bundle care measures to reduce antimicrobial resistance in respiratory tract infection in icu at a tertiary care hospital.

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Abstract

The usage of antibiotics in medical practice had made clinically important bacteria more complicated with the adoption of the resistance mechanism. Pneumonia is one of the life-threatening infections among all respiratory tract infections. 2639 tracheal aspirate specimens were taken under study. Patient care protocol called care bundle was designed and monitored randomly. It was monitored during starting and ending period i.e. base line and end line respectively. In *A. baumannii,* rise in PDR and downward trend was observed in XDR category during end line. In *P. aeruginosa*, slight decrease in MDR and rise in XDR was observed during end line. In *K. pneumoniae,* sharp rise in MDR and reduction in XDR was observed during end line. In *E. coli*, mild rise in MDR as well as XDR was observed during end line. In *S. aureus*, sharp reduction was observed in MDR in end line. Bundle care compliances were 66.9% and 91.8% for baseline and end-line, respectively. P value of unpaired t-test shows that $p<0.0001$ ($t = 10.33$, $df = 22$). In Gram-negative isolates, colistin resistance percentage was reduced from 5.3% (%R 95% Confidence interval (CI): 2.8-9.5) to 0% (%R 95% CI: 0-5.3). Similarly, tigecycline resistance percentage was also reduced from 20% (%R 95% CI: 14.8-26.4) to 0% (%R 95% CI: 0-7.9). In Gram positive isolates, linezolid, teicoplanin and daptomycin remains sensitive during base line and end line with varied %R 95% CI i.e. 0-28.3 (base line) to 0-22.9 (end line) for linezolid, 0-53.7 (base line) to 0-28.3 (end line) for daptomycin and 0-53.7 (base line) to 0-22.9 (end line) for teicoplanin. Vancomycin shows reduction in resistance from base line, 14.3 (%R 95% CI: 2.5-43.9) to end line, 0 (%R 95% CI: 0-24.1). The study concludes that infection control measures can effectively limit the antimicrobial resistance in long run.

OP517

Combating Multidrug Resistance

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Abstract

The resistance among various microbial species to different antimicrobial drugs has emerged as a basis of public health threat all over the globe at a horrifying rate. Multidrug resistance is a problem that continues to challenge the healthcare sector. Due to the expansion of novel resistance mechanisms in microorganisms and decrease in efficiency of treating common infections, it results in failure of microbial response to multiple drugs, leading to lingering illness, higher expenditures for health care, and mortality. The excessive and unnecessary use of antibiotics in humans has led to the emergence of multidrug resistance. Almost all the capable infecting agents have employed high levels of multidrug resistance (MDR) with enhanced morbidity and mortality rate; thus, they are referred to as “super bugs.” Although the development of MDR is also a natural phenomenon but inapt use of antimicrobial drugs, inadequate sanitary conditions, inappropriate food handling, and poor infection prevention and control practices have also contributed to MDR. Due to this, attempts are being made to develop new techniques to combat multidrug resistance. The use of novel technologies, alone or in combination, is promising for solving a problem that humanity faces today and that could lead to human extinction: the domination of pathogenic bacteria resistant to multiple drugs.

Keywords: Multidrug resistance, super bugs, healthcare, antimicrobial drugs.

OP518

Transfer of MBL resistance from clinical isolates to Bacillus species

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Abstract

The antimicrobial treatment is being increasingly challenged by the emergence of resistant microorganisms. The emergence of resistance has been accelerated by the excessive use of antibiotics in conjunction with the remarkable genetic plasticity of microorganisms Third generation cephalosporins (ceftazidime,cefatoxime, cefperazone, ceftriaxone) and carbapenems (meropenem, imipenem,doripenem) are main antibiotic weaponry which are being exhausted or at stage of extinction due to ESBL(Extended Spectrum of Beta Lactamases) and MBL(Mettalo Beta Lactamases) enzymes inactivation. Nowadays resistance spreads to all gram positive and gram negative isolates and to various groups of antibiotic drugs. Aim and objectives: To detect the presence of MBL in clinical isolates. To study the transfer of MBL resistance to bacillus species and to check the MBL status in bacillus species. To demonstrate the plasmids in them. All bacterial isolates were characterized using Standard microbiology methods. The E strip method was used to demonstrate the metallo beta lactamases producers. Result: A total of 15 clinical isolates were used for the study of MBL resistance. Of the 15, 10 were Psedomonas aeruginosa and 5 were klebsiella pneumoniae. Among the 15 strains 12 were showing MBL resistance. Among the 12, 8were selected for resistance transfer experiments. Eight different bacillus species isolates from environment, food samples were used in the resistance transfer experiment. Individual MBL positive stains were mixed with individual bacillus species and incubated for various length of time. Those bacillus species were re- isolated and checked for their resistance pattern. Out of eight strains, 7 acquired the resistance. All were checked for the presence of plasmids in them and all of them showed plasmids. Be aware on bacillus species.

OP519

Molecular characterisation of urine and vaginal samples and their antibiotic susceptibility pattern associated with β- lactamases resistance gene

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Abstract

Infection or inflammation of the vagina is called vaginitis. The two most common causes of vaginitis are bacterial vaginitis and Candida vaginitis. The causative organisms may be sexually transmitted or endogenous, usually by *Gardnerella vaginalis* and *Mycoplasma hominis* in combination with other anaerobes. Urinary tract infections (UTI) refer to the presence of microbial pathogens within the urinary tract and are caused by a range of pathogens but most commonly by *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus saprophyticus*. Highly increase in antibiotic-resistant among uropathogens, including ESBL producing E.coli, AmpC β-lactamase or carbapenemase-producing Enterobacteriaceae (e.g., New Delhi metallo-β-lactamase [NDM]) are being reported among health care unit. Carbapenem-resistant Enterobacteriaceae (CRE) is a growing concern worldwide and a major challenge by the WHO 2014. The aim of this study was to determine the occurrence of CTX- M gene and TEM gene and the possible role of ESBL in resistance to antibiotic. A study was conducted on a total of 38 urine and vaginal samples from Dr. B. Lal clinical laboratory and was cultured on Nutrient Agar and MacConkey agar for the detection of etiologic agents. Bacteria isolation, identification was done by using biochemical test by viteck and multiple drug resistance patterns of the selected isolates were studied by Kirby-Bauer Disk Diffusion (KBDS) method was used for detection of ESBL-producing strains. A disc of Cefotaxime (30 µg) and Clavulanic acid (30 µg) were placed at a distance of 20 mm on Muller Hilton agar plate along with Imipenem(30µg), Piperacillin/Tazobactam(10µg) and Ceftazidime(30µg). The zone of inhibition generally greater than 20mm was considered as ESBL producer. Total 14 isolates were identified as ESBL producer. In order to find out the plasmid profile of these isolates, plasmid DNA extraction was done by using Plasmid DNA Extraction kit (HiMedia). Isolates was found to have one or more than one plasmid gene responsible for the ESBL resistance. This finding concludes that CTX-M gene is most common gene in ESBL producing isolates. It is highly recommended that antibiotic prescription should be monitored according to guideline. The prevalence of ESBL is increasing day by day and necessary steps should be taken to prevent the spread and emergence of resistance.

Keyword: Antibiotic sensitivity, Enterobacteriaceae, ESBL, CTX-M, TEM gene

OP520

Novel polyherbal nanocolloids to control Bovine Mastitis

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Abstract

Mastitis is a widespread disease in dairy cattle occurring throughout the world. The increased use of antibiotics brings about the development of antibiotic-resistant microbes. The application of antibiotics in dairy farming led to increased antibiotic resistance and represents a major obstacle for the treatment of mastitis. Recent advancements in nanotechnology led to the development of nanocolloids to overcome disadvantages posed by conventional antimicrobial agents. Hence, Novel, environmentally friendly, cost-effective, biocompatible, and long-term antibacterial represent a promising solution for medicine and farming. Hence, Poly Herbal Nanocolloids (PHNc) was formulated by using the extracts of *Syzygium aromaticum*, *Cinnamomum verum*, *Emblica officinalis*, *Terminalia belerica*, *Terminalia chebula* and *Cymbopogon citratus* and physiochemically characterised. From Mastitis Milk samples microorganisms were isolated including *Acinetobacter junii, Klebsiella pneumoniae, Pseudomonas stutzeri, Acinetobacter baumannii* and screened for antibiotic susceptibility. All the isolated strains were tested with PHNc and compared with antibiotics. Minimum Inhibitory Concentration (MIC), Minimum Bactericidal Concentration (MBC), and Biofilm assays were performed at different concentrations and antibacterial effects were quantified and the genes responsible for antibiotic resistance were analyzed to identify the mechanism of infection and pathways critical for causing mastitis. In our results, PHNc showed potent bacteriostatic, bactericidal and antibiofilm activity against all the strains. Further, the antibiotic resistant genes CTXM-15 and AmpC, expressions were suppressed upon treatment with PHNc. Our results indicated that PHNc can reduce the virulence factors responsible for infection by different bacterial strains. This study confirmed that PHNc had the potential to inhibit the growth of pathogenic Gram-negative, and Gram-positive strains and could be utilized as an alternative to antibiotics to inhibit multi drug resistant microbial pathogens in cattle.

Keywords: *Acinetobacter junii, Klebsiella pneumoniae, Pseudomonas stutzeri, Acinetobacter baumannii,* CTXM-15, AmpC

OP521

Studies on antimicrobial activity against Multidrug resistant bacteria and other Health benefits of Lactic acid bacteria (LAB, Probiotics)

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Abstract

Health is man's greatest possession, maintained by their habits and practices. Verses quoted in Drishtant Ashtasangraha substantiate the use of curds and buttermilk as a means of healthy diet and their health benefits. Regular consumption of curds of a particular texture , composition, and pleasant taste, stimulates secretion of digestive juices, reduces bloating of stomach and lessens the aggravated kapha and vata. It is useful in disorders of kidneys, excessive consumption of fatty substances, anemia, spleen disorders, fever, typhoid, diarrhea and common cold. Lactic acid bacteria are one of the most commonly used probiotics, with a potential for production of metabolites including organic acids, bacteriocins, enzymes, vitamins and other unknown metabolites. In this study, extract of cultured LAB was evaluated for its antimicrobial activity against MDR uropathogens, antioxidant activity, anticholesterol activity and calcium oxalate degradation. The Gram negative uropathogens were highly resistant to quinolones, aminoglycosides, cephalosporin, ureidopenicillin and some β lactams. Sensitivity of MDR pathogens is carried out in Muller Hinton agar by well diffusion method. Antioxidant activity has been expressed in various ways. The radical scavenging activity was measured by the 1,1-diphenyl-2picrylhydrazyl method. Cholesterol oxidase activity important in reduction of cholesterol was estimated by cholesterol estimation kit. The rate of oxalate degradation was determined by the titration by potassium permanganate and Calcium precipitation test. Results indicate that among the 6 isolates *Lactobacillus acidophilus* showed highest antimicrobial activity against MDR Enterobacter with ZOI of 27mm and least for Klebsiella 12mm. S. lactis showed the highest antioxidant activity (68.7%) in 4 hrs and *L. brevis* showed lowest activity 50.73%. *S.lactis* showed highest reduction in serum cholesterol level (68.51 %) and *L. fermentum* showed lowest reduction level (42.86). The isolated organism is efficient in degradation of calcium oxalate. Antimicrobial activity of cell free extracts was studied by neutralization, protease and protein precipitation treatment. All strains demonstrated a drastic reduction in growth inhibition upon neutralization. The inhibitory action of the CFS was mainly due to the organic acids produced by LAB.

Keywords:- Antimicrobial activity, MDR, DPPH, Cholesterol reduction, Calcium oxalate.

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OP126

Antagonistic activity of lactic acid bacteria on phytopathogenic isolates from bacterial-blight infected pomegranate fruits

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Abstract

Bacterial-blight is a major destructive disease of pomegranate caused by *Xanthomonas axonopodis pv. punicae*, recording about 60-80% loss of yield and quality of the pomegranate fruit in India. The management of the disease requires expensive chemicals and hence, there is a strong need to identify an eco-friendly and cost-effective procedure to combat the issue of bacterial-blight in pomegranate. Lactic acid bacteria (LAB) are popular probiotic organisms, known for their ability to produce antimicrobial substances that can serve as a substitute for conventional pesticides. This study explored the antagonistic activity of different LAB cultures against bacterial-blight causing phytopathogens. Three microorganisms were isolated, and characterized, from bacterial-blight infected pomegranate fruits from different orchards in Maharashtra. *L .plantarum*, *L .acidophilus* and *L.casei var. rhamnosus*, along with isolates from indigenous cow (Khillari) dung were tested individually and in combination, against the isolated phytopathogens. To identify the primary source of substances responsible for inhibitory action of LAB, their whole-cell broth, cell-free broth, and live-cells were used during the study. The antimicrobial activity was tested using agar well-diffusion assay. The samples were stored for 7 days at room temperature and also under refrigeration conditions. The inhibitory activity of stored samples was tested after 7 days against the pathogens. Whole-cell broth and cell-free broth of all the LAB cultures and cow dung isolates, individually and in mixtures, were observed to exhibit higher antagonistic activity against all the plant pathogens, as compared to live-cells. The whole-cell broth consortium of three LAB strains was observed to show the highest activity against the plant pathogens. The antimicrobial activity of the LAB consortium was observed to be consistent at refrigerated conditions as well as room temperature after 7 days of storage. Our results confirm the antagonistic activity of the metabolites produced by the LAB mixture against the phytopathogenic isolates from pomegranate fruits, with a shelf-life of 7 days.

3.4.6
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3.4.6
Dr. V.V. Kulkarni

In India, majority of the population resides in rural communities. The development of all aspects within rural communities is vital for the effective development of the country. The rural population is residing in the conditions of poverty, they are illiterate and unemployed. Due to these factors, they are unable to sustain their living conditions in an appropriate manner. It is essential to formulate programs, schemes and measures that have the main objective of bringing about improvements in rural communities. The main areas that have been taken into account in this research paper include, concept of rural development, approaches to rural development, problems experienced by rural individuals, programs initiated by the Government for rural development. On this background this book will be very useful to policy makers, planners, academicians, research scholars, development professionals and social science students especially professional social workers.

Fr Rohan Francis Gawdhya is a professional social worker with Urban and Rural Community Development specialization and working as a Priest for Poona Diocese Social Service Society. He is also associated with Institute of Social Transformation. He was a team leader of volunteers for flood relief work in 2013 in Uttarakhand. He possess substantial field experience and good insight about community organization for social action and situation analysis. He have very strong network of professional social workers working in various fields of social development.

Dr. V.V. Kulkarni is a former Dean of Faculty of Arts, Social Sciences and Commerce at Bharati Vidyapeeth Deemed University. He was Associate Professor at Social Science Centre since 1995. He worked as a Statistician and Research Consultant at NCERT New Delhi for "All India Survey of School Dropout Girls" a project of World Bank and Planning Commission. He worked with Padmabhushan Prof. P.V. Sukhatme a World-renowned Statistician at Agharkar Research Institute for his doctoral work and subsequently Scientist at Dept. of Biometry and Nutrition during 1984-1992. About 15 reports submitted to Government of India, author of 30 books and 150 research papers are to his credit. He is an expert in impact assessment and social sector planning and development.

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Hanuman Nawandar is a professional social worker with Urban and Rural Community Development specialization. He worked in various professional social work organizations run by government and voluntary organizations. Pandit Jawaharlal Nehru Udyog Kendra Pune, Parinili Project and Child Line are some of the NGOs. He is working as a volonteer at Panchyat Samiti, Latur on the project assessment of Mahatma Gandhi National Rural Employment Guarantee act. He possess the Experience of using Participatory Rural Appraisal (PRA) Tools such as Venn diagram, Social Mapping, Transect walk, Resources Mapping, Seasonal Calendar, Focus Group Discussion (FGDs).

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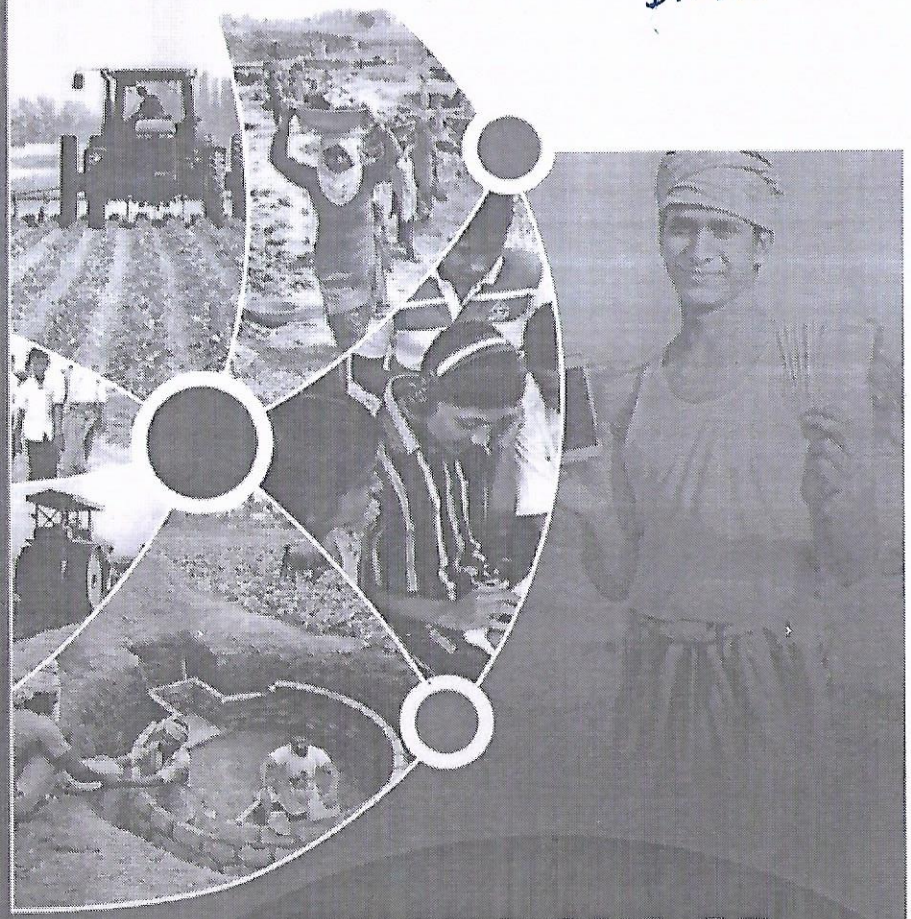

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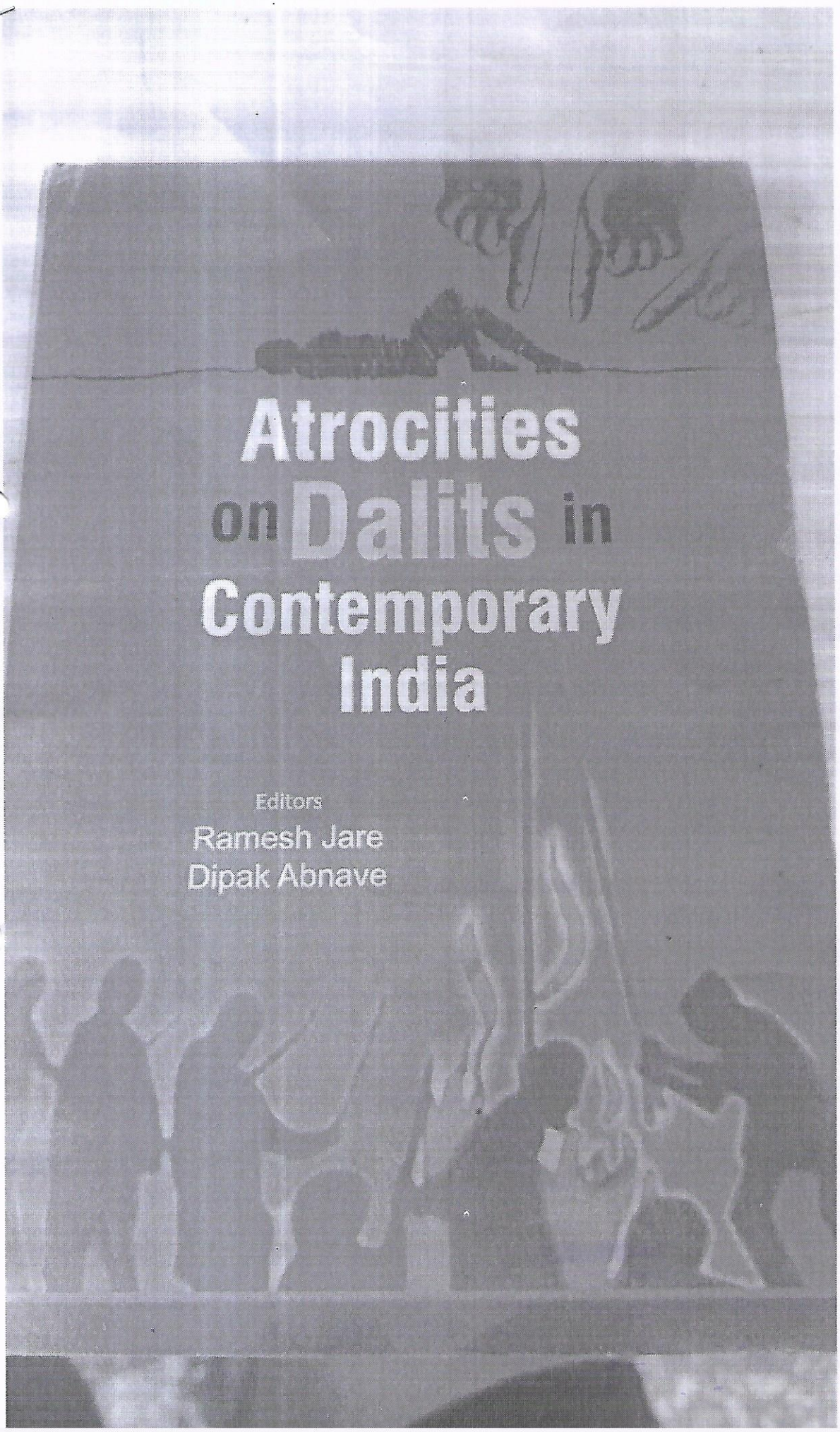

Neo-Buddhism[1] as a Form of Dalit Assertion in Maharashtra and Its Impact on Contemporary Indian Society

■ Dr. Kirtiraj D.C.*

Introduction

The Buddhist revival in modern India was started by Pandit Iyothee Thass way back in 1890 by converting the south Indian Tamil Dalits into Buddhism. However, the credit of resurgence of Buddhism in modern India goes to a Sri Lankan missionary Anagaric Dhammapa and the voice of India's voiceless Dr. B.R. Ambedkar. Anagaric Dhammpal mostly worked for freeing the Buddhist pilgrimages and sacred places located in northern part of India from the clutches of Hindu priestly class, Brahmins, while Dr Ambedkar dedicated his entire life to free the oppressed and downtrodden untouchables from the centuries of social, economic and cultural slavery of Hinduism by converting them into Buddhism and giving them a new identity as "Neo-Buddhist." Historic conversion led by Dr Ambedkar on 14, October, 1956, at Nagpur had dramatically increased the population of Buddhist in India from 180,823 in 1951 before conversion to 3,250,227 in 1961and 7, 955,207 in 2001, after conversion and the vast majority of them are from Maharashtra, the birthplace of Neo-Buddhism.

More than 50 years have passed for the realization of Neo-Buddhism in India and it is right time to look into what changes it had made in the lives of the millions of converted neo-Buddhist in India and ponder over

1. The Word Neo-Buddhism is used just for the purpose of convenience because it is known to the lay people. I do not mean to say that it something different than the Buddhism. In fact the word Buddhism and Neo-Buddhism are used in this paper interchangeably and they mean one and the same thing.

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Abstract

Metabolic syndrome (MS) is a cluster of risk factors, which further may lead to serious health problems such as cardiovascular diseases. These risk factors are the development of chronic inflammation, insulin resistance, oxidative stress, hypertension, and dyslipidemia, indicating disturbed metabolism. MS affects individuals not only physically but also psychologically and financially. Diet is one of the basic factors responsible for MS that can be easily modified. Mediterranean diet pattern especially inclusion of extra-virgin olive oil (EVOO) is considered to promote health. Here, we have discussed dysregulated metabolic pathways in MS and their modulation by treatment with EVOO.

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Keywords

Dyslipidemia; extra-virgin olive oil; hypertension; inflammation; insulin resistance; oxidative stress; metabolic syndrome

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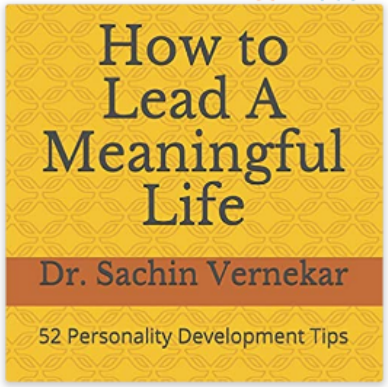

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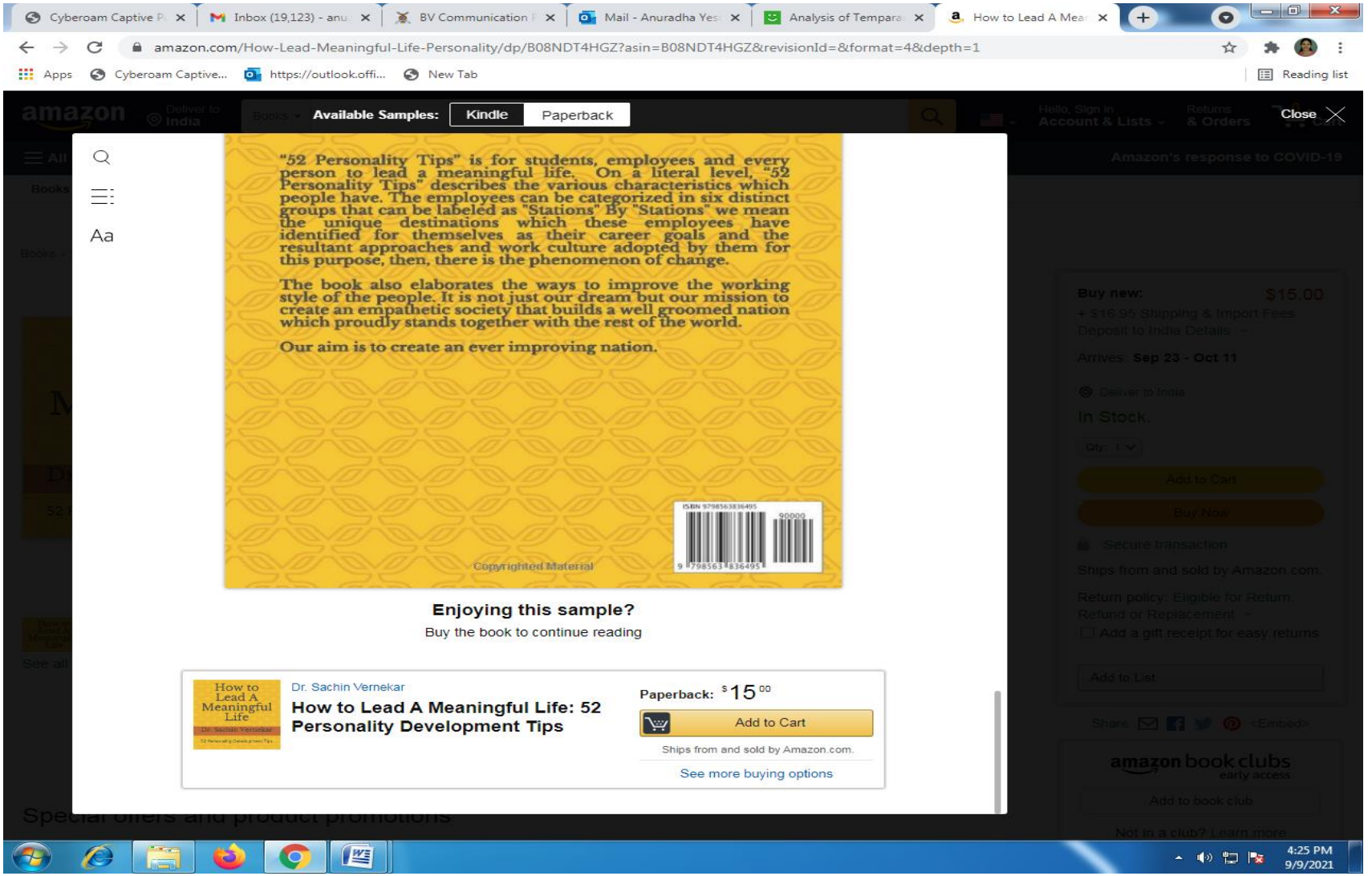
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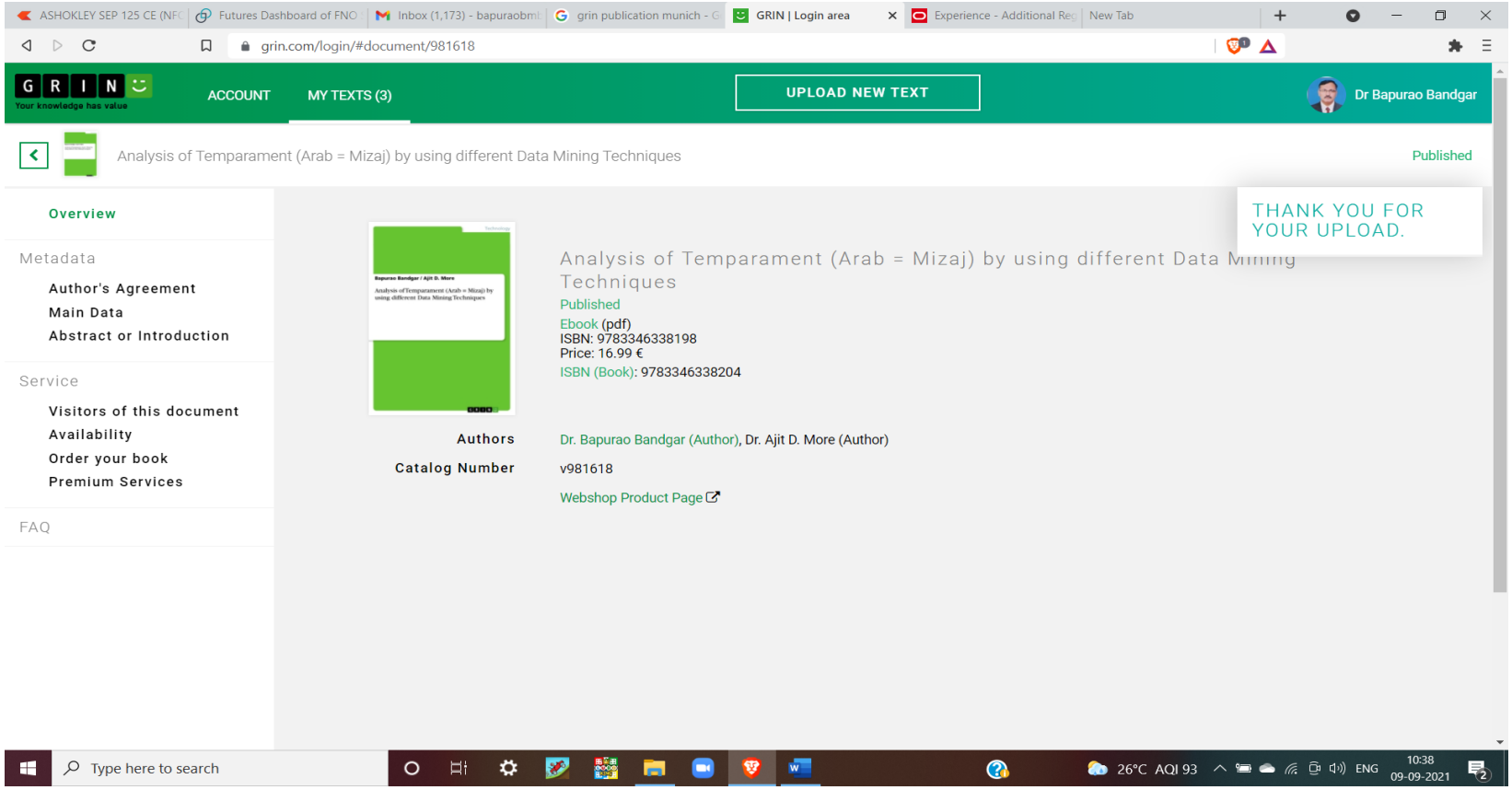
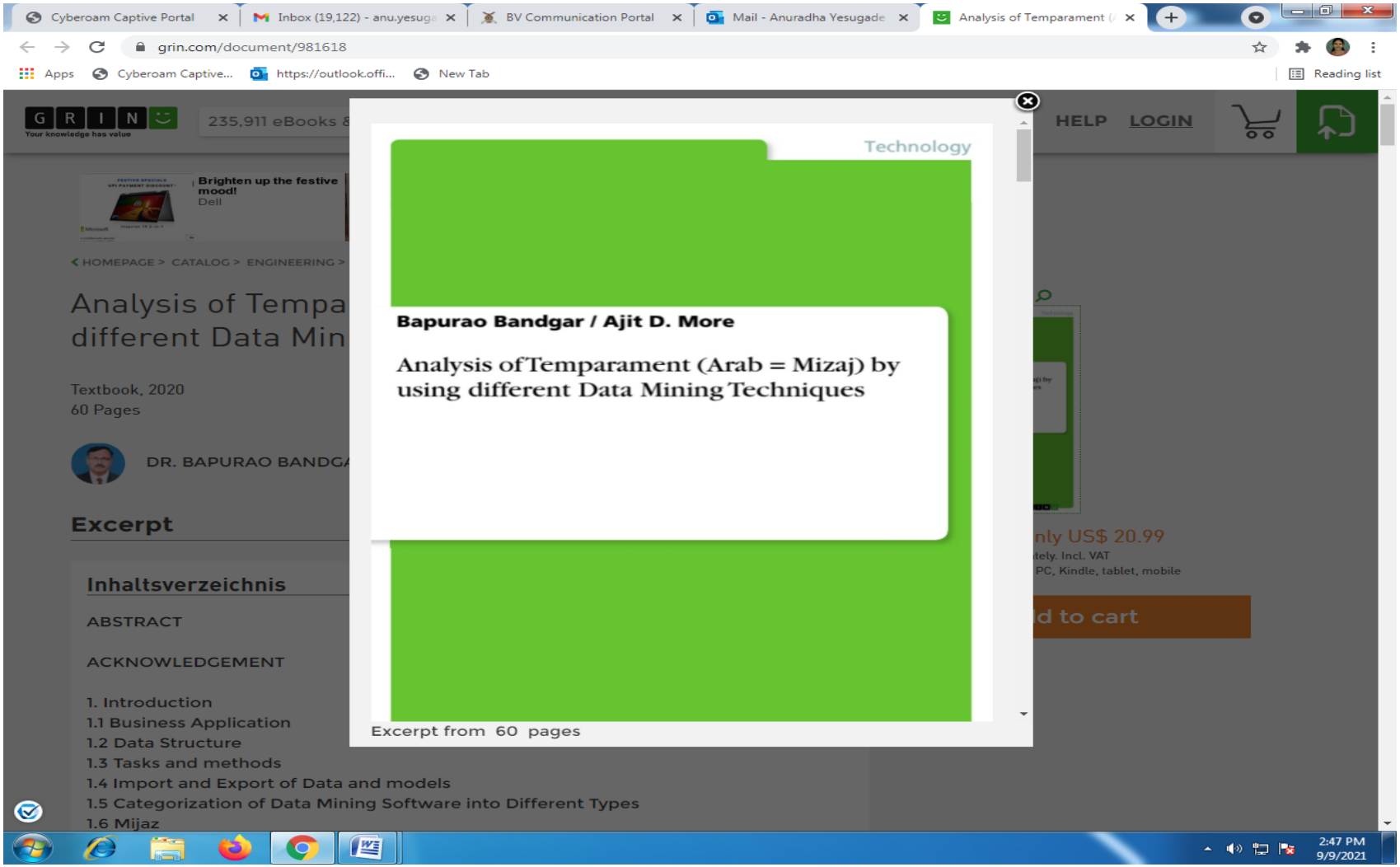
- 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***Abstract*—Data science is a blanket term for Machine learning, Artificial Intelligence and Big Data. Data science is being used by commercial and noncommercial organizations to get the insides of their customers, their behavior about selecting a product, insides of the staff. Many of the organizations use data science to provide better services to their customers. Financial Institutions use data science to analyze and predict stock markets, determine the risk of lending money, and learn how to attract new clients for their service. Government organizations get inside of public services by using data science and also use data structures to provide better services to citizens. Universities use data science to improve research and enhance study experience of students. Data grows exponentially over the period of time. The problem of working on large data sets can be solved by using the adept algorithm for your problem, use different data structures, and by relying on tools and libraries. The three main data structures used in data science are sparse matrix, hash functions and tree structures. Python has many tools that can deal with large data sets. In reality most of the data which is stored in a relational database is structured data. Now days the data retrieve from most of the websites is not structured and cannot be used by the relational databases. This paper describes how different tools in Python can improve user experience and provide better services to customers by using appropriate data structure and algorithm. This user experience and the better services to the customer boost the business and hence it is important for business strategy and ensures quality of experience (QoE) for the delivery services to their users.**

Keywords—Machine Learning, Data Science,Python

I. INTRODUCTION: DIFFERENT FACETS OF DATA

Thegrowthofdataisexponentialduetodigitization of processes at various levels in organizations, business, industry and government. Data can be categorized as structured data, unstructured data, natural language,machine generated data, graph based data, audio, video, images and stream data. Structured data is traditional data which is easy to store in tables within databases and excel file. Structured query is generally used to manage and retrieve data from the database. Sometimes structured data like hierarchical data is difficult to store in traditional relational database managementsystem.

For example: family tree is one such example. It is difficult to fit unstructured data into a data model.Now-a-days World Wide Web is growing as a huge repository with high source of voluminous and heterogeneous information which continues to expand in size and complexity. But still Web pages are observed unstructured, semi-structured or asynchronous, which contains excess irrelevant information like advertisement, sponsored links, headers, footers etc[1]. The content of unstructured data is context based, for example: an email. An email has various structured elements like sender, receiver, title, subject and body. But, it is difficult to find number of students who have given a negative feedback about the English teacher. Natural language is specific unstructured data. The data models trained in one domain do not generalized well to the other domain.Graph Data Structure is used to represent the relationship between different data objects. Social networks can be easily represented by graph based data structures. LinkedIn, Twitter, social networks like Facebook use graph based data to see who you know and how you know them (i.e. through which thread). Special query language like SPARQL and CYPHERare used for query in graph baseddata structures. The data like audio, image and videos poses challenges for a data scientist because whatever is trivial for humans, turns out to be challenging forcomputers.

II. DATA SCIENCE PROCESS:

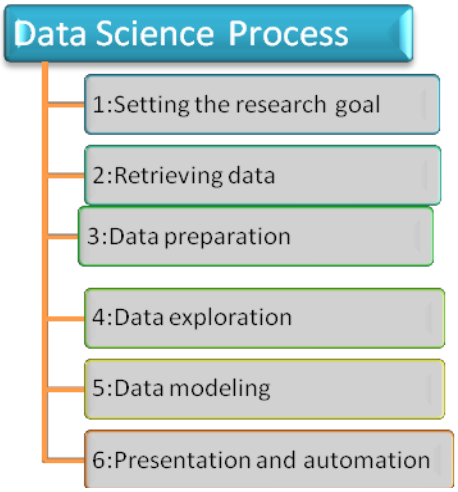

Figure 1: Overview of Data Science Process

Generally, data science process is applied for business logic in an organization as shown in figure 1. Data Scientist is asked to prepare a project charter in which he prepare what would be the research topic (research goal), how the company benefits from that, what data and sources you need, timetable anddeliverables.

The next step after finalizing the research goal is to collect the data. In this step ensure that the data that we are going to use in our program is available for usage. Therecan be many error in data during collection process. In the data preparation process data goes through data cleansing, data integration and data transformation before it is applied in your datamodel.

Data exploration provides the deeper understanding of data collected [2]. During data exploration the data scientists try to understand how variables communicate with each

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other and how distribution of data is done. During data exploration we get the insights of data. When these data insides are combined with domain knowledge, we can use it to create data models. Building a model is an iterative process which is not selecting a variable for the model, executed model and model diagnostics. The final step is to present the results to your business. Sometime we need to automate this whole process so that the inside gained in one project can be used by business in other project too.

III. MACHINE LEARNING AND DATASCIENCE

"Machine learning is a field of study that gives computer the ability to learn without being explicitly programmed."[3] This definition of machine learning is quite broad but leaves us with the question that how machines learn.

In machine learning, data scientist developed algorithms for a particular problem that can be used for large classes of learning problems. When we try to solve particular problem, we have to provide the specific data to the algorithm in context with the problem. If you train the algorithm with more data (" experience"), the machine becomes better as its designated job as it is done by human beings. For example, when a user write more text messages on a mobile phone, mobile phone learn more about the vocabulary we use and can easily predict the world's faster and more accurately.

Data scientist use regression and classification as primary methods [4]. The problem like finding oil fields, identifying profitable customers uses regression and classification. The problems like finding place name, recognizing board based on their whistle, predicting which team will win the football league uses classification. The problems like proactively identifying the car parts that are likely to fail, predicting the amount of money a person will spend onspecific product uses regression. A model can be created to provide the inside of underlying Problem. When a model is capable of giving a good interpretation then this model can be called as root cause analysis. For example a root cause analysis will not predict but determine the cause of the traffic jams. Regression and classification techniques are just one example; there are many other machine learning techniques that can be used in data scienceprocess. Universities use data science to enhance the study experience of the students [1].

A. Python tools @ MachineLearning:

Python has many packages that can be used in machine learning. First category of Packages like *SciPy, NumPy, Pandas, Scikit-learn, PPy2, NLTK*are mainly used in simple task and when data fits into memory. Second category of the packages like *Numba, PyCUDA, Cython help* to speed up the operations. Third category of packages like PySpark, Hadoopy helps in handling the big datainfrastructure.

B. Data modelingprocess:

The data modeling process consists of various steps like feature engineering and model selection, training the model, model validation and selection, applying the trained model to the unseen data [5]. Model has two types of variable predictors and response variables. The careful study of features we can easily identify the possible predictors for the model. Sometimes many of the features are the variables that we get from the data set. In practice, you have to find out the features that are scattered among different data sets. In some scenarios, you have to combine various data sets together to extract variables. Sometime output of a model becomes the part of another model. Sometimes we extract the only features that were available resulting into availability bias. These models fail when they go through a validity check. When the features are properly extracted, a model can be trained to the data. After training of data, your model should be checked through validation model. A good model should have good predictive power and it should generalize well to the data that it has not seen. There should be error measures to validate a model. Classification error rate is used for classification problems and mean squared error is used for regression problem. You can use many validation strategies like K-fold cross validation, leave-1 out, dividing your data into training set with X% of the observation and keeping the rest as holdout data set. Validation of your model ensures that your model will work in real life situation. After your model is validated, it is ready to processing the unseen data. The process of applying your model to the new data is called model scoring. Buy now, you trust your model enough to use it for real life scenarios.

C. Types of machinelearning:

Machine learning can we categories on the basis of Human efforts that are required to co-ordinate them. Human interactions are required to enable the data in supervised learning. In this technique patterns are identified in a labeled data set. On the other side unsupervised learning does not rely on the labeled data and attempt to find out patterns in a data set without human interactions. In semi supervised learning, labeled data is required and human interaction is also required to find the patterns in the dataset.

Sometimes application data outgrows and we need some techniques and tools to handle large data sets that are manageable. The following sections we will see some tools to perform classification and regression when the data is no longer bits into the RAM.

IV. HANDLING LARGE DATA SETS USING MACHINE LEARNING AND DATASCIENCE:

As the data grows in the system it becomes overhead on the memory and algorithms take more time to execute. Many algorithms are not designed to handle large data sets, delete the whole data into the memory at once.

Whenwetrytofitalldatainmemorywhichitcannothandle, the operating system will swap the memory blocks to hard disk, which is not efficient. Sometimes it results into out of memory error. Sometimes algorithm also needs to maintain multiple copies of the data in memory or store intermediate results in memory. This also aggravates the problem. Some algorithms taking reasonable amount of time when they need to handle huge amount of data and sometimes these algorithms take reasonable time to handle only a few megabytes of data. The problems that arise from large volume of data can be solved by using the correct algorithm, choosing the right data structure and using the right tools as shown in the following figure2:

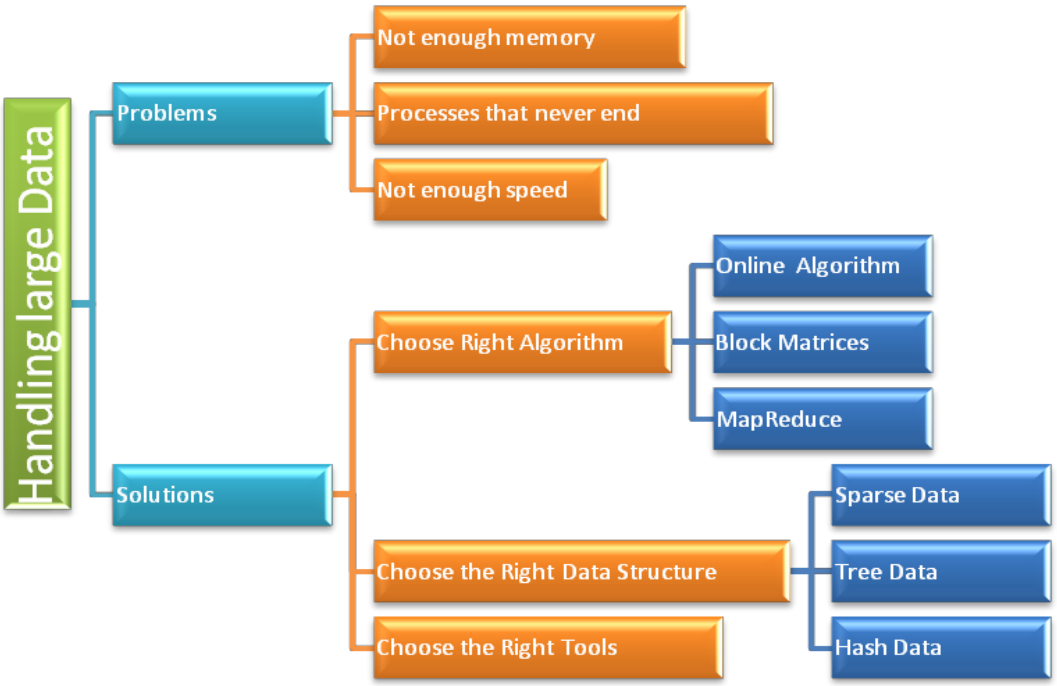

Figure 2: Overview of problems and solutions for handling large data sets

There are no specific solutions for the specific problems. For example data set compression can help in memory issues as data becomes smaller. But data compression also affects the computationspeed.

Choosing the **right algorithm** for the specific problem can solve many problems rather than having a better hardware. An algorithm that doesn't require the whole data to be in memory to make predictions about data is a good choice. We will discuss specifically about three types of algorithms: onlinealgorithms, block algorithms, and map-reducealgorithms.

An online learning algorithm doesn't require the whole data to be in memory at once. They require small packets of data for observation. Data can be presented in small batches (as small as a single observation), which enable you to go over the data multiple Times. We can **cut a large data set into the smaller matrix**, we can still do a linear regression over it. The Python libraries like *bcolz*store data array compactly and uses the hard drive and the array no longer fits into the main memory. *Dask*is a library that enables you to optimize the flow of calculations and make performing calculations in parallel easier.**MapReduce**also solve the problem by first mapping values to a key and then do and aggregation on that key during the reduce phase.

Selecting a right data structure improves the efficiency of data operation. The three data structures that improve the efficiency of data operation are sparse data, tree data, and hash data. This sparse data set contains relatively little information as compared to its entries/ observations. Luckily, sparse data can be stored in compact form. Python also supports the working with sparse matrix. Tree supports fast retrieval of data as compared to a tabledatabase.

Databases use indices which is based on data structure such as trees and hash tables to find observation faster. Hash tables are the data structures that calculate key for every value in your data and put the keys in a bucket. Various libraries in Python that help us to deal with large data sets areCython, Numexpr, Numba, Bcolz, Blaze, Theano,Dask.

A data scientist should use the tools and libraries developed by others rather than trying to reinvent these library by his own. You should use your machine to its full potential and you should slim down your memory and processing needs as much as possible.

Following section work on a simple research problem of building a recommender system for customers who have rented similar books as other customers and then suggest those that the others have read but you haven't seen yet.

V. BUILDING A RECOMMENDERSYSTEM:

This section discusses a recommender system where a customer and out a book from my library and the recommended system suggest him the books that others have watched but he has not seen them yet. The data science process explained in earlier sections is explored to find the solution for this research problem asfollowing:

A. Researchquestion:

Suppose you are working in a library and the librarian ask you if it is possible to use information on what boots people have rented to predict what other books they might like. Suppose data is stored in MySQL database to stop it is required to have a recommender system, an automated system that Learns people preferences and recommend books and other products the customers have not triedyet.

B.** Retrieving data**:

We have created the data our-self for this case study. So we can skip data-retrieval step and go ahead for data preparation.

C.** Datapreparation**:

The data is collected in following form as shown in the table 1. We have created this data ourselves for the sake of demonstration. "0" represent if the customer has not rented the book before. "1" represent if the customer has rendered the book before. The following Database represents the books rented by the customers (Table 1):

Table 1:Database represents the books rented by the customers

Column1	Book 1	Book 2	Book 3	Book 4	Books
Customer 1	1	0	1	1	1011
Customer 2	0	0	0	1	0001
Customer 3	1	1	0	0	1100

Comparing multiple columns to find out the customers who have rented out the similar books is an expensive operation, so we need another way to speed up this calculation. In every column the binary value 0 or 1 indicate whether the customer has rendered a book or not. We can concatenate the information so that the same information is contained in the new column as shown in the above table with the column “Books”.

What demonstration we created the data for hundred customers and randomly assigned whether they did or didn't read a particular movie and we have 32 books in total. Now we make an intermediate table suited for acquiring, we apply the hash functions and represent the sequence of bits as a decimal number. Finally you can place them in a table. First, you need to create a bit strings. You need to convert the string"11111111" to a binary or a numeric value to make the hamming function work we opted for a numeric representation as shown in the next listing. We represent the string as a numericvalue.

D. Creating a bit string:

We represent the string as a numeric value. The string will be a concatenation of zeros (0) and ones (1) because these indicate whether someone has read a book or not. The string are then regarded as bit code. For example: 0011 is the same as Number 3. In the current study, we take in 8 values, concatenates these eight column values and turns them into a string and then turn the byte code of the string into a number. Hence we will convert the information of 32 columns into four numbers be compressed it for later lookup. The following table 2 shows the first two observations in the new format Retreat from the old table shownabove:

Table2:firsttwoobservationsinthenewformatRetreat fromtheoldtableshownabove

Column1	Byte1	Byte 2	Byte 3	Byte 4
Customer 1	10	62	42	182
Customer 2	23	28	223	180
Customer 3	23	25	123	253

The next step is to create the Hash Function, because they will enable us to sample the data we will use to determine whether the two customers have the same behavior.

E. Creating a HashFunction:

The Hash Function will take the value of books who the customer as input. We are going to create 3 hash functions for this case study. The first function combines the books10, 5, and 18; the second Hash Function combine books 7, 18 and 22: and the third Hash Function combines 16, 19, and 30. We have picked these books specifically for this particular case study, this can be picked randomly also. Create hash values from customers books, respectively [10,15,28],[7,18,22],[16,19,30].

Hash Function concatenate the values from the different books into a binary value like what we did in the previous table. This time we have taken 3 books instead of 8 as input. For the first Hash Function, if the client has rented the book of 10 but not the 15 and 28, it will return value '100' and store this value to a bucket 1. When the client when did the book seven and 18, but not 22, it will return a value '110' and value in bucket 2. Based on these observations the above table can be defined as following (Table3):

Table3:Basedontheseobservationsthetable2canbe defined asfollowing

Column1	Byte1	Byte 2	Byte 3	Byte 4	Bucket1	Bucket2	Bucket3
Customer 1	10	62	42	182	011	100	011
Customer 2	23	28	223	180	001	111	001

The last time that we will apply is indexing the customer table so look up happen more quickly.

F. Adding an index to the table and modelbuilding:

Now you must add indices to speed up pretty well as needed in the real time system. After indexing we can now move on to the "model building part ".

G. Model Building:

In this case study, we will use a very simple technique: string distance calculation. Two strings can be compared using hamming distance. We have implemented a user defined function which can calculate the distance for 32 bit integer. Using hamming distance we can find out the similar customers for a given customer. Let us move to the next part i.e. utilizing our set up as a sort of application.

H. Presentation and automation:

Now we have gone through all the steps of data creation, data preparation and model building. Our application need to following Two Steps when a data of particular customer isavailable:

1. Find the customers with similarrecords.
2. Suggest the customer the books he has not yet, but other customers have seen who have the same history.

Let us try to use our system to find the customer similar to customer number 27 and give the recommendation to the customer number 27 for the book he can rent. We have done two level sampling. At first level, we are looking for the customers indexes who have the same as one of the selected customer.

This selection is based on the nine books that we selected for hash function. Selected customer must have seen or not seen these 9 books exactly like our customer did. Second level of Sampling is based on 4 byte string which takes into account the all books in the database.

The following resulting table4 shows the most similarcustomertocustomer 27.

Table 4: Most similar customer to customer 27

	Customer ID	Hamming Distance
1	27	0
2	2	8
3	97	9

The above table shows that customer 2 and 97 are similar to customer 27. Now the next step is to find the books that we can recommend to customer number 27 which he has not yet but his nearest customer has read. Hash indexes have helped in querying the large databases. First of all we need to select the books that customers 27, 2, and 97 have seen. Then we can find out the transpose from the 32books.Finallywecanfindoutthebooksthatcustomer 27 did not see yet. The following table 5 shows the recommended movie 12, 15 31 based on the customers 2 behavior:

Table5:showstherecommendedmovie12,15,31basedon thecustomers2behavior

	0	1	2
Customer ID	2	27	97
Book 3	0	1	1
Book 9	0	1	1
Book 11	0	1	1
Book 12	1	0	0
Book 15	1	0	0
Book 31	1	0	0

After getting this table, our book lover can now indulge in reading new books, tailored to his preferences.

VI. CONCLUSION:

Data science is designed to analyze small data sets to big data. Data can come in different forms and the new forms of data keep on evolving. The data science process involves selecting the research goal retrieving data, data preparation, data exploration, data modeling, its presentation and automation. Data scientist rely heavily on techniques from statistics and machine learning to perform their modeling. This paper analyzed different problems that you can run into when working with the large data sets and also suggested the solutions that you can apply to these problems like adapt the right algorithm, use different data structures and use smart tools and libraries frompython.

This paper discussed case study to give a recommendation to a customer on the basis of the data of books he rented from a library. We use the data science process including retrieving data, data preparation, data exploration, and data modeling and its presentation and automation for the customer data. This recommendation system can help the library owner to give customers a better experience while giving preferences to him for new book reading. This better customer experience will boost his business. Hence, we can say that data science is the key to business strategy.

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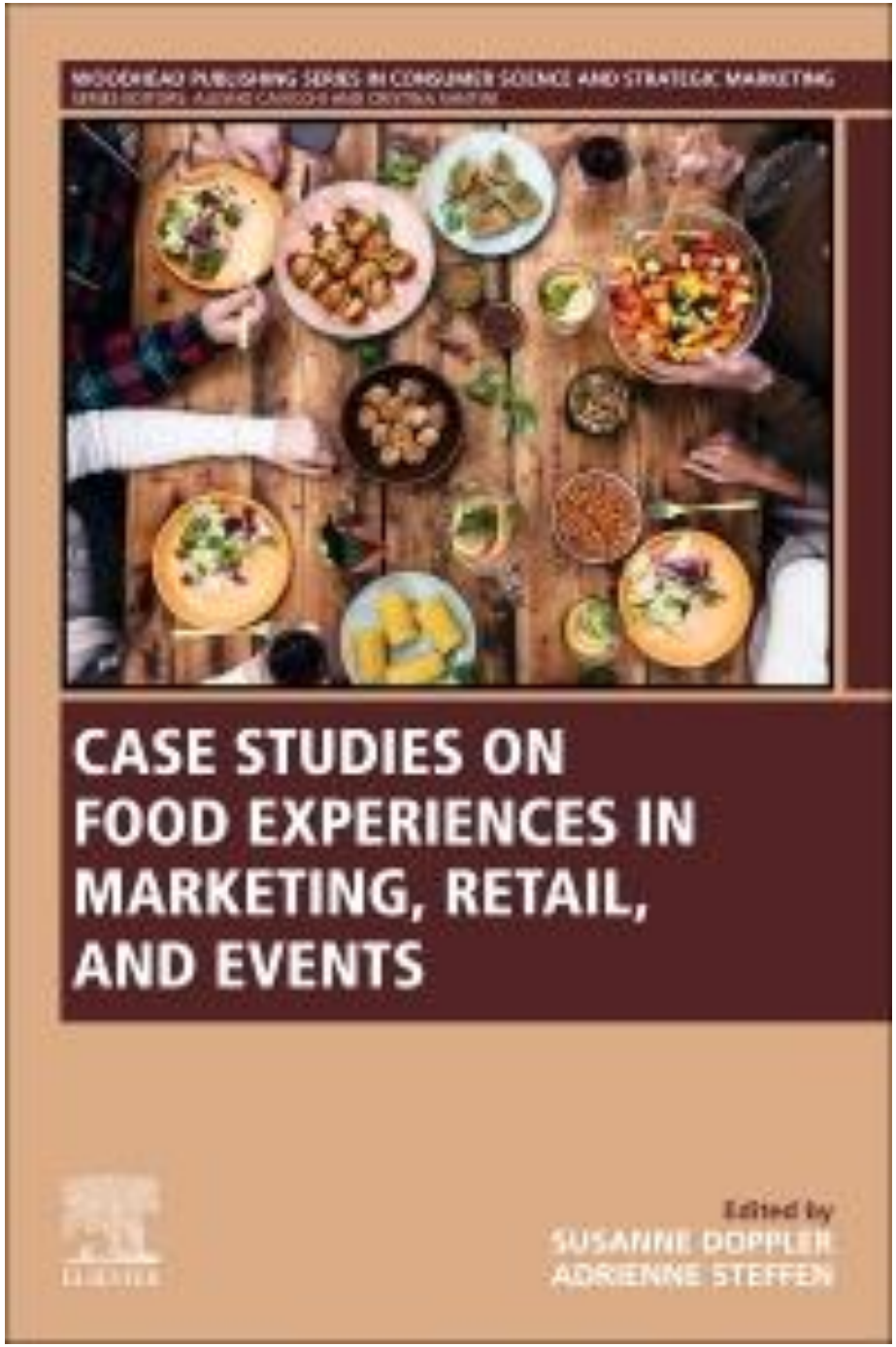

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1st Edition

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Promoting organic products in India: the case of Two Brothers Organic Farms

7

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7.1 Introduction

Awareness on and acceptance of the health benefits of consuming organically cultivated food is growing in the developed and developing world. Customers are now concerned about "where their food comes from" and "how it was produced" (Morgan, Marsden, & Murdoch, 2006). Buoyant by the resultant high demand for such "alternative" food led to the emergence of alternative food networks (AFN) in general and expansion of organic food markets in particular (Maye & Kirwan, 2010). It created opportunity for entrepreneurs who are interested in venturing into supplying authentic organically produced farm products. Realizing the potential of AFN the entrepreneurs of this case, siblings Mr. Satyajit Hange and Mr. Ajinkya Hange, decided to move into organic farming after having a successful stint with corporate world.

There exists a plethora of books and scholarly articles that deal with entrepreneurial outlook of the thriving cult of entrepreneurs who proved themselves in their domain. Nonetheless, in modern era that witnesses fast-paced societal changes, technology disruption, government's dynamic policy making, and ever-changing marketplace, it is imperative to conduct research in the field to keep the findings and propositions contemporary and relevant (Katz & Green, 2007; Kuratko & Hodgetts, 2007; Timmons & Spinelli, 2007). This case study is intended to infuse fresh blood in the entrepreneurship domain in general and organic-farming-entrepreneurship in particular.

7.2 Literature review

The growing population of developed countries led to "industrialization" of the agriculture sector where chemicals, such as petrol-based fertilizers and pesticides,

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Abstract:- Transportation system plays in vital role in deciding standard of life of the peoples of that nation. A good/efficient, safe road transportation system can broaden the goods market. Considering this national government of India is paying attention to broaden the road infrastructure in India. But along with betterment of physical infrastructure it is necessary to know plight of basic stakeholder of goods transportation through roads and they are truckers and transporters. Transportation through roads is facing challenges as well as opportunities due to changes in the situation because of demonetisation, e-way bill, GPS system, insurance and RTO issues, parking conditions etc. It was found that among these issues some are suiting/ favourable to road goods transportation while others have yet to be improved. This paper tries to bring it forward with the help of specimen study of a particular district in Maharashtra.

Keywords:- *Transportation, Goods, Road, E-Way Bill, Insurance.*

I. INTRODUCTION

Transportation system plays in vital role in deciding standard of life of the peoples of that nation. A good/efficient, safe road transportation system can broaden the goods market. The necessaries of production like raw material, fuel, machinery etc. movements of these are made easy by the efficient road transportation system. The distant and remote region become accessible and development becomes easier. In order to study and know the plight of transporters and the problems they are facing in real business life, it is decided to study it as a research problem.

❖ *Objectives of study*

- To know the present scenario of goods transportation through roads in India as well as in Sangli district.
- To know transporters opinion regarding issues faced by them such as demonetisation, insurance, e-way bill, GPS, parking facility etc.

❖ *Methodology of Study*

Sangli district is chosen to study transporters plight in India as a convenient sample. The district contains around 350 transporters. 18 transporters (5% sampling) were chosen randomly and interviewed. Along with this 3 key persons were interviewed. They are a member of All India Motor Transport Congress and two members of Sangli District Transportation Association. Their opinions are aggregated and the summary is discussed.

II. SCENARIO OF GOODS TRANSPORTATION BY ROADS IN INDIA

With 55 lakh kilometres of road, India is second in the world having largest road network. With government allowing 100% direct foreign investment in this sector, this sector is experiencing growth as many foreign companies collaborating Indian companies investing in this sector. With government policy support, many private players are entering into the business through PPP(public private partnership) model. The government's move to reduce GST rules from 28% to 18% on construction equipment is boosting the road industry.

Roads in India can be classified as below;

- Express Highways- They are 6 to 8 lane roads of good quality. Presently India contains around 1583 km. of express highways where passenger as well as goods transportation takes place.
- National Highways- The important road grid of the nation is national highways. It has total length of 66.8 thousand kilometres. Though they are 1.5% of total length of the road system, it takes burden of 40% of goods transportation.
- State Highways- Construction and maintenance of these roads is with state government. It has a total length of 154.5 thousand kilometres. It is around 3.87 of the total road length in India.
- District and Rural Roads- Lacs of kilometres of road are built in the country comes under this category. They are connecting villages and nearby towns. They are constructed under minimum need programme, Rural Landless Employee Guarantee Programme, National Rural Employment Programme, Command Area Development, Pradhan Mantri Gram Sadak Yojna etc.

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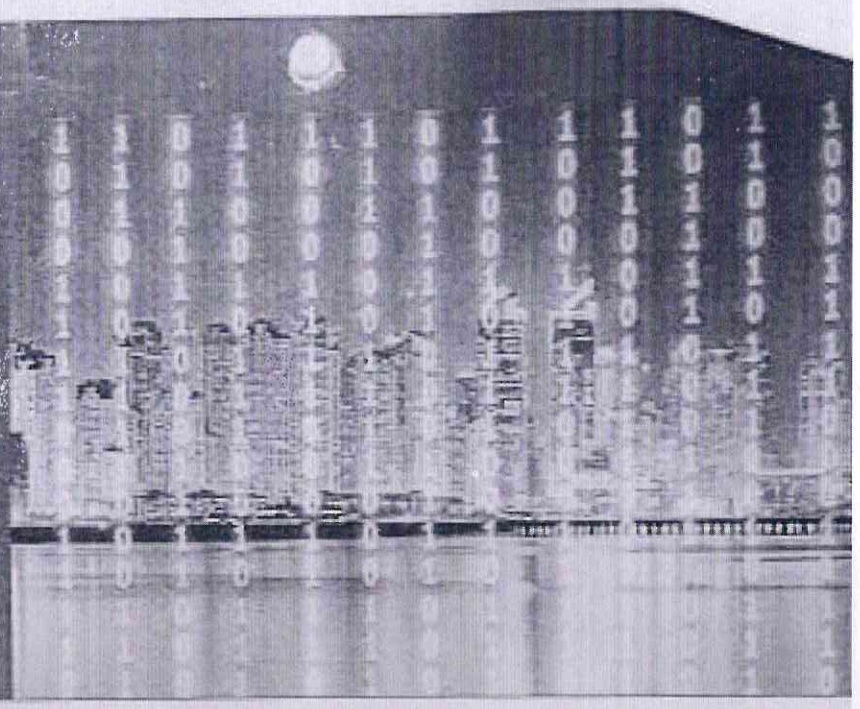

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